Introduction
This training manual is an electronic collection of information available from the Intranet and past training seminars. It was created to help Kadant employees learn the essentials needed to professionally and successfully sell and promote fluid handling products and services. The manual is an internal tool and should NOT be distributed outside of the organization.

Using the Electronic Training Manual
To use this manual, select any category and click on the desired link. The corresponding link will bring up the document, PowerPoint presentation, image, or tool that is available for the selected topic.

Additional product literature and disassembly and repair instructions are available on the Kadant website or Kadant Intranet. New information is always being added; the Intranet should be checked regularly to find the most current information.

1. Resources
1.1. Applications
   Description and Personnel

1.2. Business Development Managers
   Description and Contact Information

1.3. Customer Service
   Description
   Regional Map and Contact Information

1.4. Marketing
   Capabilities and Contact Information

1.5. Research and Development
   NPI (New Product Introduction)

2. Products

2.1. Accessories
   Overview Presentation
   Air and Steam Separators Description
   Flexible Metal Hose Description
   Sight Flow Indicator Description
   Vacuum Breaker Description

2.2. Cooling Rolls
   Description
   Presentation - Cooling Equipment
   Presentation - PTX™ Swing Dryer and Cooling Roll Configurations

2.3. Desuperheaters
   Presentation

2.4. Direct Steam Injection Heaters
   NPI (New Production Introduction)
   Presentation

2.5. Dryer Management
   Presentation

2.6. Liqui-Mover® Pumps
   Playbook
   Presentation - Economic Savings
   Presentation - Typical Applications
   Presentation - What is Stall?
2.7. **Rotary Joints and Unions** – Field Identification Guide available in section 4.4

5750SBAF Rotary Joints.
- NPI
- Presentation

BCI™ Rotary Joints
- Presentation

C-Cast™ Rotary Joints
- Presentation

CorrPro™ Rotary Joints
- Application Summary
- NPI
- Presentation

EL™ Rotary Joints
- Presentation - ELS Rotary Joints
- Presentation - 4” and 5” ELS Rotary Joints

G™ Rotary Unions
- Presentation

IC™ Rotary Joints
- Application summary
- Presentation

LJ™ Rotary Joints
- Presentation

OTS™ Rotary Unions
- NPI

Piston Type (PT™/PTX™) Rotary Joints
- Application Summary
- NPI
- Presentation - PTX Joints and Stationary Syphon
- Presentation - PT Upgrade Kits
- Presentation - PTN and PTXN Joints

RX™ Rotary Unions
- Application Summary
- NPI
- Presentation

SNX™ Rotary Joints
- NPI
SX™ Rotary Joints
   NPI
   Presentation
   Presentation - SX Rotary Joint with Adjustable Syphon

2.8. Syphons – Stationary

Elbows
   NPI – Pivot™ Body Syphon Elbow
   NPI – 45 Degree Locking Syphon Elbow
   Presentation - 45 Degree Locking Syphon Elbow
   NPI – Spring Locking Syphon Elbow
   Presentation - Spring Locking Syphon Elbow

Internally Supported Stationary Syphons (ISSS™)
   NPI - ISSS Overview
   NPI - Medium Speed Stationary Syphon
   Presentation

Cantilever Stationary Syphon (CSS™)
   NPI – PTX Rotary Joint and Stationary Syphon
   Presentation - PTX Joints and Stationary Syphon

2.9. Syphons - Rotary

   Rotary Scoop
   NPI
   Presentation
   Rotocurves (Journal Mounted Rotary - JMR)
   Traditional

2.10. Steam Systems

   Presentation - Defining Dryer Performance
   Presentation - Dryer Drainage Systems

2.11. Corrugator Steam Systems

2.12. Thermocompressors

   NPI

2.13. Turbulator® Tube™ Bars

   Application Summary
   NPI
   Presentation
   NPI – De-tuned™ Bars
   Presentation - De-tuned Turbulator Tube Bars
2.14. Yankee Dryer Products

NPI - Turbulator tube bars-Yankee Dryer Applications
Presentation - PT Joints for Yankee Dryers
Presentation - Yankee Dryer Steam Systems
Presentation - Yankee Dryer Design

3. Obsolete Products

3.1. Rotary Joints and Unions
Balanced Seal Rotary Joints
Impact Rotary Joints
S™ Rotary Joints - Upgrade to type SX rotary joints.
W™ Rotary Unions – Upgrade to type RX rotary unions.
WH™ Rotary Unions - Upgrade to type RX rotary unions
WR™ Rotary Unions – Upgrade to type RX rotary unions.

4. Markets

4.1. Corrugating
OEM Profiles

4.2. Converting and Printing

4.3. Food Processing
Overview - Dryers
Dryer OEM Profiles
Internal Training Presentation - Dryers

4.4. Machine Tool

4.5. Plastics
Internal Training Presentation

4.6. Pulp and Paper
Internal Training Presentation

4.7. Rubber
Internal Training Presentation

4.8. Steel
OEM Profiles

4.9. Synthetic Fiber and Textile
Internal Training Presentation
5. Miscellaneous

5.1. Basics of Fluid Presentation
5.2. Basics of Steam Presentation
5.3. Competition
5.4. Field Identification Guide
5.5. Hot Oil Joints
5.6. Inside the Dryer
   Presentation – Stationary and Rotary Syphon Applications
5.7. Rotary Joint and Union Overview
   Maintenance
   Nomenclature
   How to place an order
   Upgrades
Kadant Johnson Three Rivers Applications Group

The Applications Group provides the following sales support activities:
  - Evaluate inquiries and provide product recommendations
  - Provide technical support regarding KJ products and services
  - Prepare quotes for large and strategic projects
  - Project management
  - Proposal drawings
  - Assist Customer Service
  - RMA Support
  - Provide assistance developing solutions for challenging installations

Rick Lull
  - Paper industry focused to support product sales
  - Project Management for all markets
  - Customer Service support for Midwest and West

Erich Bernhardt
  - Liqui-Mover Sale Support
  - Customer Service support for Northeast

Field Service
  - Contract Services
  - Technical Support
  - Maintenance Planning
  - Turn-key Installation Services
  - Maintenance Services
  - Non-Destructive Testing (NDT)
  - Dryer Re-rating

Field Service Personnel
  - John Hotovy
  - Lloyd Mehaney
Business Development Group

Business Development Managers

- **Bob Tuesley**
  - Email: bob.tuesley@kadant.com
  - Phone: (269) 278-1715 ext 2200

- **Frank Marsden**
  - Email: frank.marsden@kadant.com
  - Phone: (269) 278-1715 ext 2201

- **Mike Sneary**
  - Email: mike.sneary@kadant.com
  - Phone: (269) 278-1715 ext 2202
What is Business Development?

- Take existing Kadant products
  - Excellent reputation in the Paper Industry

- Position these products in the Industrial Market
  - Leveraging existing relationships
    - Food/Chemical/Pharmaceutical/Steel

- Help develop existing product line

- Research new markets

Targets

- Corrugators
  - Steam Systems and Blades

- General Industry
  - Steam Systems & Thermocompressors

- Solution Mining

- Filtration
  - Hot Oil (Sell 300+ joints/year)

- Steam Profiling
  - Existing installed base
  - Sell Unions
## Summary

- **Support and promote all Kadant products**
- **Continue to work alongside DSM’s offering:**
  - Sales support
  - Product support
  - Technical assistance
  - Training
- **Continue to work independently to develop:**
  - New markets
  - Key accounts
CUSTOMER SERVICE GROUP

Customer Service is responsible for order fulfillment, including working with our Representatives and customers to help resolve questions/problems concerning orders, products and related services.

Our Customer Service Representatives (CSRs) are assigned to geographic locations that correspond to the (4) different regions. If your CSR is not available when you call, ask for their back up (see the attached Customer Service Regions map for your CSR’s name and their back-up).

Customer Service answers questions regarding product availability, pricing (but NOT for “Machine” quotes), shipping schedules, order status, product identification, shipment tracking and Returned Goods (RMA). We will also prepare and send non-machine quotes for you but you must provide the “who, what and how much” information.

As to Technical Support, Customer Service can usually cross-reference competitor’s joints to Kadant Johnson models, if provided with the make, model number, service and other particulars. We don’t do joint sizing, applications or “Machine” quotes. These requests are forwarded to the Applications Group.

Customer Service can usually provide customer “history” – in some cases, back to the 1970s or earlier.

After-hours Emergency service is available by calling 269-278-1715, pressing “4” when prompted and then leaving a message (which includes particulars as to type of problem, name and phone number). Your call will be returned ASAP.
February 9, 2012

Customer Service Regions

- **NORTHEAST**
  - MARGARET/ JAN
  - beth.parsons@kadant.com - (269) 273-3076, ext. 2135
  - jan.walter@kadant.com - (269) 273-3076, ext. 2208

- **SOUTHEAST**
  - BILL/ JAN
  - bill.hasbrouck@kadant.com - (269) 273-3076, ext. 2122
  - jan.walter@kadant.com - (269) 273-3076, ext. 2208

- **WEST**
  - BETH/ JAN
  - beth.parsons@kadant.com - (269) 273-3076, ext. 2135
  - jan.walter@kadant.com - (269) 273-3076, ext. 2208

- **MIDWEST**
  - BETH/ JAN
  - beth.parsons@kadant.com - (269) 273-3076, ext. 2135
  - jan.walter@kadant.com - (269) 273-3076, ext. 2208
Contact Information

• Wes Martz
  Email: wes.martz@kadant.com
  Phone: (269) 278-1715 ext 2263

• Danielle Rohrer
  Email: danielle.rohrer@kadant.com
  Phone: (269) 278-1715 ext 2261

• Gayle Van Heukelum
  Email: gayle.vanheukelum@kadant.com
  Phone: (269) 278-1715 ext 2262

• Jan Walter
  Email: jan.walter@kadant.com
  Phone: (269) 278-1715 ext 2208

• Kandi Hagenbuch
  Email: kandi.hagenbuch@kadant.com
  Phone: (269) 278-1715 ext 2268

• Sally Mast
  Email: sally.mast@kadant.com
  Phone: (269) 278-1715 ext 2265

Marketing Focus

Support Kadant’s initiatives to profitably increase sales revenue in both the Industrial and Paper market segments

Create, nurture, and sustain customers
Strategic Marketing

• New Market Development
  – Market evaluation checklist

  Define market characteristics
  Identify organization fit
  Synthesize data
  Make evaluative conclusion
  Product Development
  Marketing actions

Strategic Marketing

• Target Marketing and Positioning
  – Brand awareness
  – Lead generation
Marketing Communications

- **Internet marketing**
  - Google keywords, ThomasNet, online catalog
- **PR and editorial features**
  - Press releases, articles, white papers
- **Product advertising**
Marketing Services

• Direct Sales Support
  – Intranet
    • Sell sheets, brochures, catalogs
    • Newsletters, articles
    • CMM (Customer Message Management) material
    • Sales presentations
  – Installation and Repair Manuals
  – New Product Introduction (NPI) packages
    • Product/Technical Overview
    • Selling Strategies
    • Competitive Offerings
    • Ordering and Pricing Information
General Customer Availability:

<table>
<thead>
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<th>Ready for Promotion Date:</th>
<th>Now</th>
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<tbody>
<tr>
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<td>Now</td>
</tr>
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The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

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<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>01 Dec 08</td>
<td>All</td>
<td>General updates; corrugator roll addition</td>
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Service Description

Kadant Johnson has the most unique paper machine dryer and corrugator roll testing facility in the world. Kadant Johnson has invested millions of dollars in this Research Center, not only to support internal development work, but also to promote the sales of joints and syphons by solving unique customer problems. The challenge is to find ways to get customers to run trials in Three Rivers, to improve the chance of Kadant Johnson getting orders.

A good way to generate sales is to get the customer to visit Three Rivers and see what Kadant Johnson has to offer. The probability of getting an order is greatly increased when the customer has attended a Kadant Johnson Drying Seminar, when he has visited Three Rivers for a technical meeting, or when he has participated in a dryer or corrugator roll trial at the Research Center. Competitors can duplicate seminars and technical meetings, but none can run dryer or corrugator roll trials.

Unique Selling Proposition

Kadant Johnson helps its customers optimize dryer section and corrugator performance using its process knowledge and extensive understanding of steam and condensate systems. Supported by a focused R&D commitment and a global sales and service network, Kadant Johnson is the single-source for optimization.

Things to do at Research

Following is a sampling of the activities that can be used to bring a customer to the Kadant Johnson Research Center:

1. A customer can take the steam and condensate equipment alternatives for a “test drive” before it is purchased. No other supplier can offer this.

2. Practice installation of joints, syphons, and bars. The Joco 4000 and Joco 6000 dryers can be used for this, or the half-dryer cylinder can be used for larger groups (or larger people!).

3. Factory Certification for installation and maintenance crews for Kadant Johnson equipment. Confined space entry training.

4. Heat transfer comparison, before and after installation of Kadant Johnson equipment, such as Turbulator® bars, stationary syphons, and rotating syphons.

5. Control and adjustment of dryer edge temperature profiles.

6. Evaluation of blow-through characteristics for specific syphon and dryer configurations.

7. Evaluation of dryer drive and torque requirements over a wide range of operating and non-production conditions.

8. Evaluation of drying capacity using detailed dryer simulation programs.

9. Demonstration of the potential for reducing energy consumption (reduced venting, less vacuum condenser flow, lower steam pressures) by installing new joints, syphons, and Turbulator bars.

10. Provide education on the behavior of condensate in the dryer under a wide range of machine conditions. The behavior is monitored live, with a closed circuit TV, and indirectly with measurement of dryer surface and corrugator roll surface temperatures, condensing loads, steam pressures, and drive power.

11. Measure roll surface temperature response to changes in pressure, heat load, or speed.

12. Demonstrate advanced steam system control strategies.
**Service Description**

**JOCO 6000**
- Dryer: 72” diameter x 345” face (1.8 m x 8.76 m)
- Pressure: 160 psig (11 bar)
- Speed: 6000 fpm (1830 mpm)
- Condensing Load: 10 lb/ft²-hr (49 kg/m²-hr)
- Service: Steam
- Video: Digital color camera mounted inside the dryer

**JOCO 4000**
- Dryer: 60” diameter x 250” face (1.5 m x 6.35 m)
- Pressure: 160 psig (11 bar)
- Speed: 4000 fpm (1220 mpm)
- Condensing Load: 10 lb/ft²-hr (49 kg/m²-hr)
- Service: Steam
- Video: Digital color camera mounted inside the dryer

**JOCO 2000**
- Corrugator roll: 20” diameter x 104” face (0.5 m x 2.63 m)
- Pressure: 200 psig (13.8 bar)
- Speed: 2000 fpm (610 mpm)
- Condensing Load: 6 lb/ft²-hr (30 kg/m²-hr)
- Service: Steam
- Video: Digital color camera mounted inside the roll
Targeted Customers and Applications

Target customers for the Kadant Johnson Research Center are characterized by:

- Runnability issues
- Dryer limited production
- Chronic flooding
- Rebuild project under consideration
- Machine speed increase project
- The need to reduce energy consumption
- The desire to improve operating efficiencies
- Large moisture or temperature profile deviations
- Variations in heat transfer rates
- Wet edges
- Dry edges
Selling Strategy

When talking to production supervisors, focus on:

- The ability to test drive corrugator roll or dryer equipment before the purchase
- The opportunity to improve operating efficiencies and reduce operating costs
- The ability to look inside the corrugator roll or dryer at the mill’s operating conditions

When talking to maintenance supervisors, focus on:

- Installation and maintenance best practices
- Reduced maintenance time due to factory-certified training and proper installation
- Local entertainment

Procedures for Scheduling a Trial

1. The first step in scheduling a trial is to identify the goals. Is the objective to increase drying capacity, reduce steam pressures, reduce energy consumption, decrease drive loads, improve cross-machine profiles, reduce picking, increase thermal response, avoid flooding dryers, increase speed over rimming, observe the installation of equipment, to get Factory Certification for installation and maintenance, for general education, or just take the equipment for a spin?

2. Before the trials, the basic machine operating data should be obtained for the subject machine (Green Sheet data for paper machines; roll speed, roll width, steam pressure, and syphon and joint equipment for single facers).

3. Trials should be arranged through the Kadant Johnson Regional Sales Manager, to ensure the cost of the trials is handled appropriately. The RSM should contact Jerry Timm (jerry.timm@kadant.com) or 269-273-3076 ext 2352) who will then enter the appropriate trial request and schedule the trials.

4. The RSM / Sales Representative is responsible for coordinating travel and lodging logistics for the customer. It is best to accompany the customer to the trials, handle the hotel and ground transportation, and arrange for meals.

5. The RSM / Sales Representative should plan on being with the customer at the Research Center for the entire duration of the trials.

6. Because of the slow pace of corrugator and dryer trials (waiting for the heat transfer to stabilize), it is also good to arrange for a short technical presentation in the auditorium during the trial days. These presentations can cover the range of Kadant Johnson products and services.
Customer Attendance

It is important that the customer comes to Three Rivers for dryer trials. It is quite common to find that neither Kadant Johnson nor the customer really understands the problems, objectives, and options, until the customer has a chance to talk at length with the drying and heat transfer experts.

Direct one-on-one, on-site time is critical in tailoring the trial plan, conducting the trials, proposing the best solution to the problems, and meeting the real needs of the customer. The customer’s input is also needed during the trial program, to modify the program as it progresses. These are all good reasons to have the customer present during the trials.

Customer trials also present a unique opportunity for Kadant Johnson Sales to establish relationships with its customers, but this only happens when the customer is present.

Charging for Dryer Trials

Kadant Johnson has historically not charged customers for trial time. Charging for customer trials is a unique way to “set the hook” on a customer for a machine upgrade, to put value on the trials, to show distinction from the offerings of our competitors, and to minimize “window shopping” or conducting research for our competitors. Once the customer has made an investment in Kadant Johnson technology, and particularly if there is a financial credit from trial charges that can be used to purchase Kadant Johnson equipment, the probability of getting an order is significantly improved. Charging for machine trials is a common tactic used by paper machinery builders.

Giving away dryer trials is similar to giving a customer a trial joint to put on his machine. Kadant Johnson could just give the joint away, whether or not the customer elects to put it on his machine. Deublin has done this in the past. This is not very smart. Instead, it is best to invoice the customer for the trial joints.

In a similar way, dryer or corrugator roll trial time can be quoted to a customer at its value (about $10,000 per day). This clearly defines the value of the offering, as a premium above the bare equipment offerings of the competition.

Charging a customer for trial time should be part of a sales strategy. This is at the disposal of each Regional Sales Manager, to use to his advantage. The RSM has the options to:

- Charge the customer for the trials
- Discount the charges for the trials, based on previous business
- Apply the payment to a pending order
- Waive payment of the charges, based on previous business

The Research group routinely delays internal development work for customer trials. The RSM is responsible for ensuring that Kadant Johnson will get a corresponding return for its investments in running these trials.
Standard Charge

The standard charge for running dryer or corrugator roll trials at the Kadant Johnson Research Center dryer is $10,000 per day. When an RSM quotes or charges a customer, this is the rate that should be used. This charge includes the cost of installing the specified dryer equipment, utilities (gas, electric, and water), running internal pre-trials (when necessary), engineering and technical support during the trials, and engineering time for preparing a formal report of the trial results. In some cases, the charge for special equipment may be added to the standard daily rate.

These trial costs are incurred each time a trial is ran—even when Kadant Johnson elects not to charge the customer.

Guidelines for Charges

Following are suggested guidelines for charging customers for these trials:

1. Before scheduling a trial, ask the important question: “What’s in it for Kadant Johnson?” The cost for running trials at the Kadant Johnson Research Center is $10,000 per day. This cost can be charged to an order, but there must be an order to charge it to.

2. If the trials were part of a capital equipment order (over $250,000), the charges for the Research trials would normally be waived.

3. If the trials are used to compare equipment to support a decision for purchase, Kadant Johnson Sales should invoice for the number of trial days. This payment can then be applied to the purchase of Kadant Johnson equipment. This provides an incentive to purchase from Kadant Johnson.

4. If trials are conducted in support of customer problems, but there is no order for equipment pending, the charge for the trials could be waived, but only if a designated representative of the customer attends the trials. This gives the opportunity to establish customer relationships that may be useful later.

5. Kadant Johnson Sales should be very cautious in offering trial time to customers who cannot afford the time to come to Three Rivers to participate in the trials. If a customer does not have the time or the funds to evaluate joint and syphon equipment for a $250,000 project, he probably is not going to pay a premium for it. If a customer will take time to come to the Kadant Johnson Research Center, it is clear that he is serious and Kadant Johnson will have an excellent chance to sell.

6. The Kadant Johnson Sales Representative should also attend the trials, to take advantage of the opportunity to develop the customer relationships and to provide coordination of the logistics and commercial issues.

7. Sales should qualify customers in advance, to be sure that the customer is a real customer, not just a window shopper! We do not want to be running tests to identify a solution to a problem and then have a purchasing agent at the mill just go to the equipment supplier with the lowest cost.

8. If a mill budget is indeed too tight to support a visit to Three Rivers, it may still be useful to offer the Research trials, just to show the depth of Kadant Johnson capabilities in comparison to the competition. The decision is left to the RSM.
Sales Strategy

Sales Collateral / Reference Material

Bulletins / Brochures

Kadant Johnson R&D Bulletin

Technical Papers from Kadant Johnson

- Drive Power and Torque Requirements for Paper Machine Dryers
- Vibration Characteristics of Cantilever Stationary Syphons
- Dryer Response Characteristics
- Improved Dryer Control

Can-by-Can calculations to show potential for upgrades

Travel directions and reservation assistance
Services

Professional Services

One of the most effective ways to sell Kadant Johnson products and solutions is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the Kadant Johnson equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

Ordering Information

General Customer Availability

<table>
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<th>Ready for Promotion:</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Scheduling:</td>
<td>Now</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead-time for scheduling a customer trial is four weeks. However, Kadant Johnson Research will be made available when needed by the customer.

Pricing

See “Guidelines for Charging” in the previous section.

Required Information to Schedule a Customer Trial

- Green Sheet data for machine under review
- Purpose of trial
- Available dates for testing

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson Inc.
Rotary Joint Accessories

Flanges
Insulating Sleeves
Supports

Threaded Adapter Flange
‘Q’ Journal Flange and ‘Q’ Nipple Flange

- Replacing RH & LH nipples w/ Q’s reduces inventory
- Nipple flange gets bolted to the journal flange and wedges against a split ring, locking the nipple into place

Threaded to ‘Q’ Conversion Flanges
Double ‘Q’ Flange

End of the roll journal is machined similar to a quick release nipple

Reversing Journal Flange

Reverses the flow of the medium in applications with outlet pressure significantly greater than the inlet pressure
Insulating Sleeve

The steam insulating sleeve provides air space between the steam flow and the bearings.

Generic recommendation for applications above 75psi *

*Check with bearing supplier
Horizontal Pipe Supports

- Internal Spider Support Flange
- External Spider Support Flange

Internal Spider Flange
Supports horizontal pipe internally and can be installed with or without an insulating sleeve
External Spider Flange

Rotary Joint Support Accessories

- Support rods
- Support stands
- Support brackets
Support Rods

- Threaded or unthreaded rods
- When combined with support stands or brackets, external support arrangement is created

Support Stands

- Fastened to brackets, shelves, or machine framing
- Used to install rod supported joints
Support Tees

- Fastened to threaded rods to support the rotary joint
- Offer less rigid support than support stands

Support Brackets

- Support the rotary joint from below or above
- Attaches to machine framework, bearing cover, or gear cover for external support

*Internally Compensated (IC) Joint*
Ring Bracket-Supported

PT joint for stationary syphon service

LN-IC joint for rotary syphon service

Miscellaneous Accessory Products

Sight Flow Indicators
Flexible Hose
Vacuum Breakers
Separators
Liqui-mover® Pumps
Sight-Flow Indicator: Port Hole Series

- Rated to 150 psig
- 1” to 4”
- Bronze or ductile iron
- Condensate service up to 75 psig

Type PSFS, PSFF

Sight-Flow Indicator: Thru-Flow Series

- Rated to 150 psig
- 1” to 3”
- Bronze or ductile iron

Type TSF
Sight-Flow Indicator: Dome Series

- Rated to 150 psig
- 3/8” to 1-1/4”
- Bronze or ductile iron
- Not recommended for condensate service

Type DRS, DRSF

Flexible Hose

- Stainless steel braided hose
- ¼” to 8”
- Threaded or flanged
- Self supported rotary joints
- Rod supported rotary joints
- Two pieces of flex hose per connection
Good Piping Example

Vacuum Breakers

- 3/8” to 1-1/2” sizes
- Brass or 303 stainless
- 300 PSIG
- 365° F
Vacuum Required to Open

Vacuum Breaker Sizing

NOTE: Capacities will vary slightly due to position of installation.
Separators

• Three elements of separation
  – Abrupt direction change
  – Filtration
  – Expansion
• Removes 99% of all entrained moisture and solids in a steam service system

Separators

• 3/8” to 4”
• Steam or compressed air
• Screens
  – bronze-steam applications
  – aluminum-air applications
  – stainless-air or steam applications
Separators – Type SA

- Steam or compressed air
- Ductile iron construction
- 3/8” to 2”
- 340 psig

Separators – Type SA w/ Float

- Integral drain/trap
- ¾” to 2” sizes
Separators – Type SF

- 3” or 4” flanged
- Class 150 or 300 flanges
- Gauge glass optional

Liqui-Mover® Pumps

- Uses steam under pressure as the motive force to lift or pump liquids
- Has fewer parts than conventional pumps
  - Increases reliability
How they work...

Framed Liqui-Mover Pump with Receiver & Piping
Liqui-Mover Pump with Vertical Tank, No Frame
# Kadant Johnson Inc.

## Air and Steam Separators

### PRODUCT FUNCTION

Separation devices provide clean air or clean steam for compressed air equipment or steam service systems by removing moisture and contaminants.

### HOW IT WORKS

**Kadant Johnson integrates the three separating functions of expansion, abrupt direction change, and filtration in its separators.** Vapor entering the separator is forced to change directions many times by negotiating several layers of coarse mesh wire screen. Immediately following filtration, the air or steam enters the expansion chamber. Together these functions isolate and capture up to 99% of the precipitate. Foreign particles are “knocked” out of the air or steam to settle in the bottom of the separator, where they are removed.

### KEY ELEMENTS OF PRODUCT LINE WHICH DISTINGUISH MODELS

<table>
<thead>
<tr>
<th>Separator Body</th>
<th>Constructed of ductile iron, maximum pressure 340 PSIG, maximum temperature 650°F, also may be furnished in bronze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasket</td>
<td>Standard for gasket is 500°F, or 650°F for grafoil gasket</td>
</tr>
<tr>
<td>Screen</td>
<td>Constructed of bronze for steam and aluminum for air. Stainless steel is also available.</td>
</tr>
<tr>
<td>Size</td>
<td>Range from 3/8” to 4”</td>
</tr>
<tr>
<td>Connections</td>
<td>Screwed connections for separator sizes up to and including 2”; flanged connections for separator sizes 3” and 4”; 150# or 300# drilling available.</td>
</tr>
</tbody>
</table>
KEY APPLICATION CHARACTERISTICS

Separation devices are designed for use in steam service and pneumatic applications. The operating efficiency of all pneumatic equipment is increased by clean, dry air. Contaminants, such as moisture, pipe scale, dirt, and oil, foul air nozzles and paint spraying equipment. They also deteriorate air hoses and pipes. These contaminants can easily be eliminated by installing a Kadant Johnson separator.

Operating efficiencies in steam service are increased by cleaner, drier steam. A Kadant Johnson separator can remove over 99% of all contaminants wherever steam is used and will effectively reduce downtime and high maintenance costs.

INSTALLATION/MAINTENANCE CONSIDERATIONS

Kadant Johnson separators are best used close to work stations and not on the main supply line.

Compressed air separators should be installed as close to the point of use as possible, to take advantage of all possible temperature drops in the piping. If the piping is warm, the separator cannot function and an aftercooler will be required.

Decrease the flow rate to optimize separation.

Maximum flow rate is 10,000 FPM, with 6,000 to 8,000 FPM being the best maximum flow rate.

Periodically check the screen for clogging and replace if necessary.

An indication of clogging will be increased pressure drop across the device.

SPECIFICATIONS

- Maximum pressure is 340 PSIG for all standard air and steam separators (separators can be furnished for higher pressure service, please consult the factory)
- Maximum temperature is 650°F for all standard air and steam separators

HOW TO ORDER

The Kadant Johnson Sales Representative will size the separation device for a customer’s application before ordering. To size, consult factory for required customer data.

The following information is required by Kadant Johnson to order a separation device:

- Model type and size.
- Type of service (air or steam).
PRODUCT FUNCTION

Flexible metal hose is used as inlet and outlet connections to Kadant Johnson rotary joints and unions. It is used to prevent pipe strains from creating stress on the rotary joint and limiting the rotary joint’s built-in flexibility.

HOW IT WORKS

Flexible metal hose keeps pipe strains from crowding the rotary joint and does not restrict movement, thus allowing the rotary joint to maintain its built-in flexibility. The hose is constructed entirely of metal, with a corrugated liner that is fully armored with metal braid.

The couplings are double welded to the hose to make the joint stronger than the hose itself. First, the sleeve is slipped over the end of the hose and welded to it. Then, the fitting (threaded nipple or flange) is welded into position.

KEY ELEMENTS OF THE PRODUCT LINE WHICH DISTINGUISH MODELS

| Material | 300 Series stainless steel. Has stainless steel braid, stainless steel sleeve, and carbon steel fittings. Stainless steel fittings are available; check with factory. |
Kadant Johnson Inc.
Flexible Metal Hose

Couplings
Threaded both ends, flanged both ends, or a combination of threaded one end and flanged one end.

Size and Minimum Lengths
Pipe fitting sizes range from 1/4" to 8". Recommended minimum hose length for each size is available from the Flexible Hose product flyer.

KEY APPLICATION CHARACTERISTICS
Flexible metal hose is recommended for use with steam, condensate, heat transfer oils, and other liquids and vapors.

Flexible metal hose is used on conventional joints to allow for joint body movement as seal ring wear occurs, and to allow for the thermal expansion of piping.

It can also serve in many other types of piping systems; wherever piping misalignment or expansion presents a problem.

INSTALLATION CONSIDERATIONS
Flexible hose should be of recommended minimum length, or longer, to provide sufficient flex for seal ring movement and thermal expansion of piping. It should be installed in a relaxed position and on a straight plane, without being in compression, tension, or an offset position. The hose should be connected directly to the joint, but the weight of the pipe and fittings should be suitably supported beyond the hose.

EXPLANATION OF CATALOG NUMBERS FOR KADANT JOHNSON FLEXIBLE METAL HOSE
The letters and numbers identify all details of size and construction of the hose.

Example: FH-SS-150-18-FFLF-02

(A) (B) (C) (D) (E) (F)
FH -SS -150 -18 -FFLF -02

(A) Product FH - Flexible hose

(B) Construction SS - Stainless steel
Kadant Johnson Inc.
Flexible Metal Hose

(C) Size
- 1/4": 025
- 3/8": 038
- 1/2": 050
- 3/4": 075
- 1": 100
- 1-1/4": 125
- 1-1/2": 150
- 2": 200
- 2-1/2": 250
- 3": 300
- 4": 400
- 6": 600
- 8": 800

(D) Length
Overall length in inches (18 = 18" long)

(E) Coupling
- TT Threaded male nipple each end
- TLF Threaded male nipple one end, lap flange other end
- FFLF Fixed flange one end, lap flange other end
(Other fittings available - Consult Kadant Johnson for further information.)

(F) Series Number
Indicates the current JOCO production number

HOW TO ORDER

(See the Flexible Hose flyer for recommended minimum hose length for each size)

The Kadant Johnson Sales Representative needs to provide the following information needs to be provided to Kadant Johnson when ordering flexible metal hose:

- Part Number
- Size
- Hose Length
- Configuration of Couplings
Sight Flow Indicators

PRODUCT FUNCTION

Sight flow indicators provide a visual means of verifying flow through a system by allowing an unobstructed view of the flowing liquid or gas.

HOW IT WORKS

Kadant Johnson sight flow indicators are installed as fully assembled units directly in the piping line of the system. As the media flows through the sight flow indicator it passes by or through a glass window, tube or dome; providing visual verification that the media is flowing. Flow of invisible media is indicated by the spinning of a rotor in the rotor type sight flow indicators.

KEY ELEMENTS OF PRODUCT LINE WHICH DISTINGUISH MODELS

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Qty.</th>
<th>Part Name</th>
<th>Kadant Johnson Part Number</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BODY</td>
<td>TSF300-1-1</td>
<td>DUCTILE IRON</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>RETAINER RING</td>
<td>TSF300-2-1</td>
<td>BRASS</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>SEAL</td>
<td>TSF300-8-3</td>
<td>TEFлон ENV.</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>GLASS</td>
<td>TSF300-50</td>
<td>PYREX</td>
</tr>
</tbody>
</table>

Body

Constructed of ductile iron or brass. Some models are available in 304 stainless steel.

Sight Port

Heavy duty Pyrex™ glass is standard. Mica liner is optional for high erosion and corrosion applications.

Seals

Gylon™ (-350°F to +500°F) is standard. Other materials also available: Silicone, Viton, Teflon™ Envelope, Ethylene propylene (-65°F to +300°F).

Retaining Ring

Steel

Rotor

In the rotor type indicators only. In port hole and dome types, minimum flow is required to activate rotor.

Connection

Flanged or threaded. Size 3/8" to 4".
KEY APPLICATION CHARACTERISTICS

Sight flow indicators can be used with steam, water, non-lethal gases, acids, oils, hot and cold liquids, and non-corrosive liquids. **Check with factory for complete information on media compatibility.**

**Ductile Iron-Bodied Sight Flow Indicators**  
Media: steam, water, non-corrosive, non-lethal liquids and gases.

**Brass-Bodied Sight Flow Indicators**  
Media: air, water, non-corrosive gases.

INSTALLATION CONSIDERATIONS

**Sight Glass**

In **application conditions where a medium has a Ph above 8 or below 6, the sight glass can corrode from chemical action.** These media include hydrofluoric acid, sodium, potassium hydroxides above 125°F, and condensate water above 75 PSIG and/or 250°F. The actual rate of corrosion is affected by media concentration, liquid velocity, and degree of agitation.

Under application conditions like these, the sight glass should be specified with mica liner for protection. When this protection is worn away, the glass, seals and cushion should be promptly replaced.

Pyrex is normally suitable up to temperatures of 450°F. However, sudden changes in temperature can be harmful. **When used with media above 300°F, a shield or deflector should be attached to the indicator to protect the glass against chilling from blasts of air or water.**

HOW TO ORDER

The following information is required by **Kadant Johnson** when ordering sight flow indicators:

- Series
- Size
- Threaded or flanged connections
- Choice of material for body, if available
- Choice of material for seals, if available
PORTHOLE SERIES

Kadant Johnson porthole sight flow indicators have large round viewing ports; usually larger in diameter than the surrounding pipe, for unobstructed observation of liquid and gas flows. Heavy windows fit into precisely machined grooves, and are heavily sealed to prevent leakage at high pressures.

Flow restriction is minimized by the straight through design with a flow area as large, or larger, than pipe of the same nominal size.

Each unit is installed as a fully assembled unit in vertical, horizontal, or angular piping, with flow in either direction.

The body is ductile iron (130 PSIG at 450°F to 200 PSIG at -0°F) or brass (150 PSIG at 450°F to 225 PSIG at -0°F). They are available with flanged connections (1-1/4" to 4") or screwed connections (3/8" to 2-1/2").

Regular Type Porthole Sight Flow Indicators

Provide direct unobstructed flow pattern with viewing ports on opposite sides.

Indicator Type Porthole Sight Flow Indicators

Contains a free-swinging bronze indicator which is moved by flow through the unit. Indicator position varies with rate of flow, to show comparative velocity.
Rotor Type Porthole Sight Flow Indicators
Contains a stainless steel rotor assembly with a vaned wheel, which spins with flow. Speed of the turning wheels serves as an index of comparative velocity.

DESIGN BENEFITS

- Low flow resistance and high flow capacity
- High visibility; the entire internal passage is observable
- High pressure capacity; rated up to 225 PSIG
- Easy installation and servicing
- Glass and seals can be accessed by removing a few screws

APPLICATIONS

Porthole indicators are the most widely used Kadant Johnson sight flow indicators. They are intended for pressure or vacuum applications, including condensate drainage lines of textile dry cans, paper machines, heating calender rolls, and cold or hot water service.

LIMITATIONS

Not recommended for condensate service over 75 PSIG.
THRU-FLOW SERIES

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Qty.</th>
<th>Part Name</th>
<th>Kadant Johnson Part Number</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BODY</td>
<td>TSF300-1-1</td>
<td>DUCTILE IRON</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>RETAINER RING</td>
<td>TSF300-2-1</td>
<td>BRASS</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>SEAL</td>
<td>TSF300-8-3</td>
<td>TEFLOM ENV.</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>GLASS</td>
<td>TSF300-50</td>
<td>PYREX</td>
</tr>
</tbody>
</table>

The thru-flow series of sight flow indicators has a sight glass consisting of a straight, heavy-wall glass tube with an inside diameter as large as or larger than the surrounding pipe; offering virtually no flow restrictions.

A heavy duty iron housing (120 PSIG at 450°F to 200 PSIG at 0°F) or brass housing (130 PSIG at 450°F to 205 PSIG at 0°F) surrounds the glass, and seals are set into machined grooves to stay leak-free. The end seal protects the glass tube against thermal expansion of metal parts.

The thru-flow indicator can be mounted between two standard 150 lb. flanges (1" to 3") in any piping position.

Customers can specify the extra safety of a protective enclosure. A simple wire mesh cage can be furnished to surround the flow indicator; to shield it from moving or flying objects, and to contain any large glass pieces if the tube should break from excessive pressure.

**DESIGN BENEFITS**

- Entire flow area is exposed
- Minimal flow restriction and pressure drop
- Simple design tolerates high pressures and temperatures
- Self cleaning in normal service (the media constantly scrubs the glass)
- Protective cage available
- Easy to install

**APPLICATIONS**

Thru-flow indicators can be used in pressure applications, including cold or hot water service, non-corrosive, non-lethal liquids and gases, and some acids and oils. They are not recommended for condensate service.
The inside passages of the body are designed with a double reverse curve which forces the media against a Pyrex™ glass dome, creating turbulence that makes the flow easily detectable.

The standard body is made of ductile iron (125 PSIG at 350°F to 175 PSIG at -0°F) or brass (120 PSIG at 450°F to 200 PSIG at -0°F), with some sizes and models available in 304 stainless steel.

Threaded connections are in sizes from 3/8" to 1-1/4".

There are three sealing materials available: ethylene propylene, Viton™, and Gylon™.

**Standard Dome Indicator**

Media is forced against the glass dome. Can be installed in any position with flow in either direction. Best suited for fluids with air bubbles or other foreign particles.

---

### Dome Series

<table>
<thead>
<tr>
<th>Item No</th>
<th>Qty</th>
<th>Part Name</th>
<th>Kadant Johnson Part Number</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BODY</td>
<td>DSF-37-1-2</td>
<td>STAINLESS STEEL</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>RETAINER RING</td>
<td>DSF-100-2-1</td>
<td>STEEL</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>CUSHION</td>
<td>CSS 825 229 E</td>
<td>EPR SPECIAL</td>
</tr>
<tr>
<td>3A</td>
<td>1</td>
<td>SEAL</td>
<td>PSF200-8-11</td>
<td>GYLON</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>GLASS</td>
<td>DSF-100-50</td>
<td>HEAT RESISTING</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>LABEL</td>
<td>DSF-100-10</td>
<td>METAL</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>CAP SCREWS</td>
<td>SOCKET HEAD</td>
<td>¼-20 X ¾ STEEL</td>
</tr>
</tbody>
</table>
Ball Indicator

Detects clear gases and liquids using a Teflon™ ball that bounces inside the dome whenever a flow is present. Bouncing action varies with flow. Can be installed in horizontal or vertical lines, but the flow must enter from the ball end.

DESIGN BENEFITS

• Better visibility - Dome creates turbulence in the flow
• Self cleaning - Turbulence scours the glass dome
• Ball models detect clear gases and liquids

APPLICATIONS

Dome sight flow indicators are intended for use in pressure applications, including cold or hot water service, and many types of processing equipment. **Dome sight flow indicators are not recommended for condensate service.**

PANEL INSTALLATION

Dome sight flow indicators can be installed on instrument panels by providing holes for the glass dome and retainer screws. Only the dome and the screw heads are visible from the front of the panel. The dome extends out 7/8" from the face of the panel.

EXAMPLE OF DOME SERIES SIGHT FLOW

1” DOME BALL SIGHT FLOW
Vacuum breakers relieve any unwanted vacuum condition which may develop in a closed vessel or pipeline. They can be used to prevent contamination from back siphonage in fluid handling systems, and to protect equipment against collapse or implosion.

**HOW IT WORKS**

The vacuum breaker is installed in a threaded opening in either the vertical or horizontal position. The spring action on a round ball seats the ball against a soft, resilient seat. Only slight spring pressure is needed for seating. The ball comes off the soft seat under minimal vacuum conditions, providing almost instantaneous protection against an unwanted vacuum condition.

Sealing is accomplished by an EPR o-ring. However, the supporting seat is designed to assume any pressure in excess of the small amount needed for sealing, thus preventing any excessive compression of the o-ring.

**KEY ELEMENTS OF PRODUCT LINE WHICH DISTINGUISH MODELS**

One product line.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Qty.</th>
<th>Part Name</th>
<th>Kadant Johnson Part Number</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BODY</td>
<td>VB-150-1-5</td>
<td>303 STN. STL.</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>RETAINER TUBE</td>
<td>VB-150-84-3</td>
<td>STN. STL.</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>BALL</td>
<td>VB-150-4-3</td>
<td>440C</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>O-RING</td>
<td>CSS825-023-E</td>
<td>EPR</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>SPRING</td>
<td>VB-150-7-2</td>
<td>316 STN. STL.</td>
</tr>
</tbody>
</table>
SPECIFICATIONS

Maximum Pressure  300 PSIG  
Maximum Temperature  365°F  
Pipe Thread Size  Ranges 3/8” to 1-1/2”  
Outlet Pipe Size  Ranges 1/4” to 1-1/4”  
Net Weight  Ranges 1 oz. to 13 oz.

Every individual vacuum breaker is bubble-tested under water at both low and high pressure before it leaves the factory.

KEY APPLICATION CHARACTERISTICS

• Used in fluid handling systems to prevent back siphonage.
• In the textile industry, used on draw strand/roll strand machines for steam and hot oil.
• Installed in heat exchangers on the heating coil to break a vacuum.
• Used on steam boilers to break a vacuum imposed when a boiler is shut down.
• To prevent collapse of textile dry cans, multiple slasher cylinders, print cans, etc.

INSTALLATION CONSIDERATIONS

• For applications where the operating temperature exceeds our maximum limits, we have an installation method that keeps the vacuum breaker well below the process temperature, yet still operating normally when a vacuum is needed. Consult the factory for recommendations.

• For applications where the operating pressure exceeds our maximum limits, consult the factory for recommendations. Higher operating pressures are possible depending on the size, type and temperature conditions.

• When installed in a pipeline fitting, use of a reducing bushing is required to make sure the vacuum breaker does not intrude far enough to impede flow in the line or bind against any internal wall.

EXPLANATION OF VACUUM BREAKER CATALOG NUMBERING SYSTEM

Example: VB8-51-BR-T-S-E

(A) (B) (C) (D) (E) (F)  
VB8 - 51 - BR - T - S - E
Kadant Johnson Inc.

Vacuum Breakers

**DESIGNATION**  OPTION

(A) Series       VB8
(B) Size         
                 38 = 3/8"
                 51 = 1/2"
                 76 = 3/4"
                 101 = 1"
                 126 = 1-1/4"
                 151 = 1-1/2"
(C) Body         
                 BR = Brass
                 SS = Stainless Steel
(D) Outlet       
                 P = Plain
                 T = Threaded
(E) Ball         
                 S = Stainless Steel
(F) Seal         
                 E = EPR (consult JOCO for other options)

**HOW TO ORDER**

The *Kadant Johnson* Sales Representative sizes the vacuum breaker for the specific application and provides *Kadant Johnson* with the catalog number of the vacuum breaker needed (see the “Explanation of Vacuum Breaker Catalog Numbering System” section).
PRODUCT FUNCTION

A Cooling System is used in the paper industry to remove heat from the product before reeling or calendering, to cool press roll covers for protection from failure, and to add moisture back into the paper sheet prior to calendering. Cooling systems are also used in other industries.

HOW IT WORKS

Passive Systems

In the past, a passive system was the typical method of cooling something. Passive systems are akin to the old blacksmith’s tub of cool water in which the hot product is submerged. This method works best when there is a large temperature difference between the cooling medium and the object to be cooled, but becomes progressively ineffective as the temperatures of the water and the product approach each other. As heat is transferred to the water, its cooling capability is lessened.

Some older passive gravity drainage cooling systems for press rolls consisted of large rolling tubs half filled with water, where cool water would enter in one end and the warmed water would drain out the opposite end. This system had several disadvantages:

- Extra horse power was needed to turn the large rolls of water.
- The cascading warmer water that was in contact with the hot shell would mix with the incoming cool water, creating an energy loss.
- Non-uniform water temperatures were caused by the larger mass areas.
- Short circuiting was a probability with gravity drainage flow.

A different style of passive gravity drainage cooling system utilizes a bored head and radial inlet pipes. Cooling water flows across the bottom of the shell and outlet ports on the opposite side drain into a collector trough. This system has several advantages:

- Water exchange is more frequent, to use the most efficient temperature differential.
- Less horse power is used, since large amounts of water do not remain in the cylinder.
- A better use of temperature differential is realized, since the water is only in contact with a portion of the shell wall.

Active Systems

An active system uses a different concept to increase the effectiveness of water cooling in a press roll. This system uses a difference in pressure between the inlet and discharge to get flow through the system.

At the inlet, a combination of water flow and air pressure allows cooling water into the dryer and raises the internal atmosphere so that enough pressure differential exists to evacuate this water through a discharge syphon at the end of the cycle.

This system uses a combination of rotary joints, a syphon, and supply piping (consisting of control valves, isolation valves, filters and check valves, flow meters for both air and water, pressure and temperature gauges, and sight flow indicators for adequate control of the system),
with flex hose used for vibration and to allow for temperature expansion.

Some of the early active systems had an inherent problem with poor flood recovery because some of the outlet tubes were exposed to air instead of only water at some time during the cycle.

KEY ELEMENTS OF KADANT JOHNSON COOLING SYSTEMS

FM Spray System (Shown with Turbulator Bars)

![Diagram of FM Spray System]

The FM Spray System has a rotary or stationary syphon equipped with an end mounted plate that disperses the cooling medium in a spray as it enters the cylinder.

Spray orifices, in the end mounted plate, project the cooling medium down the length of the cylinder to a certain point. The medium then “drains” back to the tending end (syphon end), picking up heat along the way, and is removed from the system by the syphon.

The temperature profiles that resulted from trial testing of a rotary syphon setup and a stationary syphon setup were similar. The major difference seen in the performance of the FM Spray System when used in the rotary syphon setup was a substantial rise in the differential pressure from the dryer to discharge. This is an expected result, since the rotary syphon needs the increase in order to overcome the centrifugal force that is applied during rotation. (See the Syphons Section of this manual for more discussion of the differences between stationary and rotary syphons.)

The FM Spray System is essentially a fixed point system designed for a single flow rate. When the FM Spray System is operated at flow rates for which it was designed, the higher flow rates will produce lower shell temperatures with less temperature deviation (at the same heat flow).

Delivery Pipe System

![Diagram of Delivery Pipe System]
The Delivery Pipe System is a simple modification of the FM Spray System. Using the rotary syphon setup, a horizontal pipe is attached at the tending end (syphon end) in lieu of a spray orifice. The pipe runs nearly the length of the dryer to the drive end, where it is supported. The cooling medium travels directly through the horizontal pipe to the drive end before contacting the inner surface of the dryer. The medium then “drains” back to the syphon end, where it is evacuated by the syphon.

Another type of distribution system is often used in rolls that are not American Society of Mechanical Engineers (ASME) coded. In these non-coded vessels, the maximum allowable working pressure is 15 PSIG. In this type of system, the water enters the vessel through the journal, and flows to the opposite end, where it is removed by the syphon.

**Advantages of the Delivery Pipe System over the FM Spray System**

- A Delivery Pipe System can accommodate a wide range of water flow rates, while an FM Spray System is essentially designed for a single flow rate.
- The differential pressure is lower in a Delivery Pipe System because it does not require the high velocities needed in the FM Spray System to spray to the other end of the cylinder.

**Inexpensive Distribution System**

The Inexpensive Distribution System is another modification of the FM Spray System that works much like the Distribution System. A horizontal pipe, 2" in diameter and containing many holes drilled radially from its center, is flanged to the nozzle of the FM spider at the tending end (syphon end) of the dryer. This horizontal shower pipe runs the length of the dryer and is capped and supported at the drive end. The cooling medium is dispersed throughout the length of the dryer through the horizontal shower pipe. The medium then “drains” back to the tending end, where it is evacuated by the syphon.
In trial testing the Inexpensive Distribution System has a temperature profile that is fairly even across the length of the dryer, showing little deviation. In turn, the temperature differential was much lower than that of the FM Spray System or the Delivery Pipe System.

**Distribution System**

The Distribution System design consists of a horizontal shower pipe with dual rotary syphons equally spaced along its length. The horizontal shower pipe contains many holes drilled radially from its center. The cooling medium enters the roll through the horizontal pipe and is distributed along the length of the dryer via the holes in the shower pipe. The dual rotary syphons then draw the medium back up and discharge it at the tending end through an interior syphon pipe.

The Distribution System is the most efficient cooling system for maintaining an even temperature profile across the length of the roll, with a minimal temperature differential.

The even distribution of the medium, and the use of the dual rotary syphons makes the pressure drop requirements for the Distribution System design a bit lower than that of the Inexpensive Distribution System design. The Distribution System design provides a well balanced system of cooling and evacuation under all conditions.

**BENEFITS OF KADANT JOHNSON COOLING SYSTEMS**

**Provides Roll Cover Protection on Press Rolls**

You know that the tires on your automobile get hot when running. The heavier the load and the higher the speed, the hotter the rubber will be. Most press rolls are very similar. With every rotation of the press roll, a part of the roll cover deflects as it passes through the nip. The expansion and contraction of the cover as it deflects creates heat. The harder the cover, the more heat it generates (temperatures of over 200°F are possible).

The rule of thumb used to be that, if cooling water returned from the press roll 10 degrees warmer, then the roll cover should never fail. Also, a 10 degree temperature deviation across the face of the roll was acceptable. But, paper machine speeds have significantly increased, and many press loadings have doubled. Protecting the press cover and getting the press to work more efficiently can offer big returns.
The press cover material is cast on the roll then ground to the proper shape, so the rolls will meet in the center. The shape the cover is ground to is called the crown of the roll, and is characterized by an increase in diameter at the middle of the roll. Crowning compensates for the bending that occurs in the roll and ensures that the nip pressure will be uniform over the full width of the press.

Failure of the roll cover directly relates to the amount of heat generated within the cover. In turn, the amount of heat generated is related to: load, roll speed, cover compound, cover thickness, cover hardness, and service conditions.

If the proper amount of cooling water flow is not maintained inside the roll, an uneven temperature profile across the roll will occur. This non-uniform temperature profile can easily lead to uneven wear and premature loss of crown shape. These, in turn can cause poor performance and the possibility of cover failure.

**Reduces Moisture in the Press Section of the Paper Machine**

Reducing moisture in the press section by 1% may equate to a 4% change in evaporation load in the dryer section. Therefore, a press that works most efficiently has a big return.

**APPLICATIONS**

**Paper Industry**

- Remove heat from the paper prior to reeling or calendering on a paper machine.
- Used in a **Sweat Dryer** to add moisture back into the paper for surface finish control at the calender. The moisture content of the paper has an important effect on its compressibility. Therefore, the paper is sometimes passed over a cooled roll at the end of the dryer section, where moisture is condensed and transferred to the surface of the paper prior to calendering.
- Used in a **Swing Dryer** at the end of a dryer section to act as a cooling system; to help prevent “loose rolls” after removal of the reels from the rewinder.

**Rubber Industry**

- Calenders, mixers, rolling mills.

**Plastics Industry**

- Sheet and film calenders, extruders.

**Food Industry**

- Mixers, dough machines.

**Printing**

- Multi-web presses, label/stamping machines.
Glass Manufacturer

Roller cooling, sample drilling.

Pharmaceutical

Mixers, tableting equipment.

HOW TO ORDER

The Kadant Johnson Sales Representative will complete a “Cooling, Sweat, and Swing Dryer Information Sheet”, and Kadant Johnson will use that information to size and recommend a cooling roll system for the particular application.
Cooling Roll Systems

PURPOSE OF COOLING SYSTEMS

• Remove heat from product
• Roll cover protection
• Add moisture back into sheet
• Cool roll sheet
History

- Passive Systems
  - Water flow in; water flow out
  - Hp intensive
- Active Systems
  - Established water distribution patterns
  - Effective use of temperature differential
  - Used air pads for water draining
  - Reduced Hp requirements

Passive Systems

- Rely on mass of water to remove heat
- Often does not provide uniform temperature profile
Passive System - Single Flow

Passive System - Dual Flow
OLDER STYLE OF COOLING SYSTEMS

• Rolls half full of water
• Cascade – energy loss
• Non uniform water lost
• Water flow is short circuited

Active Systems

• Active Systems
  • Established water distribution patterns
  • Effective use of temperature differential
  • Used air pads for water draining
  • Reduced Hp requirements
ACTIVE SYSTEMS

Which System to supply?

• What is the purpose of the system?
  – Protect a roll cover
  – Cool a product
  – Add moisture to a product
• Is the roll coded for pressure?
  – Yes/No
• Is the product profile critical?
  – Yes, how critical?
  – No
Protect a Cover

Both Active and Passive will protect covers

Cool a Product

- Normally an active system is supplied
- Normally profile is important
Add Moisture back to a Product

- Active system supplied
- Profile is normally critical

Active Systems

- Required for flat profiles
- Variety of systems
Profile Drives Equipment Selection

**FM SPRAY - ROTARY**

**TEMPERATURE PROFILE @ 200,000 Btu/hr**

- 10 GPM w/4 .250” holes
- 20 GPM w/4 .315” holes
- 30 GPM w/3 .438” holes

**Profile Drives Equipment Selection**

**INEXPENSIVE DISTRIBUTION SYSTEM**

**TEMPERATURE PROFILE @ 200,000 Btu/hr**

- 20 GPM
- 30 GPM
- 40 GPM
Profile Drives Equipment Selection

**Distribution System**

**Temperature Profile @ 200,000 Btu/hr**

![Graph showing temperature profile with distances from the tending end in inches and flow rates in GPM]

COOLING ROLL INFORMATION SHEET

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Machine No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Phone:</td>
</tr>
<tr>
<td>Contact person</td>
<td>e-mail:</td>
</tr>
</tbody>
</table>

- **Type of roll:**
- **Diameter of roll:** (O.D.) (I.D.)
- **Product trim:** (inches)
- **Roll speed:** (fpm/rpm)
- **Is Roll ASME Coded**
- **Basis Weight of sheet**
- **Entering sheet Moisture**
- **Entering sheet Temp.**
- **Air available:** (psi)
- **Cooling water available:** (gpm)
- **Condition / Quality of water to be used**
- **Cover material**
- **Engineered drawings of roll & journal end including machined faces.**

- **Position:**
- **Roll face:** (in.)
- **# of cooling rolls in application**
- **rating**
- **Basis Area**
- **Air Temp.**
- **Exiting sheet temp.**
- **Water available:** (psi)
- **Inlet water temp.**
- **Filtration**
- **Required flow rate:**
PTX™ Swing Dryer Equipment

New Cooling Roll Configurations

• New configuration is available
  – 9750PTX rotary joint
  – 9800PTX rotary joint (preferred over the 9750PTX)
  – 5750SBAF rotary joint

• All versions utilize standard seal components and most of standard syphon components
Rotary Joint and Syphon Configuration

Features and Benefits

- One rotary joint and syphon provides all features required to heat and cool the roll
- Steam does not pass through the water nozzles when used in heating mode
  - Full inlet steam capacity is maintained
- Water and air enter the roll through separate passages
- Water flows across the seal ring to keep it lubricated when operating in the cooling mode
Features and Benefits

• Cantilever syphon
  – Less air consumption when in cooling mode
  – Less blow through steam when in heating mode
  – High speed produces better evacuation
  – Support structures not required inside the dryer

• Standard rotary joint and syphon components are used

Features and Benefits

• Unique nozzle configuration
  – Flow capacity can easily be changed
  – Spray pattern is easily customized
  – Different nozzle patterns can be used to cover different areas of the roll
  – Nozzles can be angled upward to reach far end of roll
    • Angle can be changed easily
    • New parts not required to change the spray position in the roll
Demonstrations
Desuperheaters

What is Superheated Steam?

- Occurs when heat is added to saturated steam that is not in contact with liquid, its temperature is increased above the saturation temperature
- Superheated steam can also occur when the pressure of saturated steam is reduced through a pressure control valve
- Superheated steam is “dry” steam
- Dry steam contains no water droplets (water droplets can damage steam turbines)
Effects of Excessive Superheat

- Reduced equipment life (steam joints, dryer isolation valves, steam pressure control valves, etc)
- Can produce hot dryers during sheet break conditions
- Generates higher piping losses due to higher specific volume of superheated steam
- Reduced heat transfer
- Reduced steam mass flow due to higher specific volume
- Temperatures can exceed equipment rating

Desuperheating

- Superheat should be reduced before the steam enters the dryers
  - Target 20°F superheat
  - Range of 0 to 40°F is acceptable
  - Superheat over 60°F is excessive
Desuperheating Steam

- Superheated steam is cooled by mixing with liquid water/condensate
- The extra energy in superheated steam evaporates the cooling water, creating additional steam
- Efficient mixing is important
- Treated water (condensate) is required
- The process is called “desuperheating”
- The device used is called a “desuperheater”

Kadant Johnson Desuperheaters

- Spray Type
- Venturi Type
- Ejector Type
Spray Type

- Simple Construction
- Low Cost
- Ideal for constant load applications
- Low pressure drop
- Turn down ratio is 2:1
- Requires condensate at 22 psig above pipeline pressure for constant load applications
- Requires condensate at 60 psig above pipeline pressure for 2:1 turn down ratio
Ejector Type

Atomising Steam inlet

Water inlet

Venturi Type

Water inlet

Steam flow
**Venturi Type**

- No atomizing steam required
- Does not require high-pressure cooling water
- Turn down ratio up to 10:1 (vertical installation)
- High pressure drop

**Ejector Type**

- Turn-down ratio up to 50:1
- Medium pressure drop
- Requires more controls
- Requires atomizing steam flow at a pressure = 1.5 x process pressure
Typical Ejector Desuperheater Control

- **PRV**
- **Ejector Desuperheater**
- **On/Off Ejector Valve**
- **Desuperheater Pump**

Relative Price

- **Spray Type**: 1
- **Ejector Type**: 1.8
- **Venturi Type**: 3.6
Common Desuperheater Problems

- Insufficient head from pump
- Pump reliability and control
- Oversized water control valve
- Temperature transmitter too close
  - Recommend at least 30’ away
- Inappropriate desuperheater type
  - Spray type has limited turndown and range
  - Ejector requires high pressure steam

Kadant Johnson Desuperheaters

- Fabricated steel construction up to 750° F
- Chrome molybdenum above 750° F
- Flexible design
- Wide range of connections available
- Sizes from 2” to .....ask for it
- Controls package available on request
Direct Steam Injection Water Heater

General Customer Availability

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
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</table>

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Record of Changes

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<th>Page</th>
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<tr>
<td>A</td>
<td>29 March 2010</td>
<td>All</td>
<td>Initial release</td>
</tr>
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|   |   |   |   |
Kadant Johnson direct steam injection water heaters are used to rapidly and accurately heat liquids by injecting steam into the fluid. Direct steam injection is a more efficient way to transfer heat energy from the steam to the fluid than indirect heat exchangers. Direct injection heating uses all the sensible and latent heat of the steam in heating the fluid. It can provide equal heating to that of an indirect heat exchange process with 20% to 30% less energy. The direct steam injection heater is also referred to as a “steam jet heater”.

Direct injection heaters consist of a motive body, suction body, throat, throat support, throat retaining plate, spindle, nozzle and actuator. The direct steam injection water heater is available in sizes 1½” through 6”, with an 8” unit to be developed. The product line nomenclature is designated as DIH. An example symbol number is DIH-AS-0300-01-1.

- Standard pressure rating: 150 psig (10 bar); high pressure rating: 250 psig (17 bar).
- Flow rate up to 1,280 gpm (4845 lpm) for 8” unit.
- Temperature rise up to 250 F (139 C) in a single pass through heater.
- Temperature control within ± 1 F (± 0.55 C).

Achieving temperature rise and maximizing temperature control are highly dependent on application conditions. Consult Kadant Johnson Technology group for specifications.

### Dimensions

<table>
<thead>
<tr>
<th>Size</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>Motive Steam Connection Flange</th>
<th>Liquid Connection Flange</th>
<th>Outlet Connection Flange</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>6.44&quot; 21.65&quot;</td>
<td>32.16&quot;</td>
<td>65.56&quot;</td>
<td>6.44&quot;</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td></td>
</tr>
<tr>
<td>4&quot;</td>
<td>7.75&quot; 28.21&quot;</td>
<td>40.28&quot;</td>
<td>73.9&quot;</td>
<td>7.75&quot;</td>
<td>4&quot;</td>
<td>4&quot;</td>
<td>4&quot;</td>
<td></td>
</tr>
<tr>
<td>5&quot;</td>
<td>8.38&quot; 33.75&quot;</td>
<td>46.22&quot;</td>
<td>80.68&quot;</td>
<td>8.38&quot;</td>
<td>5&quot;</td>
<td>5&quot;</td>
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<tr>
<td>6&quot;</td>
<td>8.38&quot; 42.25&quot;</td>
<td>55.21&quot;</td>
<td>89.68&quot;</td>
<td>8.38&quot;</td>
<td>6&quot;</td>
<td>6&quot;</td>
<td>6&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions shown are for standard design. Direct steam injection water heaters are custom-engineered and dimensions provided above are for reference only. Consult factory for other dimensional references.
Operating Principle

High-pressure motive steam enters the heater through the motive body and passes into the nozzle. As the motive steam passes through the nozzle, its pressure drops and its velocity increases. This increase in velocity will continue until sonic velocity is attained in the nozzle orifice.

The stream of high-velocity steam leaves the nozzle and passes through the motive body to enter the throat, where it is brought into contact with the fluid to be heated. Entrainment of the fluid occurs as the motive steam jet transfers its energy to the low-pressure fluid stream.

The combined flow progresses through the diffuser throat and the two streams mix resulting in uniform cross-sectional velocity. As the flows mix, the steam condenses and the liquid absorbs the heat as well as the kinetic energy in the steam jet. Unlike a thermocompressor, a steam jet heater does not require a diverging or diffuser section after the throat. However, the throat must be long enough to ensure that all of the steam is condensed in the liquid stream before the mixture exits the throat and passes into the process piping, otherwise the unit will vibrate, temperature control will be less accurate, and the efficiency will be reduced.

Design Considerations

Direct steam injection heaters are optimized for a specific set of operating conditions. In other words, its design will be the best at a single set of conditions known as the design point. This will typically be the high steam pressure condition with the maximum fluid flow. The combined steam and liquid velocity in the throat is used to determine the preferred throat diameter. The throat diameter is selected to maximize the outlet fluid pressure or maximize the flow rate.

It is important that the correct design conditions are specified. Once the throat bore has been set, the selected bore and the motive steam flow rate determine all other flows. Although steam jet heaters can be configured to operate very efficiently over a wide range of flow rates, deviations from the design point result in reduced efficiency. The motive steam pressure should be at least twice the liquid pressure as the two media enter the heater. Lower motive steam pressure will result in a loss in performance capabilities.

With the exception of the actuator and modulating spindle, direct steam injection heaters have no moving parts. Maintenance problems are rarely encountered.

It is important that the throat be properly positioned in relation to the nozzle. This is one of the design parameters that is selected based on the design operating point. If the design conditions are later changed, the throat position can be re-adjusted. This is generally done by Kadant Johnson, but it can be a field adjustment once the proper set-up dimension is determined.

Installation

A direct steam injection heater can be installed in any convenient position, but it is recommended that, wherever possible, the heater have its discharge connection pointing downwards. This will improve the operation of the actuator assembly, minimize piston wear in the plug guide, and prevent liquid backflow into the heater when it is not in service. Consult the Kadant Applications or Engineering department before applying any steam jet heater with the discharge connection pointing up. It is possible to orient the heater in this position, as long as proper attention is given to the application and installation.

Once the location for the direct injection heater has been determined, consideration should be given to the three connections: motive steam inlet, water inlet, and discharge. Each of these connections is discussed below.
The motive connection: It is important that the motive steam be “dry” steam (that is very little condensate in the flow). The motive steam nozzle is designed for steam quality that is 98% or better. Wet steam is detrimental to both the performance and the parts of a heater, because it erodes the nozzle, spindle tip, and the diffuser. It is recommended that all steam supply lines come off the top of the main steam supply line and, where necessary, provision be made for draining the steam lines of any residual condensate. Lower motive steam pressure requires more steam volume flow. A steam pressure gauge should be located in the motive steam line, as close as possible to the motive body steam inlet of the direct injection heater.

A back flow check valve should be installed in the motive steam line to prevent the liquid from flowing back into the motive steam line when the unit is shut down or when there is a loss of motive steam pressure.

An isolation valve is required in the motive steam supply line to prevent steam from leaking through the spindle and nozzle seating area when the unit is not operating. The spindle in the steam jet heater is not intended to act as a shut-off valve. The spindle is used only to regulate the steam flow to provide accurate liquid temperature at the discharge.

The water inlet connection: The water supply line should be the same diameter as the water inlet connection of the direct injection heater. It should also be free from any restrictions. A pressure gauge should be located as close to the water inlet connection as possible.

A back flow check valve should be installed in the water supply line to prevent steam or liquid from flowing back into the water supply line when the unit is shut down or when the discharge line becomes blocked. An isolation valve is required in the liquid supply line to prevent liquid from entering the heater when the unit is idle.

The discharge connection: The discharge pipe connection should be the same diameter as the heater discharge flange. Avoid placing any restrictions or obstructions in the discharge line that could increase the discharge pressure above the design value. It is important that the discharge line be the correct size. If the discharge back pressure is increased beyond the design value, the heater will not operate as efficiently or may fail to provide the required flow capacity.

Steam Supply

It is important to know the minimum motive steam pressure that will be supplied to the direct injection heater. If the steam pressure is below the design value, the heater may become unstable and it may be impossible to achieve the required flow capacity and discharge temperature.
Steam pressures above the design value generally do not cause performance or reliability problems provided that the pressure never exceeds the maximum ratings allowed for the flange configuration or connection type. Wet steam will result in poor performance and will erode the internal components of the heater. In all cases, the steam quality should be high (dry steam). The motive steam can be superheated, but the amount of superheat must be considered in design. With excessive amounts of superheat, the steam nozzle and throat could be undersized, reducing the steam flow and adversely affecting the performance of the heater.

**Inspection**

To ensure trouble-free service and obtain maximum operational efficiency, it is recommended that a periodic inspection of the direct injection heater internal components be conducted. The frequency of this inspection will depend on the type of service, the quality of the steam supply, and the cleanliness and chemistry of the liquid that is being heated. A direct injection steam heater that is used in corrosive or erosive service must be inspected more frequently. At a minimum, the heater should be inspected annually. The main components to inspect are the nozzle, throat, spindle tip, and the spindle guides. A visual examination will typically identify any external leakage that occurred while the unit was in operation. All external leaks must be repaired before the unit is placed back into service. Between inspections, the operation of the heater can be monitored for any changes in performance.

The spindle, guides, nozzle, and throat should be visually inspected for any obvious defects including wear, corrosion, erosion, plastic deformation, fractures, and material deposits. The spindle and guides should be measured to determine if the wear has exceeded the recommendations. Any material deposits inside the heater must be removed or the performance may suffer.

All seals, packing, gaskets, and fasteners should be replaced when the unit is reassembled.
**Unique Selling Proposition**

Kadant Johnson direct steam injection heaters are designed to operate with low vibration and noise levels. They are reliable and extremely efficient. Steam injection heaters typically require a control system with temperature, pressure, and flow rate sensors to provide accurate control. Manual controls can be provided for applications that do not have variable flow rates or require precise temperature control. Kadant Johnson can also provide process and system knowledge, field service support, and turn-key project management.

**Customer Value**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precise temperature control to ±1 F (±0.55 C)</td>
<td>Improved process reliability</td>
</tr>
<tr>
<td>Instant hot water – temperature rise up to 250 F (139 C)</td>
<td>Reduces down time</td>
</tr>
<tr>
<td>Large turn down ratio</td>
<td>Accommodates wide range of flow rates</td>
</tr>
<tr>
<td>Low vibration and low noise level</td>
<td>Low maintenance costs</td>
</tr>
<tr>
<td>Efficient steam utilization</td>
<td>Energy savings</td>
</tr>
<tr>
<td>Corrosion resistant materials</td>
<td>Reliable service</td>
</tr>
<tr>
<td>Compact size and no floor space required</td>
<td>Retrofit existing heat exchanger or sparger installations</td>
</tr>
</tbody>
</table>

**Industries and Applications**

**Paper**

Applications include boiler feedwater preheating, fibrous slurries such as pulp stock and biomass pretreatment, paper starch processing, and shower systems, among others.

**Chemical**

Applications within the chemical industry that require precise and accurate temperature control include heating reactor vessels, cleaning and sanitization, filter washing, and tank car washing.

**Wastewater Treatment**

Applications include thermophilic digestion and anaerobic treatment of organic waste. Tight temperature control in both applications is important to the process.

**Industrial Laundry**

Direct injection steam heaters can provide hot water and instantaneously respond to water temperature changes. Other heating systems such as a shell and tube heat exchanger are not able to keep up with rapid temperature changes. Direct steam injection heaters are better able to handle the fluctuations in load that are occur when adding additional chemicals and during wait times for sanitation of the laundry.

**Food Processing**

Cleaning stations and commercial dishwashers require a continuous flow of hot water. These applications generally use sparging systems. Sparging systems often fail to keep up with changes in the hot water demand and the water temperatures often fluctuate out of safety ranges.

Direct injection heaters can also replace three-way valves that are used to heat the water. These valves tend to clog and provide inconsistent water temperatures. Three-way valves can be found in tomato sauce cooking, high fructose corn syrup cooking, and soup cooking.
Selling Strategies

Other industrial applications include Ethanol production, sweetener and alcohol production, wet and dry starch conversions, textiles, steel mills, mining, mineral processing, renewable energy, and refineries.

Selling Strategy

When talking to prospective customers, focus on:

- Efficient and reliable systems for rapid heating of water or other liquids
- Tight, precise temperature control
- Low vibration and noise levels

Sales Collateral / Reference Material

Bulletins / Brochures

Direct Injection Heater Flyer

Sales Presentations

PowerPoint Presentation – Direct Steam Injection Water Heater

Video animations
The primary competitors in this market are Hydro-Thermal, Pro-Sonix, and Pick. These companies are all located in Wisconsin. The following information on their heating units was obtained primarily from their web sites and published materials. The claims are listed as they appear in these publications. Contact Kadant Johnson Marketing if a competitive comparison is required for one of these units.

**Hydro-Thermal Hydroheater® Steam Heater**  
*Source: [www.hydro-thermal.com](http://www.hydro-thermal.com)*

The Hydro-Thermal steam injection heater is an internally modulated mixing valve that controls both steam flow and mixing. Steam mixing is controlled by an internal stem plug that meters the amount of steam allowed to pass through the nozzle. Internal modulation eliminated the need for an external steam control valve.

Its nozzle design is patented and claims to ensure constant steam pressure and velocity at the point where steam contacts the liquid or slurry, eliminating the potential for pressure upsets. Hydro-Thermal also claims that the design provides tight temperature control to the process and extraordinary energy efficiency.

Hydro-Thermal steam injection heaters are installed as part of the piping. Chemical clean out is not needed for these steam injection heaters because they are cleaned by a turbulent mixing action. Hydro-Thermal claims this feature saves money and lowers environmental impact of harsh cleaning chemicals.

**ProSonix PSX Inline Direct Steam Injection Heater**  
*Source: [www.pro-sonix.com](http://www.pro-sonix.com)*

ProSonix uses a method referred to as Internal Steam Modulation for steam injection. This method is used to control steam through the variable area referred to as choked flow. Steam is then accelerated through the steam diffuser into the steam-condensing chamber for sonic velocity injection. The condensing chamber is where the steam is mixed with the liquid for energy transfer. The direct steam injection heater is available in four designs:

1. **PSX Jet Diffuser D-Series Heater™**  
   **Advantages & Improvements**
   - Precise temperature control (+/- 1°F)
   - Flow rates from 1 - 5,000 gpm
   - Compact size and no floor space required
   - Temp rise of up to 250°F in a single pass through the heater.
   - The PSX Direct Steam Injection heater uses both the latent and sensible heat of the steam providing up to 100% efficient energy use
   - The PSX DSI heater is easily configured to fit existing piping to replace heat exchangers and sparging devices. It has a rotatable steam inlet that allows for simple steam piping connections.
   - Eliminates plugging and fouling as there are no hot surfaces to scorch slurry
   - Does not require condensate return system
   - Well suited for water and light slurries
   - Self cleaning design reduces maintenance and provides more process reliability by eliminating mineral & scale build-up
Common Applications & Solutions
• Water and light slurry heating
• Intermittent heating applications
• Tank heating for rapid heat-up and trim heating
• Jacketed Vessel and Kettle heating for cascade control
• De-activation of waste and postproduction fluid streams
• Replacement of inefficient sparger devices
• Washdown and CIP cleaning
• Replacement of maintenance-prone steam sparger devices

2. ProSonix™ J-Series Jet Sparger
Advantages & Improvements
• High velocity steam injection to improve steam mixing and rapid condensation
• Reduced process upsets (hammer & vibration) and reduced energy loss
• Integral steam flow control with double acting air cylinder
• Simple installation as steam inlet connection rotates 360 degrees with flange mount design
• Automatic (Local or Remote) or manual control
• Available in 316 SS and Carbon Steel construction
• Optional Pneumatic Actuator for modulated steam control available for more demanding applications

Common Applications & Solutions
• Suitable for water and slurry heating applications
• Tank & vessel heating
• Pipe mount for inline process fluid heating
• Vent Steam recovery & utilization
• Boiler feedwater pre-heating
• Multiple Jet Spargers (2 or more) can be installed for mass heat-up and trim temp control
3. PSX OptiShear™ C-Series Jet Cooker

Advantages & Improvements
- Radial Slurry Flow assured by the precise alignment between the Condensing Tube and Steam Injector for more uniform flow
- Optimized Starch Cooking Performance leads to improve yields and a reduction in enzyme & chemical costs
- Reduced Maintenance and reduced localized wear
- Automatic Control is designed for remote operation
- No Black Box Controls or Proprietary Software - Control direct from your plant DCS/PLC
- Condensing Tube adjustment uses no plant air. Simple AC motor controls
- Ease of Installation via the Positional Steam Inlet

Common Applications & Solutions
- Wet & Dry Mill Starch Conversion Applications
- Sweetener & Alcohol production
- Ethanol production
- Paper starch processing
- Industrial starch processing

4. PSX Inline Diffuser I-Series Heater™

Patent Pending

Advantages & Improvements
- Flow rates from 1 - 10,000 gpm
- Compact size and no floor space required
- Temp rise of up to 250° F in a single pass through the heater.
- The PSX Direct Steam Injection heater uses both the latent and sensible heat of the steam providing up to 100% efficient energy use
- The PSX DSI heater is easily configured to fit existing piping to replace heat exchangers and sparging devices
- Eliminates plugging and fouling with no problematic scale build-up.
- Does not require condensate return system
- Ability to handle high particulate, large particles and difficult to pump slurries, fibrous & thick stock slurries & sludge’s
- Self cleaning design reduces maintenance and provides more reliability for your process
- Precise temperature control to +/- 1° F
Common Applications & Solutions
- High viscosity fluids that are difficult to pump
- Fibrous slurries require precise & uniform heating such as pulp stock heat & bleaching, and Biomass Pretreatment
- Anaerobic digestion wastewater sludge heating for Municipal & Industrial wastewater, along with Biogas production for Agricultural & Food processing
- High solids concentration slurries with large particulates
- Mineral processing & mining applications with abrasive issues
- Slurries that require minimal flow disruption

Pick Heaters Inc. Pick Direct Steam Injection Heaters
Source: www.pickheaters.com

The Pick system injects steam into the liquid through hundreds of small orifices in the injection tube. Its spring-loaded piston rises or falls as more or less steam is required. This prevents pressure equalization between steam and water pressure, thus eliminating steam hammer.

Pick Heater claims the heart of the Pick Heater is the steam injection tube and piston. This duo breaks steam into small streams and responds immediately to changes in steam demand.

Advantages:
- Energy Efficient - When compared with indirect shell and tube or plate and frame heat exchangers, Pick Direct Steam Injection Heaters can cut fuel costs dramatically – up to 28% – because 100% of the available energy from the steam is absorbed by the liquid.
- Exceptional Temperature Control - Accurate temperature control throughout the entire operating range conserves energy and assures product quality. The Pick Direct Steam Injection Heater adapts quickly to load changes and maintains precise temperature control to within 1°C or less in many systems.
- Wide Operating Range - Unlimited turndown both in process flow rates and heat load.
- No Steam Hammer - Pick's unique variable orifice injector automatically maintains a minimum differential between the steam and water pressures. This eliminates harmful vibration and steam hammer.
- Low Noise Level - The Pick Direct Steam Injection Heater operates at a low noise level, normally below 85 dba...far superior to venturi-type heaters.
- Low Liquid Pressure Drop - Pressure drop does not exceed 2 PSI under normal flow rates.
- Complete Mixing in Heater Body - With Pick Direct Steam Injection Heaters, there is no need for straight run discharge piping after the heater as required by venturi-type heaters.
- Instantaneous - Pick Heaters deliver an unlimited supply of hot water on demand, thus eliminating the need for large storage tanks.
- Compact Design - When compared to conventional heat exchangers, Pick Direct Steam Injection Heaters take up only a fraction of the space.
Services

Professional Services

One of the most effective ways to sell Kadant products is by leading with services. Services include on-site analysis of the application and heater operation, proper sizing, inspection and trouble-shooting, installation supervision, and installation contracting. Professional services from Kadant can demonstrate to a customer or prospective customer the benefits and financial return of the Kadant equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Direct injection heater rebuild or replacement

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and employees that are more experienced.

- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<table>
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<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
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</table>

Lead Time

The standard lead-time is the time required, under normal business conditions, from placement of an order until delivery of the product to the customer. This is typically six to eight weeks. Delivery information for all orders should be confirmed with Kadant Johnson.

Pricing

Consult Kadant Johnson for application-specific pricing. Special versions will be priced higher than standard configurations unless the order quantity is large. The price depends on size, material of construction, type of actuator, and feature selections.

Required Information to Place an Order

- Application description
- Flow rate (gallons or liters per minute) minimum, typical, and maximum
- Temperature rise required
- Water inlet and outlet temperatures
- Water inlet pressure
- Available steam pressure at heater
- Heater body material (typically 300-series stainless steel)
- Liquid connections (type of thread or type of flange)
- Steam connection (type of thread or type of flange)

For fluids other than water:
- Specific gravity of fluid (water = 1.0)
- Percent solids
- Density of solids
- Specific heat
- Viscosity
- Maximum particle size
Direct Steam Injection Heater

Direct Steam Injection Heater – The Basics

- Used to rapidly heat water or water-soluble liquids, by injecting steam directly into the liquid
  - The liquid is diluted slightly by the steam
  - There is no condensate returning to the boiler
- Very efficient heat transfer from steam to the liquid
  - Uses all of the heat of the steam (sensible and latent)
Direct Steam Injection Heater - Overview

- Steam enters through the motive body and passes through the nozzle
- High-velocity steam exits the nozzle and goes into throat
- High-velocity steam entrains the liquid to be heated
- Steam condenses and heats the liquid
- Velocity decreases and pressure increases as the liquid exits the throat

Direct Steam Injection Heater - Offerings

- Sizes available 1½” – 8” (others on request)
- Common pressure rating: 150 psig (10 bar)
- High pressure rating: 250 psig (17 bar)
- Flow rate up to 1,280 gpm (4845 lpm)
- Temperature rise up to 250 F (139 C) in a single pass through the heater
- Temperature control within ± 1 F (0.55 C)

Note: The temperature rise and temperature control depend on the application conditions
Direct Steam Injection Heater - Product Features

- Instant hot water
- Large turn down ratio
- Low vibration and low noise level
- Very efficient steam utilization
- Corrosion resistant materials
- Only two moving parts
  - Spindle
  - Actuator stem
- Compact size
  - No floor space required

Direct Steam Injection Heater - Product Benefits

- Significant energy savings
- Accommodates wide range of flow rates
- Improves process reliability
- Reliable service
  - Low maintenance costs
  - Reduces downtime
- Replaces heat exchangers and steam spargers
### Direct Steam Injection Heater - Application Examples

**Paper**
- Boiler feedwater preheating
- Pulp stock and biomass pretreatment
- Paper starch processing
- Shower systems

**Chemical**
- Heating reactor vessels
- Cleaning and sanitization
- Filter washing
- Tank car washing

### Direct Steam Injection Heater - Application Examples

**Wastewater Treatment**
- Thermophilic digestion and anaerobic treatment of organic waste

**Industrial Laundry**

**Food Processing**
- Cleaning stations and commercial dishwasher

**Others**
- Ethanol production, sweetener and alcohol production, wet and dry starch conversions, textiles, mining, steel mills, refineries

**Replacing spargers, shell and tube heat exchangers and plate and frame heat exchangers**
Frequently Asked Questions

• What is the maximum outlet temperature?
  – Application conditions determine the maximum temperature
  – Limited by motive steam pressure and outlet backpressure

• Why do we need a nozzle?
  – To reduce the flow area to create a high-velocity steam jet
  – High velocity is required to pull the liquid into the throat

• Why does the spindle move?
  – To adjust the motive steam flow
  – This provides temperature control

• What is the discharge pressure?
  – Normally it is 10-20 psi higher than the suction pressure
  – Depends on the down-stream backpressure

Frequently Asked Questions

• What is the maximum solids content for the liquid?
  – Market research indicates 3% is a typical maximum
  – We have no direct experience with this application yet

• Are Kadant direct steam injection heaters noisy?
  – High velocity steam generates noise regardless of the application, but is typically below 90 dB for a heater
  – Heater geometry has a very significant impact on noise and vibration

• What about water hammer?
  – Water hammer is common with poorly designed heaters
  – Kadant Johnson direct steam injection heaters are designed specifically to avoid water hammer

• Is there an NPI for Kadant Johnson direct steam injection heaters?
  – Yes! It can be obtained from the Kadant Intranet
  – Or contact Gayle VanHeukelum
Dryer Management System® Control Software (DMS)

Dryer Management System® Control Software Concept

- Use “Supervisory Logic” to continuously manage system setpoints
  - Consistency of operation
  - Improved energy efficiency
  - Improved machine efficiency
  - Manage upsets
    - Sheet breaks, grade changes, wash-ups, start-ups, etc.
    - Operator ease of use
- Incorporates Kadant Johnson’s drying & systems knowledge to more efficiently operate dryer system
- Control resides in DCS
  - DMS links to DCS to read and write information
  - Setpoints are managed
Systems are Complicated

Operator’s Responsibilities

- Adjust all pressures as machine conditions change
- Understand how pressure changes affect dryer operation (drying curve, runnability, shrinkage, draws, overdrying, etc.)
- Adjust differential pressures
- Turn down dryer pressures on sheet breaks
- Reset dryer pressures following a sheet break
- Manage pressures on grade changes
- Start system up following shutdowns
- Understand thermocompressor operation
- Monitor system operation
- Troubleshoot the system
What Areas Can DMS Impact?

- Operational consistency
- Energy efficiency
  - Reduced steam waste
  - Reduced motive steam use
- Pressure range of system
- Management of differential pressures
- Elimination of dryer flooding
- Tail threading – dryer temperatures
- Recovery from sheet breaks to 1st quality
- Grade change time
- Thermocompressor operation
- Vacuum condenser management
- Start-ups automated
- Ease of operation
- Monitoring & troubleshooting
DMS Functional Features

• Pressure management
• Differential pressure management
• Sheet break management
• Automatic system start-up
• Anti-flood logic
• Thermocompressor anti-choke logic

Optional Features
• Dryer grade change logic
• Press moisture indication & energy reporting
• Dryer air system management

Pressure Management

• Improper setting of dryer pressures
  – System operated outside the “design limits”
  – Steam waste
  – Inconsistent dryer operation
  – Maximum drying potential not achieved
  – Inability to operate at low pressures
    • Need to valve out dryers
  – Poor MD moisture control
  – Draw breaks during grade and speed changes
  – Slow recovery from breaks

• Solution
  – Simultaneous adjustment of all dryer pressures
  – Predefined steam pressure relationship curves
All pressures established from moisture control group.

“Pressure Curves” define relationship between dryer groups.

Which Type Of Control is Best?

- Differential Pressure Control
- Blowthrough Flow Control
- Managed Differential Pressure Control
Managed Differential Pressure Control

• Machine speed, condensing load, and syphon CV used to calculate differential pressure & blowthrough flow
  – ΔP varied as machine conditions change
  – Exact match of syphon curve to operating conditions

• Differential pressures reduced on sheet breaks
  – Reduced / eliminates steam loss on breaks

• Blowthrough flow meters not required

• No requirement for operators to set ΔP or blowthrough

Thermocompressor Control

• “Choke point” continuously calculated

• Logic limits thermocompressor from opening past choke point

• Prevents venting & excessive motive steam use

• Provides greater turndown of dryer pressures

• Logic eliminates deadband caused by interaction between differential and pressure loops
Anti-Flood Logic

• Three “guards” against flooding
  – Pressure curves
  – Managed differential control
  – Anti-flood logic

• Anti-flood logic
  – System “design limits” established
  – Actual pressures in system are monitored
  – Controller limits reset to keep system within operating parameters

Sheet Break Management

Most systems lack proper control during sheet breaks

• Result
  – Temperature increase / decrease
  – Poor tail threading
  – Snap-offs, wraps, & break-backs
  – Off-quality moisture around breaks
  – Slow recovery following breaks

• Solution
  – Build a model that predicts “optimum” dryer temperature turndown
  – Provide adjustability to optimize
Sheet Break Management

- Sheet break logic incorporated to manage system & aid recovery from break
- Temperature model to calculate optimum temperature / pressure letdown
- Amount of turndown varies depending on operating conditions
- Model takes into account dynamic temperature response of dryers
What Is Required Sheet Break Strategy?

- Strategy depends on recovery objective
  - Tail threading
    - Light weight, high speed machines
    - “Ideal” tail threading temperature matches normal sheet-on conditions
  - Rapid recovery to 1st quality moisture
    - Heavier weight, lower speed machines
    - “Ideal” temperature turndown minimizes time to steady state moisture

- Sheet break strategy must be dynamic

Grade Change Logic

- Poor prediction of dryer pressures often causes slow grade changes or sheet “snap-offs”
  - Many machines do grade changes manually
  - Many machines leave dryer pressures in feedback moisture control - slow
  - Many machines require operators to “guess” at dryer pressures
  - Many machines require operators to “guess” at final machine speed on dryer limited grades
  - Quality and speed of grade change is often operator dependant

- Solution
  - Use press moisture indication & drying model to better predict dryer pressures during grade change
Grade Change Challenges

• Drying efficiency (U factor) changes with:
  – Machine speed
  – Basis weight
  – Sheet caliper
  – Furnish & refining levels

• Drying load changes with:
  – Machine Speed
  – Basis Weight
  – Press solids (residence time press felt life, nip load ...)
  – Final sheet moisture

• Predicting grade change pressure requires
  – Accurate drying performance prediction
  – Accurate knowledge of press moisture

DMS Pressure Prediction

• On-line press moisture calculated using energy balance

• “Drying Performance Index (DPI)” calculated
  – Index accounts for changes in heat transfer and drying load

• Press moisture and DPI are continuously tracked by grade
  – Database provides historical information
  – Accuracy increases over time

• The grade change prediction uses historical differences in DPI between grade
Results

Grade Change Pressure Prediction
(119# to 100# Change)

Actual Pressure

Predicted pre-change pressure

Speed (fpm)

BW (lb/3000 ft), Stm Pr. (psi), Moisture (%)

Base Sheet Weight Target
Base Sheet Moisture
6th Section Steam Pressure
Predicted 6th Steam Pressure
Machine Speed

Time

Automatic System Start-up

• Typically steam systems are not started up properly
  – Started up too slowly delaying production
  – Started up too quickly
    • Risk of joint, bearing, or dryer damage
  – Improper purge of air
    • Poor drying after start-up
    • Poor CD moisture profiles
    • Low condenser vacuum levels

• Automatic start-up of system
  – Start-up logic takes control of all valves at start-up
  – Condensate temperatures used to control dryer warm-up sequence
  – Air purge from system is assured
Condensate temperature transmitters on separator tanks used in “Automatic Start-up Sequence”
On-Line Press Moisture Indication

- Energy balance allows calculation of amount of water evaporated and “on-line” press moisture
- Inputs required
  - Speed, Basis Weight, Sheet Width, Final Moisture
  - Pressure, temperature flow of make-up steam
  - Pressure, temperature flow of motive steam
  - Condensate return pressure / temperature
  - Energy losses calculated or measured

Press Moisture Calculated With A Single Flow Meter

Tracking Energy Loss Through Condenser Is A Good Energy Management Tool
Press Moisture Benefits

- Wet end and press optimization
- Press felt condition
- Press felt break in
  - Speed ups faster following felt changes
- Furnish & refining changes
- Drying efficiency changes
- Prediction of speed on dryer limited grades
- Energy consumption
- Grade change prediction
- Dryer air management
Dryer Air Management System

- Dryer hood air systems are a significant energy user
  - Typical Hood Air & Energy Flows
    - 8 tons supply air / ton paper produced
    - Heated to 180°F to 200°F
    - 430 to 550 lbs steam / ton paper produced
    - 12 tons exhaust air / ton paper produced
      - Exhaust temperature 170°F to 190°F
    - 0.4 to 0.5 hp-days / ton production fan horsepower

Typical Hood Design & Operation

- Hoods systems designed conservatively
  - Highest drying pressures
  - Highest drying rates
  - Highest press moistures
- Fan systems designed conservatively
  - High supply air flows
  - High exhaust air flows
  - High supply air temperature capability
- Fans systems balanced at start-up
  - No other adjustments likely made
- Fan systems run to maximum
  - “More is better philosophy”
  - High temperatures
  - High air flows
Optimization Of Hood Systems

• Any production condition below maximum is wasting energy if hood systems are not adjusted
  — Too much air, too much steam, too much temperature, etc.

• Hoods should be operated based on amount of water evaporated
  — High evaporation rates = high air flows & temperatures
  — Low evaporation rates = low air flows & temperatures

Kadant Johnson Approach

• Don’t control hood systems based on exhaust humidity
  — Humidity sensors unreliable.

• DMS calculates evaporation load in dryers

• Calculate amount of air required
  — Exhaust depends on hood type and condition
  — Supply depends on hood balance

• Install variable speed drives on critical fans
  — Develop curves for CFM versus speed
  — Adjust fan speed to produce air flow required

• Adjust temperature based on evaporation load

• Establish checks and limits
Typical Hood Control

DMS Implementation

- DMS workstation links directly to DCS
  - Regulatory control through DCS
  - Dryer Management workstation reads & writes information to DCS
  - Supervisory logic programmed in workstation
  - Dryer Management workstation sends set points to the DCS
  - Implementation the same regardless of DCS type

- Option
  - Implement DMS through an Allen Bradley PLC
    - DMS originally developed on PLC platform
    - Good alternative when no DCS in place
Dryer Drainage System Support

- Steam System troubleshooting & support service
  - Most problems are result of system or instrumentation problems
  - Kadant Johnson Systems engineers can review operation of steam system via phone line
  - Historical trending provides information for troubleshooting and fine tuning of system
  - Management report to quantify steam use efficiency & system operation
Typical Benefits

- Consistency of operation
  - Machine efficiency
- Energy efficiency
  - Reduced steam waste – run / break
  - Reduced motive steam use
- Faster recovery from sheet breaks
  - Tail threading
  - Time to 1st quality moisture
- Improved pressure range
  - Production on dryer limited grades
  - Turndown on light weight grades
- Fewer start-up problems / faster start-ups
- Dryer flooding eliminated
- Reduced condenser water use
- Improved monitoring & troubleshooting

Dryer Management System Control Software References

<table>
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<th>Company</th>
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Introduction:

Kadant Johnson introduced the first Liqui-Mover® pump in 1934. Since that time, we have been building and improving on the success of one of the first “pumpless” pumping traps introduced to the market.

Today, Liqui-Mover pumps are offered with other Kadant Johnson products such as vacuum breakers, separators, and valves.

The following material is intended for internal use only and should not be copied or distributed to customers. This playbook is a sales tool to better understand the Kadant Johnson Liqui-Mover pump and other products offered through Kadant Johnson.

As new material becomes available, additional pages will be sent out to be added to the playbook. Please make sure that once those additions are received they are entered into the correct section of the playbook.

The entire playbook will be available electronically on the Kadant Johnson intranet.

*Note: Kadant Johnson’s Liqui-Mover pumps are a registered trademark. Proper trademark usage is extremely important. Trademarks are adjectives that modify a noun and should always be followed by a noun. When using the term “Liqui-Mover” it should always be followed by pump/s.
# Table of Contents

## Applications
- Target Industries and Applications
- Open System
- Flash System
- Closed System
- Float Operated Sump Pump
- Pasteurizers
- Check Valves
- Application Form

## Technical
- Liqui-Mover Float & Float Free Pump Series Nomenclature
- Glossary of Terms
- Fill Height vs. Fill Head
- Pumping Trap vs. PumpTrap™ System
- Conversion Factors
- Estimating Condensate Loads
- Heat Exchanger Stall Application
- Typical Motive Piping Application
- NEMA Type Enclosure for Electrical Equipment
- Typical Piping for a Simplex Float Operated Liqui-Mover Pump
- Typical Piping for a Duplex Float Operated Liqui-Mover Pump

## Selling Strategies
- Suggested Sales Steps
- What to Look For
- General Information
- Condensate Pump Replacement Application
- Dual Motive Application
- Containing BTU’s and reducing Maintenance
- LMV Sump Pump Application
- Sewage Lift Station Application
- Questions to Ask (Solenoid Valves)
- Valve Conversion Worksheet
- Resources and Tools

## Competitive Knowledge
- Spirax Sarco 3 Million Cycles or 3 Year Warranty
- Replacement Float Mechanisms and Price
- Armstrong Information

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Kadant Johnson – CONFIDENTIAL
08/2008 Liqui-Mover™ Pump Playbook
Target Industries:

Agriculture  Government Buildings  Petroleum
Air Transport  Food  Printing
Automotive  Hospitals  Railroad
Chemical/Pharmaceutical  Hotels/Casinos  Rubber/Plastics
Colleges/Schools  Jobbers  Sewage Plants
Contractors/Consultants  Laundries  Textile
Corrugating  Lumber Products  Tire Plants
Engineering Firms  Museums  Tobacco
Ethanol Plants  Paper

Typical Applications:

Absorption Machines  Plate & Frame Heat Exchanger
Boiler Feed Pump  Presses – Tire Plants, Plywood Plants, etc.
Cookers  Shell & Tube Heat Exchanger
Distillation Towers/Columns  Steam Chests – Corrugators
Dry Cans/Slashers  Steam Coils – Fresh Air, Unit Heaters, Pocket Vent
Grain Dryers  Sterilizers
Kilns/Ovens – Steam Coils  Tank Cars – Rail Cars
Parts Washer  Tank Farms
Pasteurizers  Water Coils

Customers Served:

[Images of various company logos]
Open System – Vented

An open system is intended for use with multiple return pressures. This design requires no supplemental cooling of the condensate. Steam and/or compressed air can be used as the motive pressure.

*Float Operated:*

![Diagram of float-operated system]

*Float Free:*

![Diagram of float-free system]
Flash System

A flash system allows for medium and high pressure condensate to be flashed (vented) to a lower steam pressure for use. The receiver acts as the flash tank. There must be a requirement for all the lower pressure steam. A low pressure steam make-up source may be required as well. Steam should be used as the motive pressure.

*Float Operated:*

*Float Free:*
Closed System

A closed system is for a single steam user. This is also known as a ‘zero flash’ or ‘closed loop’ system. Depending on the incoming condensate pressure and the static backpressure of the Liqui-Mover pump, a steam trap or 2-way valve may need to be installed on the outlet of the Liqui-Mover pump. Steam should be used as the motive pressure.

Float Operated:

Float Free:
Float Operated Sump Pump

Liqui-Mover pumps can be used as a sump pump – no electricity to come in contact with water. Whether the pump is filled with cold or hot condensate, the Liqui-Mover pump will not be affected like plastic electric pumps. The pump will be the receiver during the discharge stage. The height of the Liqui-Mover pump should be less than the depth of the pump so water doesn’t spill over the lip of the pump. The level of the water in the pump should be the same level as the water in the inside of the Liqui-Mover pump tank during the fill stage. Compressed air is the most common motive pressure for sump applications.Using
Pasteurizers

This approach applies to any modulated steam coil application; steam to air, steam to water, or steam to beer. A pasteurizer has a bank of 4-6 coils, each having a modulated steam control valve. If all the steam coils are draining to a single pump, the receiver should be vented and steam traps will be required on each steam coil, along with vacuum breakers and air vents. If each steam coil has its own pump, then each pump should be closed – no venting to atmosphere. The steam traps should also be removed. A 2-way actuated valve may be required on the discharge of the pump tank. The Liqui-Mover pump can then act as the steam trap and condensate pump, PumpTrap™ system.
Check Valves

Check valves are a critical component to the successful operation of Liqui-Mover pumps. Because the operation of a Liqui-Mover pump is cyclic, the inlet and discharge check valves can be exposed to slamming (hammering), quick opening, and closing. The higher the differential pressure across the check valve, the harder the check valve will be slammed. This slamming action will eventually cause the check valve to fail. Different types of check valves will operate longer and better with high differential pressure, but can cause problems with low differential pressure.

There are three basic types of check valves that are used with Liqui-Mover pumps. There are advantages and disadvantages between them, depending on the application they are used on.

Swing Check

The swing check valve is the most common check valve used, and the most misapplied. Normally, the swing check valve has a brass body and flapper with a Teflon sealing disc, stainless steel construction is also available. Swing check valves are ideal, as an inlet check valve, for fill head applications less than 24” because they generally have a low flow resistance, which is important to the operation of a Liqui-Mover pump. If the differential pressure across the check valve is less than 20 psig, you could also use a swing check valve on the outlet of the Liqui-Mover, even though this is not a Kadant Johnson recommendation.

Lift Check

A lift check valve is basically a plug valve. It has a metal plug that moves up and down with flow, and seals against a metal seat. The downstream pressure (reverse flow) closes the valve and the motive (upstream) pressure opens the valve. The flow path is in the shape of a “Z”. This “Z” flow path will create a higher flow restriction than a swing check valve. A lift check valve will handle higher differential pressures than a swing check valve. As the differential pressure across the lift check valve increases, the potential for the plug to slam closed increases. The noise heard is a form of water hammer. Lift check valves were commonly used as an outlet check valve on Liqui-Mover pumps up to 3” pipe size.

Non Slam Check

A non-slam check valve is also known as a silent check valve. The non-slam check valves used with Liqui-Mover pumps have a metal disc that seals against a metal seat. The disc has a spring assist for closure. As the fluid flow slows, the spring assists the disc to close. This type of check valve does not rely on reverse fluid flow to close. The potential for water hammer is virtually eliminated. A non-slam check valve can be used as an inlet check valve as long as the fill head is at least 24”. Kadant Johnson uses a non-slam check valve that requires .5 psig to crack open and 1 psig to fully open. Using this type of check valve on the outlet is the standard; it can handle higher differential pressures than a left check valve.
Liqui-Mover Pump Float Series Nomenclature

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<th>TYPE</th>
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<th>LAYOUT</th>
<th>CONTROL</th>
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<td>X</td>
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</tr>
</tbody>
</table>

- **Drawing Number**
- **Number of pump tanks**
- **FSA = Float Self-Acting**
- **M = Mounted**
- **0 = Not Mounted**
- **S = Skid**
- **0 = Without Skid**
- **R = Receiver**
- **0 = Without Receiver**
- **L = Liqui-Mover**

Check valve sizes:
- 10 = 1" (only size for ductile iron LMHT-500)
- 15 = 1-1/2"
- 20 = 2"
- 30 = 3" (LMV only)
- 32 = 3" in 2" out

Size of unit:
- 5 = Ductile iron tank (LMHT only)
- 16 = 16" Fabricated tank

**LMHT** = Liqui-Mover Horizontal Tank
**LMV** = Liqui-Mover Vertical Tank

**NOTES:**
1. Description does not show receiver tank size.
### Liqui-Mover Pump Float-Free Series Nomenclature

<table>
<thead>
<tr>
<th>TYPE</th>
<th>TANK</th>
<th>LAYOUT</th>
<th>CONTROL</th>
<th>BOX</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMH</td>
<td>XXX</td>
<td>L X X X</td>
<td>XXX</td>
<td>X X X</td>
</tr>
</tbody>
</table>

- **Drawing Sequence Number**
- **1 = NEMA 1**
- **3 = NEMA 3R**
- **4 = NEMA 4**
- **7 = NEMA 7**

**ERC = Electrodes, Relay, Cylinder Valve**
**ERS = Electrodes, Relay, Solenoid Valve**

- **P = Piped Unit**
- **0 = Without Piping**

- **F = Framed Unit**
- **S = Skid Unit**
- **0 = Without Frame**

- **R = With Receiver**
- **0 = Without Receiver**

- **L = Liqui-Mover**

- **5 = 10" x 25" Pump - 10" x 26" (7.5 gal) Receiver**
- **10 = 14" x 37" (22.5 gal)**
- **20 = 18" x 35" (34 gal)**
- **40 = 18" x 47" (47 gal)**
- **50 = 24" x 40" (69 gal)**
- **65 = 24" x 44" (76 gal)**
- **110 = 24" x 56" (98 gal)**
- **150 = 30" x 66" (182 gal)**
- **200 = 42" x 60" Pump - 30" x 123" (340 gal) Receiver**

**LMH = Liquid Mover Horizontal (controller operated)**

**NOTES:**
1. Receiver and pump are typically the same size but not always (not shown in description)
GLOSSARY OF TERMS

Compressibility - Material’s resistance to a change in volume for a fixed mass. Measure of the change in mass versus pressure.

Friction Head - The pressure (in terms of feet of liquid) required to overcome the resistance to flow in pipe and fittings.

Net Positive Suction Head (NPSH) - The total suction head in feet of liquid less the vapor pressure of the liquid in feet. Liquid cannot be sucked into a pump. A positive head must exist in order to push the liquid into the impeller eye.

Total Discharge Head (TDH) - The pressure gage reading at the discharge flange converted into feet of liquid plus the velocity head (in feet) at the point of gage attachment.

TDH = Static discharge of head in feet = friction head in feet = velocity head loss at discharge of system.

Total Head - The total discharge head minus the total suction head or plus the total suction lift.

Total Static Head - The vertical distance (in feet) between the free level of the source of supply and the point of free discharge.

Total Suction Head - The gage reading at the suction flange converted to feet of liquid plus the velocity head (in feet) at the point of gage attachment.

Total Suction Lift - The reading of a mercury column at the suction flange converted to feet of liquid minus the velocity head (in feet) at the point of column attachment.

Vapor Pressure - The pressure at which a liquid is in equilibrium with its vapor.

Velocity Head - The vertical distance a body would have to fall to acquire the velocity. It corresponds to the static or pressure head which would cause that velocity. In any flowing liquid, the sum of pressure head and velocity head remains constant.

Viscosity - May be thought of as an internal stickiness. Absolute viscosity is the measure of viscosity in poise or centipoise - force per unit area. Water is 1 centipoise.

Receiver - A tank or section of pipe used to store condensate while the Liqui-Mover pump is discharging. A receiver is also used as a flash tank and vented to atmosphere.

Reservoir - A reservoir is a receiver used in a closed system with no venting to atmosphere.

Single Steam User - The Liqui-mover pump is only used on one process; a single heat exchanger.
**Fill Head vs. Fill Height**

**Fill Head** - the measured distance between the bottom of the receiver/reservoir and the top of the pump tank. Fill head is used to determine the capacity of a Liqui-Mover pump. The greater the fill head, the greater the capacity a particular Liqui-Mover pump will have, up to approximately five feet.

**Fill Height** - the measured distance from the bottom of the receiver/reservoir to grade. Fill height includes the fill head dimension. The fill height will vary with fill head and with each Liqui-Mover pump tank size.

The fill height dimension is important when using an existing receiver. From the fill height chart in the Liqui-Mover Pump Catalog, the available fill head can be determined for the proper pump selection.
Pumping Trap vs. PumpTrap™ System

What is a Pumping Trap?
A pumping trap is a generic name used for non-electric, self-actuating pressure powered pumps, like a Kadant Johnson LMV or LMHT Float Operated pump. Many people look at the float operated pressure powered pump as a modified Float & Thermostatic steam trap because it has a float to control the draining of the condensate. Hence the name pumping trap. A pumping trap is used on vented applications.

What is a PumpTrap?
A PumpTrap system is a pumping trap with a 2-way valve mechanism at the outlet of the unit. This 2-way valve mechanism can either be inside or outside of the pump tank. Some pumping trap manufacturers install a steam trap on the outlet of the pump tank. Other manufacturers make a pumping trap with a steam trap feature inside the pump tank, and is operated by the float mechanism. A PumpTrap system is used on non-vented (closed) applications, generally when the heat exchanger is temperature controlled.

Most heat exchangers are installed with a temperature control valve regulating the steam pressure (flow) to the heat exchanger, based on the desired outlet temperature of the product being heated. As the product temperature increases, the control valve will start to modulate close, reducing the steam pressure to the heat exchanger. When the temperature control valve is fully open, there may be enough pressure at the trap inlet to discharge the condensate without having to pump it. As the temperature control valve modulates close, there will be a point where the steam pressure at the inlet to the trap will be equal to or less than the discharge line pressure. At this point, the PumpTrap system will become a pump.

Kadant Johnson has the ability to offer a PumpTrap system by installing a steam trap on the outlet of a pumping trap. The steam trap must be sized to handle the condensate load at full pressure and the condensate volume of the LMV or LMHT unit at a reduced differential pressure.

The TLV GT series, Spirax Sarco APT series, and Armstrong Double Duty Steam Trap/Pump combinations are all PumpTrap systems. These units are somewhat limited in capacity.

For higher condensate loads, Kadant Johnson has a 3-probe option with a 2-way valve on the outlet of our Float Free units that would be classified as a PumpTrap system.
## Conversion Factors

<table>
<thead>
<tr>
<th>Conversion Factor</th>
<th>Equivalent in</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lb/hr Condensate</td>
<td>4 sq. ft. EDR</td>
</tr>
<tr>
<td></td>
<td>1000 BTU/hr</td>
</tr>
<tr>
<td>1 GPM Condensate</td>
<td>500 lb/hr</td>
</tr>
<tr>
<td></td>
<td>14.5 Boiler HP</td>
</tr>
<tr>
<td></td>
<td>2000 sq. ft. EDR</td>
</tr>
<tr>
<td></td>
<td>500,000 BTUs/hr</td>
</tr>
<tr>
<td>1 Boiler HP (100% efficiency)</td>
<td>34.5 lb/hr 212 F Condensate @ Sea Level</td>
</tr>
<tr>
<td></td>
<td>33,475 BTU/hr</td>
</tr>
<tr>
<td></td>
<td>140 sq. ft. EDR</td>
</tr>
<tr>
<td>1 sq. ft. EDR</td>
<td>240 BTU/hour (215 F steam in radiator and 70 F air surrounding radiator)</td>
</tr>
<tr>
<td>1000 sq. ft. EDR</td>
<td>250 lb/hr Condensate</td>
</tr>
<tr>
<td></td>
<td>1/2 GPM Condensate (actual)</td>
</tr>
<tr>
<td></td>
<td>7.2 Boiler HP</td>
</tr>
<tr>
<td>1 psig</td>
<td>2.307 ft. water column (cold)</td>
</tr>
<tr>
<td></td>
<td>2.41 ft. water column (hot)</td>
</tr>
<tr>
<td></td>
<td>2.036 inches mercury</td>
</tr>
<tr>
<td>1 ft. Head</td>
<td>0.433 psig</td>
</tr>
<tr>
<td>1 KW</td>
<td>1312 BTUs</td>
</tr>
<tr>
<td>1 inch mercury</td>
<td>13.6 inches water column</td>
</tr>
<tr>
<td>Convert BTUs/hr to lbs/hr</td>
<td>Divide BTU/hr by 1000</td>
</tr>
<tr>
<td>Convert ft. of head to psig</td>
<td>Divide ft. of head by 2</td>
</tr>
<tr>
<td>Electric condensate pump sizing</td>
<td>2 times actual condensing load</td>
</tr>
<tr>
<td>EDR</td>
<td>Equivalent Direct Radiation</td>
</tr>
</tbody>
</table>
Estimating Condensate Loads

Below are a few suggestions on how to estimate the condensate load.

**Boiler Capacity**

- One Boiler Horsepower = 34.5 lbs/hr at sea level
- 200 HP boiler = 200 hp x 34.5 lbs/hr = 6900 lbs/hr maximum condensate generated

**Pressure/Temperature Control Valve**

- Record manufacturer and model number of control valve
- Look up maximum steam flow capacity in control valve literature for given conditions
- If unsure, always use ‘Full Port’ valve capacities

**Existing Centrifugal Pump**

- Gather information on pump name plate
  - Divide GPM rating by two to get actual incoming condensate load
  - Centrifugal pumps generally have a 2:1 safety factor
  - Divide EDR by four to get lbs/hr, then divide by 500 to get actual GPM load
  - Motor horsepower doesn’t help
- Pump casing discharge connection
  - Determine reasonable flow through schedule 80 pipe of pump casing connection
  - Example: 1” schedule 80 pipe will handle 18 GPM at 8 ft/sec velocity
    - 18 GPM divided by 2 = 9 GPM incoming condensate load

**Shell & Tube Heat Exchanger**

- \[ Q = \frac{(L \times \text{Temperature Rise} \times 500)}{H} \]
  - \( Q = \) Condensate load (lbs/hr)
  - \( L = \) Liquid Flow (GPM)
  - \( H = \) Latent Heat of steam (use 1000 BTU/lb)
- Example: Heat 100 GPM from 50 F to 100 F
  - \( Q = \frac{(100 \ \text{GPM} \times (100 \ F – 50 \ F) \times 500)}{1000 \ \text{BTU/lb}} \)
  - \( Q \approx \) approximately 2500 lbs/hr condensate load

**Steam Coil**

- \[ Q = \frac{\text{CFM} \times 1.08 \times \text{Temperature Rise}}{H} \]
  - \( Q = \) Condensate Load (lbs/hr)
  - \( \text{CFM} = \) Air Flow
  - \( H = \) Latent Heat of steam (use 1000 BTU/lb)
- Example: Heat 1000 CFM outside air from 0 F to 70 F
  - \( Q = \frac{(1000 \ \text{CFM} \times 1.08 \times (70 \ F – 0 \ F)}{1000 \ \text{BTU/lb}} \)
  - \( Q \approx \) approximately 76 lbs/hr condensate load
Heat Exchanger Stall Application

**Stall** - a condition in which heat transfer equipment is unable to drain condensate and becomes flooded or when system pressure is inadequate to drain condensate.

**Situation:**
Below is a typical heat exchanger installation showing a modulating temperature control valve on a steam supply to the heat exchanger and a steam trap on the outlet for condensate drainage.

The condensate must be lifted out of the steam trap and into an overhead condensate return line. When the steam supply pressure (P2) is equal to or less than the backpressure at the outlet of the steam trap (P4), condensate will not drain from the heat exchanger and flow into the overhead return line. Process and maintenance problems that may be encountered are; temperature fluctuation in the outgoing heated water, water hammer in the heat exchanger, or damage to the heat exchanger tube bundle.

*Reminder – Steam traps do not lift condensate, differential pressure does.*

**Common Fix:**
Install an electric condensate pump after the steam trap to lift the condensate into the overhead return line. Generally, these electric condensate pumps are vented to atmosphere to reduce the condensate temperature so that the condensate can be pumped and the pump will not cavitate. The condensate temperature may need to be reduced to 180 – 200 F. This fix will allow the condensate to drain from the heat exchanger, independent of the steam supply pressure, into the heat exchanger. Valuable heat energy and some treated boiler make-up water will be lost through the flash steam that will be vented to atmosphere. Also, provisions for an opening in either the roof or the side of the building will need to be created to vent the generated flash steam.

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Liqui-Mover Playbook  TECH 7 - 08/2008
Correct Fix:
Shown are two ways to eliminate the need to flash the condensate to atmosphere and still be able to drain the heat exchanger effectively.

Install a steam operated, pressure powered condensate pump (Liqui-Mover pump) with an automatic 2-way discharge valve at the outlet of the pump. When the steam supply pressure (P2) is higher than the backpressure at the outlet of the steam trap (P4), condensate will drain from the heat exchanger and flow into the overhead return line. When P2 is equal to or less than P4, condensate will collect in the Liqui-Mover pump. When the condensate level in the Liqui-Mover pump reaches its highest level, a regulated motive steam pressure will pressurize the Liqui-Mover pump and push the condensate into the overhead return line. While the condensate is being discharged from the Liqui-Mover pump, condensate being generated by heating the water is collected in a reservoir mounted above the Liqui-Mover pump. This allows the shell of the heat exchanger to remain empty of condensate for maximum heat transfer from the incoming supply steam. The automatic 2-way discharge valve could either be a properly applied steam trap for Float Operated Liqui-Mover pumps or a 2-way pneumatic (electric) operated valve for float free Liqui-Mover pumps.
Typical Motive Piping Application

When designing a pressure powered pump into a condensate return system, consideration should be made to the motive pressure piping. To extend the service life of the pressure powered pump components, and to reduce the possibility of water hammer and erosion in the pumped discharge line, installing a properly sized pressure-reducing valve is advantageous. Many manufacturers suggest the motive pressure to be 15-20 psig higher than the backpressure to increase the service life of the pump assembly.

Below is a suggested typical piping arrangement for pressure-powered pumps. If the pressure-reducing valve cannot be located 20'-25' ahead of the pump, increase the diameter of this pipe to an equivalent volume.

NEMA Type Enclosures for Electrical Equipment

Note: This is to be used as a general guide only. Refer to the latest revision of the National Electrical Code for specifics.

NON-CLASSIFIED LOCATION ENCLOSURES

Type 1 Enclosures – General – Indoor
Type 1 enclosures are intended for indoor use primarily to prevent accidental contact with the enclosed equipment, in areas where unusual service conditions do not exist. The enclosures shall meet the rod entry and rust-resistance design tests.

Type 2 Enclosures – Drip proof – Indoor
Use Type 3R

Type 3R Enclosures – Rain proof and Sleet resistant – Outdoor
Type 3R enclosures are intended for outdoor use to protect the enclosed equipment against rain and sleet. Provisions shall be made for locking and draining the box. The enclosures shall meet the rod entry, rain, sleet, and rust resistance tests.

Type 4 Enclosures – Watertight – Indoor
Type 4 enclosures are intended for indoor use to protect the enclosed equipment against splashing water, seepage of water, falling or hose-directed water, and severe external condensation. The enclosure shall meet the hose down, rust resistance, and external icing tests.

Type 12 Enclosures Industrial Use – Indoor
Type 12 enclosures are intended for indoor use to protect the enclosed equipment against fibers, flyings, lint, dust and dirt, light splashing, seepage, dripping, and external condensation of non-corrosive liquids.

CLASSIFIED LOCATION ENCLOSURES

Type 7 Enclosures – Indoor
Type 7 enclosures are for indoor use in locations classified as Class I, Groups A, B, C or D, as defined in the National Electrical Code.

Type 9 Enclosures – Indoor
Type 9 enclosures are for indoor use in locations classified as Class II, Groups E, F or G, as defined in the National Electrical Code.
Typical Piping for a Simplex Float Operated Liqui-Mover Pump

The attached diagram illustrates some of the key piping components of a FSA (Float Self Actuating) Simplex Liqui-Mover pump. The diagram is for reference; as the piping will vary due to pump style, fill head, and available space.

Following the principles in this diagram, it is possible to see (understand) the basic requirements to pipe FSA Duplex Liqui-Mover pumps, FSA Triplex Liqui-mover pumps, etc.

When installing a Liqui-Mover pump, always follow local, State, and Federal regulations and sound piping practices for steam, condensate, and air. Questions should be directed to Kadant Johnson Liqui-Mover Products Group.
Typical Piping for a Duplex Float Operated Liqui-Mover Pump

The attached diagram illustrates some of the key piping components of a FSA (Float Self Actuating) Duplex Liqui-Mover pump. The diagram is for reference; as the piping will vary due to pump style, fill head, and available space.

Following the principles in this diagram, it is possible to see (understand) the basic requirements to pipe FSA Simplex Liqui-Mover pumps, FSA Triplex Liqui-mover pumps, etc.

When installing a Liqui-Mover pump, always follow local, State, and Federal regulations and sound piping practices for steam, condensate, and air. Questions should be directed to Kadant Johnson Liqui-Mover Products Group.
Suggested Sales Steps

Problem/Opportunity:
- Ask leading questions to find out the issues that have to be overcome
- Determine impact of each issue – efficiency, return on investment, cost savings, etc.
- Understand total financial impact of problem
- Propose value we can offer

Drivers:
- Contact person(s) and the individuals (teams) that support this person(s)
- What are the trigger points that will drive the solution
- Benefits – technical, commercial, and financial

Solutions:
- Ideas to solve the perceived problem(s)
- More than one solution may be offered
- Solutions may be approached in multi-phase offerings
- Test if proposed solutions have downside and determine how to address

Strategy:
- How to get to the end result
- How to promote benefits
- Anticipate questions and/or rejection of ideas to determine pathway for resolution
- Steps to be taken
- Anticipated timing to maintain momentum

Execution:
- Quote
- Offer ROI if applicable
- Follow-up on quote
- Network with customer and support personnel to assess standing objections that still need to be addressed
- Secure required drawings – customer and Kadant
- Enter order
- Ship on or before scheduled ship date
- Offer installation and start-up assistance – include in quote
- Follow-up installation
- Provide post start-up evaluation to ensure objectives and process warranty items – if any are achieved
- Ask for more opportunities – is this an opportunity for follow-up service and support

Support:
- Liqui-mover pump group available for assistance and site visits when needed
# What to Look For When Looking For Steam Users

**University Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Brewing/Alcohol Plant Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters
  - Bottle and Keg Washers
  - Pasteurizers

**Rubber/Tire Plant Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters
- Steam Supply Headers

**Grain Processing Equipment**
- Steam Tube Dryers
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Rendering Equipment**
- Cookers
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Food/Beverage Equipment**
- Flake Dryers
- Puffers
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Textile/Carpet Mill Equipment**
- Slashers
- Draw Strands/Roll Strands
- Dryer Cans
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters

**Steel Equipment**
- Pickling Tanks
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Hospital/Prison Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters
- Absorption Chillers

**Corrugating Equipment**
- Door Heaters
- Unit Heaters
- Doublebacker
- Waxer

**Automotive Plant Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters

**Paper Mill Equipment**
- Unit Heaters
- Door Heaters
- Air Make-up Coils
- Shell & Tube Water Heaters
- Plate & Frame Water Heaters
- Black Liquor Heaters
- White Water Heaters
## Liqui-Mover Pump Selling Strategies

<table>
<thead>
<tr>
<th>Pharmaceutical Plant Equipment</th>
<th>Petroleum/Chemical Plant Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Heaters</td>
<td>Unit Heaters</td>
</tr>
<tr>
<td>Door Heaters</td>
<td>Door Heaters</td>
</tr>
<tr>
<td>Air Make-up Coils</td>
<td>Air Make-up Coils</td>
</tr>
<tr>
<td>Shell &amp; Tube Water Heaters</td>
<td>Shell &amp; Tube Water Heaters</td>
</tr>
<tr>
<td>Plate &amp; Frame Water Heaters</td>
<td>Plate &amp; Frame Water Heaters</td>
</tr>
<tr>
<td>Cracking Towers</td>
<td>Cracking Towers</td>
</tr>
<tr>
<td>Distillation Towers</td>
<td>Distillation Towers</td>
</tr>
</tbody>
</table>
Liqui-Mover Pump Selling Strategies

When to use a Liqui-Mover Pump

- Upstream system pressure is low
- Upstream and downstream pressures modulate
- Modulated steam control

Why use a Liqui-Mover Pump

- To recover condensate/water
- To recover boiler chemicals
- To recover waste heat

Other Liqui-Mover Pump Advantages

- No seals, motors, or impellers
- Can handle higher temperatures than conventional centrifugal pumps
- Can be used when electricity is not available
- Can be used in wet hazardous environments
- Can be used in vacuum applications
Condensate Pump Replacement Application

There are thousands of electric centrifugal pumps in service trying to pump steam condensate. They are either simplex or duplex condensate pump units and are operated with a mechanical float switch assembly. Many centrifugal pumps can handle condensate temperatures of 180 to 200 F. Some pump manufacturers offer high temperature seal packages, but may also require NPSH for the pumps to operate without cavitation. Duplex pump units are very common due to the fact that centrifugal pumps are prone to high maintenance since the condensate temperature is often above 200 F. In order to lower the condensate temperature below 200 F for pumping, the receiver is vented to atmosphere so the excess heat energy is allowed to flash. It is important to be sure the centrifugal pump can generate a high enough discharge pressure to elevate the condensate into the common return line and still maintain the desired rated capacity.

The Liqui-Mover pump, manufactured by Kadant Johnson and first introduced in 1934, is a pumpless condensate pump that will replace an electric centrifugal pump. The Liqui-Mover pump is designed to handle condensate temperatures up to 365 F independent of NPSH. Pumping action is achieved using a mechanical non-electric float or a float-free 2-probe conductance level control. Steam or compressed air is the motive pressure for pumping action. Discharge pump pressure is determined by the motive pressure (steam or plant compressed air) supplied to the Liqui-Mover pump, normally 15-20 psig higher than the backpressure.
Dual Motive Application

There may be times when the boiler pressure may fluctuate for long periods of time, for instance at a hospital. During the day, the boiler pressure may be 100-150 psig in order for the kitchen and laundry to have the required temperature for proper operation. In the evening and overnight the boiler steam pressure can be reduced to 15-30 psig to maintain comfort heat and humidification throughout the facility. If steam powered condensate pumps are being used for reduced pump maintenance and electrical savings, the steam pressure reduction may cause some problems in pushing the condensate back to the boiler room. The steam powered pump may not function when pump stations require 30 psig or higher discharge pump pressure.

Kadant Johnson offers a dual motive solution. As shown in the sketch below, by installing a pressure switch in the motive steam line and a diverting valve, the pressure powered pump can be operated using either steam or compressed air pressure. Steam is the primary motive pressure and compressed air is the back-up pressure. When the steam pressure falls below the set point of the pressure switch, the diverting valve will automatically switch from steam to compressed air. The diverting valve will switch back when the steam pressure exceeds the pressure switch set point, steam will then become the motive pressure.

*Make sure to vent the receiver to atmosphere when using this arrangement. Note that this should not be used in a closed system.

*Reference drawings LMH-A-01030-7 and LMH-A-01030-10
Liqui-Mover Pump Selling Strategies

Product: Liqui-Mover® Dual Motive Station

Problem: Liqui-Mover pumps rely on high-pressure motive steam to pump hot condensate from the pumping tanks. If there is a loss of motive steam pressure, the condensate will overflow to a drain or flood steam-using equipment (shell and tube heat exchangers, unit heaters, or humidifiers), resulting in a loss of energy.

Solution: The installation of a dual motive station allows two different motive sources to be piped to the Liqui-Mover pump. Steam is normally the primary motive source, while compressed air is the alternate or back-up motive source. The compressed air system is a reliable backup source used to operate control valves and machinery.

Results: When the motive steam pressure falls below the set pressure requirement, the dual motive station will automatically switch to compressed air for the motive pressure. Once the steam pressure returns to the set point pressure, the dual motive station automatically reverts back to steam as the motive source. This process allows the pump to continue operating under conditions of steam motive loss.

Market Insights:
- The dual motive station is compact and preassembled for ease of installation.
- The dual motive station prevents pump downtime due to loss of motive steam pressure.
- The dual motive station prevents condensate overflow resulting in energy savings.
- Universities and hospitals are common target markets for this solution.
Containing BTU’S and Reducing Maintenance

With energy costs constantly increasing, it is important that Kadant Johnson helps to contain and reduce the amount of energy consumption for the customer. In the process of containing energy, cost of maintenance could also be reduced for certain plants.

Observations

The first indicator of potential savings is to look at the plants from a drive-by perspective. Is there any steam escaping through the roof or walls of the building? How about steam venting from the ground around the building or in roadways? Is there so much steam that it partially or totally hides the plant? If so, there is potential for a Kadant Johnson solution. The more steam that is seen venting, the more potential there is.

Generally, the steam seen venting from and around buildings and from streets and roadways, is called Flash Steam. Is the flash steam just a lazy plume that moves horizontally with the breeze as it exits the vent pipe, or is it blowing straight up? If the flash steam is blowing straight up, this means either there is a lot of high pressure flash steam venting, or the vent pipe size is too small. Either way, the condensate temperature is above 212 F and could be causing centrifugal pump failure. The higher the condensate temperature, the greater the backpressure will be on the steam traps of each steam user. This may cause condensate drainage problems for some of the steam users. There could also be a use for the flash steam, possibly heating water for process, air for comfort heat, or some other medium.

Steam trap considerations

Most steam traps are sized for a maximum condensate handling capacity with a given differential pressure across the steam trap. This differential pressure is generally the steam supply pressure into the steam user, less the return line backpressure. If a heat exchanger is operating on 30 psig supply steam and a backpressure of 0 psig, the differential pressure used for sizing the steam trap would be 30 psig. As the differential pressure across the steam trap decreases, due to an increase in the backpressure or a reduction in the steam supply pressure, the condensate handling capacity of the steam trap is reduced. There will come a point where the steam trap will become undersized and back-up condensate into the heat exchanger. This may result in a reduction in the heat transfer rate of the heat exchanger, water hammer in the heat exchanger, tube bundle damage, steam coils freezing, or temperature fluctuations in the medium being heated.

Condensate pump considerations

Many centrifugal pumps have cast iron receivers that are not pressure rated. If the condensate temperature is higher than 212 F, the cast iron receiver will be pressurized. The higher the condensate temperature is in the receiver, the higher the pressure could be in the receiver. This may be an unsafe situation for the plant and its personnel. Furthermore, many centrifugal condensate pumps are limited to a maximum operating temperature around 200 F. If the condensate temperature exceeds the operating temperature rating of the centrifugal pump, the liquid condensate will flash back into steam and the condensate pump will cavitate. Cavitation will damage the impeller, impeller housing, and seal package. Cavitation will also reduce or stop the condensate from being removed from the receiver, causing condensate to back up into the steam-using device.
Cavitation

In very basic terms, cavitation occurs when the pressure of the liquid drops below its vapor pressure in the eye of the centrifugal pump impeller. The liquid will boil, creating vapor bubbles in the impellers’ eye. When the liquid boils creating the vapor bubbles, these vapor bubbles move through the vanes of the impeller, where they are re-pressurized and collapse back into steam in a series of tiny explosions. A rumbling or rattling noise may be heard. These explosions will ultimately erode the impeller vanes creating small cavities in the metal. There may come a time when enough of the impeller metal is eroded away and the impeller will become unbalanced, causing vibration. Overtime, the vibration could lead to bearing failure and pump downtime.

How Kadant Johnson Helps

Where is the high temperature (pressure) condensate coming from?

- Steam trap(s) leaking or failed open
- Steam trap by-pass valve(s) open or leaking
- Undersized vent line
- High pressure steam user

If a steam trap is leaking or failed open, it needs to either be repaired or replaced. Thousands of dollars are lost each year due to steam leaks. Not only look at the energy lost, but the loss of make-up water, boiler chemicals, pipe erosion, and pump maintenance.

An open or leaking by-pass valve around a steam trap is the same as a failed steam trap. It either needs to be repaired or replaced. There are similar associated losses with an open by-pass valve as a steam trap. The losses could be significantly greater because a steam trap has a smaller orifice for the steam to pass through than a by-pass valve, which could be full line size.

A suspected undersized vent line may be properly sized if all the steam using equipment ahead of the condensate receiver is working properly. To size the vent line, do a Flash Loss Analysis. To do a flash loss analysis, the steam supply pressure into the steam using equipment and also the amount of steam being consumed (#/hr) during the heating process need to be known. The formula to calculate % flash loss is:

\[
\text{Heat of the liquid at initial pressure} - \text{Heat of the liquid at the final pressure} \\
\text{Latent heat at final pressure}
\]

Now multiply the % flash loss by the steam being consumed to get the amount of flash steam being generated in #/hr. The vent line should be sized such that the flash steam velocity through vent line is 3,000-4,200 FPM. The higher the flash steam velocity in the vent line, the higher the condensate pressure and temperature could be in the condensate receiver.

Many times high pressure steam users are piped to centrifugal pump stations with the only consideration being that the pump can handle the condensate load. This can lead to major pump problems – all temperature related. It may be beneficial to install a dedicated high temperature condensate pump for specific high-pressure steam using equipment.

One such non-cavitating pump is a pressure powered pump. The diagram shown on the next page shows how pressure powered pumps can be installed to handle the high temperature condensate, condense the flash steam, preheat water, and return almost 100% of the condensate to the powerhouse. The flash steam from the high-pressure steam user is vented to a heat exchanger where the flash steam is condensed. The condensate drains back into the flash tank through the flash line. The heat exchanger should be sized for the maximum amount of flash steam that could be generated.
LMV Sump Pump Application

Submersible vertical shaft condensate pumps are commonly found in the HVAC market. They have either simplex or duplex condensate pumps and are operated with a mechanical float switch assembly. A maximum temperature of 210 F is available on some models. Duplex units are very common; due to the fact that the pumps are prone to high maintenance since the condensate temperature is often above 210 F. Flash steam leakage around the pump mounting plate raises the ambient temperature in the room and around the pump motor, and can also cause excess moisture accumulation in the room.

Kadant Johnson manufactures a non-electric float operated condensate pump that will replace the electric operated submersible vertical shaft condensate pump. Since the unit is sealed to atmosphere, except for the atmospheric vent line, flash steam leakage into the room is eliminated. The Kadant Johnson Liqui-Mover pump is designed to handle condensate temperatures up to 365 F. The pumping action is accomplished using either steam or compressed air as the motive pressure. When a repair is needed, isolate the pump, disconnect the motive and equalize piping, remove (8) ½” bolts, and lift out the float assembly. Either repair the float assembly or drop in a new one.
Sewage Lift Station Application

Some sewage lift stations use electric centrifugal pumps to move sewage back to the treatment plant and other sewage lift stations use a much larger version of a Liqui-Mover pump to do the job. Kadant Johnson does not want to pump sewage with Liqui-Mover pumps.

An inquiry from a city, town, village, mobile home park, or campground may be received requesting a new 3-way solenoid valve or parts for an existing 3-way solenoid valve. The 3-way valve is used with a sewage lift station. Compressed air is used to push the sewage to the treatment plant.

Most sewage lift stations use either a SV3S-303-DIS-D4-126 or a SV3S-403-DIS-D4-126 3-way valve. The main problem with using either valve is the solenoid coil size. There are three solenoid coils for these 3-way valves. Each solenoid coil has a different maximum differential pressure they will open against (see chart). The “old” philosophy was to use the D4 coil on all applications, because it would always open against the differential pressure. The problem with this thought process is the D4 coil could hammer the solenoid valve apart, causing excessive downtime and high repair costs for the customer.

So what are the options? The solenoid valve could be resized. This is done by finding out the compressed air pressure used to pump the sewage back to the treatment plant. The compressed air pressure is the maximum differential pressure the 3-way valve needs to open against. The coil protection fuse will need to be changed to the proper rating.

Since sewage lift stations use compressed air to move the sewage, why not convert the customers to a cylinder operated 3-way valve. The air pressure can be compressed to the cylinder for a smooth operation. A complete new 3-way valve could be purchased or their existing solenoid valve can be converted using the valve conversion sheet.

<table>
<thead>
<tr>
<th>Valve Model</th>
<th>Coil Size</th>
<th>Max Differential Pressure</th>
<th>*Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV3S-303</td>
<td>D7</td>
<td>95 psig</td>
<td>1.4 amp</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>175 psig</td>
<td>2.5 amp</td>
</tr>
<tr>
<td></td>
<td>D4</td>
<td>250 psig</td>
<td>6.0 amp</td>
</tr>
<tr>
<td></td>
<td>D7</td>
<td>40 psig</td>
<td>1.4 amp</td>
</tr>
<tr>
<td>SV3S-403</td>
<td>D3</td>
<td>80 psig</td>
<td>2.5 amp</td>
</tr>
<tr>
<td></td>
<td>D4</td>
<td>180 psig</td>
<td>6.0 amp</td>
</tr>
</tbody>
</table>

* Note: The fuse should be a “time delay” or “slow blow” type
Questions to Ask Before Replacing 3-Way Solenoid Valves

When an inquiry is received from a customer for a new 3-way solenoid valve or parts for an existing 3-way solenoid valve, make sure to check the history for frequency of past purchased items relating to the 3-way valve and ask the questions listed below.

1. Is this for your Kadant Johnson Liqui-Mover pumps?
   a. If yes, continue.
   b. If no, see additional Valve Application Sheets.
2. Do you have multiple Liqui-Mover pumps?
3. If so, is this for the same Liqui-Mover pump as the previous orders?
4. What is the motive pressure to the 3-way valve?
5. Is the Liqui-Mover pump vented to the atmosphere?
6. How fast does the Liqui-Mover pump down?
7. Do you hear any banging or water hammer?
8. How often do you need to replace either the inlet or outlet check valves?

Most Liqui-Mover pumps use either a SV3S-303 or SV3S-403 3-way valve. Many type ERS Liqui-Mover pumps were sold with D4 coils on the 3-way solenoid valve. The main problem with using the D4 coil is that it is too strong and will damage the valve. Kadant Johnson has (3) solenoid coils for these 3-way valves. Each solenoid coil has a different maximum differential pressure they will open against (see chart). The ‘old’ philosophy was to use the D4 coil on all applications, because it would always open against the differential pressure. The problem is the D4 coil could hammer the solenoid valve apart, causing excessive downtime and high repair costs for the customer.

If the customer is repairing the 3-way valve every few months, water hammer or banging in the discharge piping is being experienced, the Liqui-Mover pumps down in less than 20 seconds, or either of the check valves need to be replaced frequently; then the motive pressure needs to be reduced for longer service life of the Liqui-Mover pump. A pressure reducing valve (PRV) needs to be installed ahead of the 3-way valve. Assistance in selecting the proper coil for their solenoid valve may be needed. The coil protection fuse will need to be changed as well to the proper rating.

Another option would be to convert to a cylinder operated 3-way valve if plant compressed air is available. Purchasing a complete new 3-way valve or converting the existing solenoid valve using the valve conversion sheet is an option as well.

<table>
<thead>
<tr>
<th>Valve Model</th>
<th>Coil Size</th>
<th>Max Differential Pressure</th>
<th>*Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D7</td>
<td>95 psig</td>
<td>1.4 amps</td>
</tr>
<tr>
<td>SV3S-303</td>
<td>D3</td>
<td>175 psig</td>
<td>2.5 amps</td>
</tr>
<tr>
<td></td>
<td>D4</td>
<td>250 psig</td>
<td>6.0 amps</td>
</tr>
<tr>
<td></td>
<td>D7</td>
<td>40 psig</td>
<td>1.4 amps</td>
</tr>
<tr>
<td>SV3S-403</td>
<td>D3</td>
<td>80 psig</td>
<td>2.5 amps</td>
</tr>
<tr>
<td></td>
<td>D4</td>
<td>180 psig</td>
<td>6.0 amps</td>
</tr>
</tbody>
</table>

* Note: The fuse should be a “time delay” or “slow blow” type
Available Collateral

Kadant Johnson Fluid Handling Product Line Card – FH Products 1001
Kadant Johnson Liqui-Mover Products for Paper Mills – LM Products for PM 1002
Liqui-Mover Pumps Bulletin – LM 3004
Float Operated Pumps Catalog – 3000
LMH combination Pump/Steam Trap System - 1001
LMHT-1600 Flyer - 1002
Boiler Feed Pump Flyer - 1004
Float Assembly Flyer - 1003
Air and Steam Separators Flyer - 1000
Vacuum Breakers Flyer - 3000

Presentations

Basics of Steam
Lunch and Learn

Forms

Application Information Form (Example at the end of the Application Section)

Others

Liqui-Mover Pump Handbook
    LMHT-1600 IOM
    LMV-1600 IOM
    LMHT-500 IOM
Spirax Sarco 3 Million Cycles or 3 Year Warranty Promotion

Spirax Sarco advertises a 3 Million Cycles or a 3 Year Warranty promotion for PTC and PTF Pivotrol Pressure Powered Pumps. Included in the sale of the product is a cycle counter.

What Kadant Johnson can do to beat the competition and add value for the customer:

<table>
<thead>
<tr>
<th>Gallons/Cycle Discharged</th>
<th>Spirax Sarco PTC</th>
<th>Spirax Sarco PTF</th>
<th>Kadant LMHT-1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Cycles using Kadant</td>
<td>40% Less</td>
<td>30% Less</td>
<td>12.0</td>
</tr>
<tr>
<td>Overall Height of Pump</td>
<td>24.9 inches</td>
<td>32.1 inches</td>
<td>19 inches</td>
</tr>
</tbody>
</table>

Based on 3 million cycles for the Spirax Sarco PTC, the Kadant LMHT-1600 pump will have 1.8 million cycles and 2.1 million cycles compared to the Spirax Sarco PTF.

Kadant Johnson’s LMHT-1600 Liqui-Mover pumps will operate between 30% and 40% fewer cycles than a Spirax Sarco pump. A calculation of the length of time to reach the 3 million cycles can be done by attaining the application’s condensate load, daily hours of operation, and number of days per year.

Also, to compare a Kadant Johnson LMHT-1600 with a Spirax Sarco pump, the Kadant Johnson LMHT-1600 is approximately 6 inches shorter than the PTC model and approximately 13 inches shorter than the PTF model. The customer would need less headroom to install a Kadant Johnson LMHT-1600 pump than he/she would need to install a Spirax Sarco pump.

A Kadant Johnson Liqui-Mover pump sells for much less (in some cases half the cost) than a Spirax Sarco pump. This creates an overall advantage to why a customer would purchase a Kadant Johnson LMHT-1600 pump vs. taking advantage of the above promotion.
Replacement Float Mechanisms and Price

Armstrong International’s Hoffman PCC replacement float mechanisms have been sold for $2500.00 to a college in Virginia. Customers are also paying between $2600.00 and $2700.00 for Spirax Sarco’s Pivotrol float mechanism.

Kadant Johnson’s replacement for a Hoffman PCC or a Spirax Sarco PPC or PPF has a 2008 list price of $1568.20.

Based on this information, pricing should not be an obstacle. Making the sales call and promoting replacement float mechanisms should result in a number of orders. Customers generally have multiple float operated pumps in service. Once the Kadant Johnson float mechanism is shown and demonstrated, the customers will convert all of their pumps to a Kadant Johnson pump resulting in immediate sales as well as future sales.

Being aggressive in the spare parts business with the competition, the competition will either have to increase their prices on bid and spec projects or decrease their mechanism prices. This will open the path for Kadant Johnson to cut into the competition’s high profit market.

Information on the replacement float mechanism can be found in the Float Mechanism flyer or in the Float Operated Pumps catalog on page 15. Both are available for download on the Liqui-Mover pump website, www.liquimover.com.

All our standard float mechanisms will operate against a maximum 90 psig motive pressure. If a higher motive pressure differential is required, we have mechanisms that will operate up to 140 psig.

Remember – most pump tanks are rated either 125 or 150 psig.

*See Float Assembly flyer for a listing of all replacement float assemblies available by competitor.
Armstrong Information

Trade Names

Pump Trap:

This would be equal to the LMV-LOOO and LMHT-LOOO Float Operated units. Armstrong supplies various additional items including: different check valve types and sizes, liquid level gauge glass, cycle counters, insulation jackets to name a few.

Low Boy Receiver Package:

This would be equal to the LMV-LRSM and LMHT-LRSM Float Operated units. Armstrong has a Commercial and an Industrial version.

The Commercial version has schedule 40 pipe with malleable iron fittings, bronze isolation valves, and bronze check valves as standard. Stainless steel check valves are optional. Liquid level gauge glass for receiver and pump tank(s) are optional.

The Industrial version has schedule 80 A106 pipe, 3000# forged steel NPT fittings, forged steel isolation valves, and stainless steel check valves. Liquid level gauge glass for receiver and pump tank(s) are optional.

A typical model number would be: SPT412LBRPI-16.

- SPT = Simplex Pumping Trap
- 412 = vertical pump tank with 3” inlet and 2” outlet check valves
- LBRPI = Low Boy Receiver Package Industrial version
- 16 = 16” diameter receiver tank

Double Duty or DD:

The Double Duty is a Steam Trap/Pump Combination. The steam trap is inside the pump tank body and operates like the Float Operated PumpTrap system. Kadant Johnson installs a steam trap between the pump tank and the discharge check valve.

Product Offering

<table>
<thead>
<tr>
<th>Models</th>
<th>Check Valve Size</th>
<th>Standard Pump Body Material</th>
<th>Max Motive Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT-104</td>
<td>1” x 1”</td>
<td>Cast Iron – 150 psig rated 100 psig</td>
<td></td>
</tr>
<tr>
<td>PT-204/206</td>
<td>1” x 1” – 1-1/2” x 1-1/2”</td>
<td>Cast Iron – 150 psig rated 125 psig</td>
<td></td>
</tr>
<tr>
<td>PT-308/312</td>
<td>2” x 2” – 3” x 2”</td>
<td>Steel - 150 psig ASME 125 psig</td>
<td></td>
</tr>
<tr>
<td>PT-3508/3512</td>
<td>2” x 2” – 3” x 2”</td>
<td>Cast Iron – 150 psig rated 125 psig</td>
<td></td>
</tr>
<tr>
<td>PT-404/406/408/412</td>
<td>1” x 1” – 3” x 2”</td>
<td>Steel - 150 psig ASME 125 psig</td>
<td></td>
</tr>
<tr>
<td>PT-516</td>
<td>4” x 4”</td>
<td>Steel - 150 psig ASME 150 psig</td>
<td></td>
</tr>
<tr>
<td>DD-4</td>
<td>1” x 1”</td>
<td>Ductile Iron – 72 psig rated 72 psig</td>
<td></td>
</tr>
<tr>
<td>DD-6</td>
<td>1-1/2” x 1”</td>
<td>Steel - 200 psig ASME 200 psig</td>
<td></td>
</tr>
</tbody>
</table>
Liqui-Mover Pump Competitive Knowledge

Product Capacity

<table>
<thead>
<tr>
<th>Models</th>
<th>Capacity Lbs/hr</th>
<th>Differential Pressure</th>
<th>Fill Head</th>
<th>Cycles per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT-104</td>
<td>1,980</td>
<td>70 psig</td>
<td>12&quot;</td>
<td>2.0</td>
</tr>
<tr>
<td>PT-204/206</td>
<td>3,700</td>
<td>120 psig</td>
<td>12&quot;</td>
<td>2.1</td>
</tr>
<tr>
<td>PT-308/312</td>
<td>16,600</td>
<td>120 psig</td>
<td>12&quot;</td>
<td>2.8</td>
</tr>
<tr>
<td>PT-3508/3512</td>
<td>14,400</td>
<td>120 psig</td>
<td>12&quot;</td>
<td>2.9</td>
</tr>
<tr>
<td>PT-404/406/408/412</td>
<td>12,200</td>
<td>120 psig</td>
<td>12&quot;</td>
<td>3.1</td>
</tr>
<tr>
<td>PT-516</td>
<td>52,738</td>
<td>145 psig</td>
<td>12&quot;</td>
<td>0.8</td>
</tr>
<tr>
<td>DD-4</td>
<td>350</td>
<td>65 psig</td>
<td>2&quot;</td>
<td>unknown</td>
</tr>
<tr>
<td>DD-6</td>
<td>4,800</td>
<td>145 psig</td>
<td>6&quot;</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Note: Capacities based on steam as motive
DD-4 and DD-6 are Trap/Pump Combination
DD-4 and DD-6 lbs/hr is pumping capacity

Terminology

<table>
<thead>
<tr>
<th>Model</th>
<th>Means</th>
<th>Kadant Equivalent Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>Pumping Trap</td>
<td>LOOO</td>
</tr>
<tr>
<td>SPT</td>
<td>Simplex Pumping Trap Skid Package</td>
<td>Simplex LRSM</td>
</tr>
<tr>
<td>DPT</td>
<td>Duplex Pumping Trap Skid Package</td>
<td>Duplex LRSM</td>
</tr>
<tr>
<td>TPT</td>
<td>Triplex Pumping Trap Skid Package</td>
<td>Triplex LRSM</td>
</tr>
<tr>
<td>QPT</td>
<td>Quadruplex Pumping Trap Skid Package</td>
<td>Quadruplex LRSM</td>
</tr>
</tbody>
</table>

Marketing

Historically, Armstrong has used Manufacturer's Representatives as a main sales channel. For years, both Armstrong and Kadant Johnson shared many of the same representatives. Armstrong also goes to market through regional and national distributors. With extensive and synergistic product offerings, Armstrong is able to package their products.

Key Selling Points

"Externally replaceable valve and seat assembly". This is not a true statement based on the Installation and Maintenance publication IB-100-F dated 10/03. On page 6 of this publication there is a note that states:' The seats are externally replaceable. This provides for visual inspection and cleaning of the valves without removal of the cap'. On pages 10 and 11, a statement will be found that says 'valve replacement requires removal of Pump cap'. Based on the Installation and Maintenance publication, the seats are externally replaceable but not the valves. Even if the valves could be replaced without removing the cap, the valve and seat adjustment cannot be checked with the cap installed in the pump body.

"Inconel X-750 Springs". Inconel does have a higher stress corrosion resistance to chlorides than the 300 series stainless steel Kadant Johnson uses for springs. Kadant Johnson is the only manufacturer of float mechanisms that uses the open coil spring design.

Web Site

www.armstrong-intl.com
Economics of Returning Condensate

Steam

An invisible gas generated by adding heat energy to water during which water changes to a gas.
Qualities of Steam

- High usable heat content
- Gives up its heat at constant temperature
- Produced from water
- Clean, odorless and tasteless
- Heat can be used over and over – flash
- Easily distributed and controlled
- Constant characteristics
  - Pressure, temperature, volume

British Thermal Unit (BTU)

The amount of heat needed to raise one pound of water one degree Fahrenheit (°F) from 32°F to 212°F
Sensible Heat of the Liquid

- Energy in the water before it boils
- Can be measured by a thermometer
- Water contains 180 BTUs at the boiling point (212 F)

Latent Heat

- Additional energy necessary to convert water to steam
- During the conversion to steam, the volume of the water increases dramatically
Heat Required to Generate One Pound of Steam

1 lb water @ 32°F
0 psig
+ 180 BTU =

1 lb water @ 212°F
0 psig
+ 970 BTU =

1 lb steam @ 212°F
0 psig

1 lb water @ 32°F
100 psig
+ 309 BTU =

1 lb water @ 338°F
100 psig
+ 880 BTU =

1 lb steam @ 338°F
100 psig
Flash Steam

• Reduce the pressure of condensate
• Condensate re-evaporates
• Flash steam is created
• Amount of flash steam can be calculated

\[
\text{Flash Steam \%} = \frac{H_{S1} - H_{S2}}{H_{L2}} \times 100\%
\]

Calculating Flash Steam

\[
\text{Flash Steam \%} = \frac{H_{S1} - H_{S2}}{H_{L2}} \times 100\%
\]

\(H_{S1}\) = sensible heat of higher pressure
\(H_{S2}\) = sensible heat of lower pressure
\(H_{L2}\) = latent heat of lower pressure
Calculating Flash Steam

100 psig condensate flashing to 0 psig

\[ H_{S1} = 309 \]
\[ H_{S2} = 180 \]
\[ H_{L2} = 970 \]

\[ \frac{309 - 180}{970} \times 100\% = 13\% \]

Properties of Steam Table
When to Use a Condensate Pump

- Upstream pressure is low
- Upstream and downstream pressures modulate
- Modulated steam control

Why Use a Condensate Pump

- To recover condensate/water
- To recover boiler chemicals
- To recover waste heat
### Potential Savings

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Pressure</td>
<td>100 PSIG</td>
</tr>
<tr>
<td>Condensate Load</td>
<td>10,000 lbs./hr</td>
</tr>
<tr>
<td>Condensate Pressure</td>
<td>50 PSIG</td>
</tr>
<tr>
<td>Steam Cost</td>
<td>$5.00/1000 lbs.</td>
</tr>
<tr>
<td>Make-up Water Temp.</td>
<td>55 F</td>
</tr>
<tr>
<td>Boiler Water Temp.</td>
<td>180 F</td>
</tr>
<tr>
<td>Make-up Water &amp; Chemicals</td>
<td>$3.25/1000 gallons</td>
</tr>
<tr>
<td>Sp. V of Water @ 55 F</td>
<td>.120 gal./lb.</td>
</tr>
</tbody>
</table>

### Potential Savings

**Flash Loss:**

- 50 PSIG Flashing to 0 PSIG = 9% Flash Loss
- 10,000#/hr Condensate Load X 9% = 900#/hr Condensate Loss
- 900#/hr X 24 hrs/day = 21,600#/Day Loss
- 21,600#/Day X 365 Days/Yr. = 7,884,000#/Yr. Loss
- 7,884,000#/Yr. X $5.00/1000 Lbs. = $39,420.00 Loss/Yr.
Potential Savings

Water Loss:
• 7,884,000#/Yr. X .120 Gal.lb. = 946,000 Gallons/Yr. Loss
• 946,000 Gallons/Yr. X $3.25/1000 Gallons = $3,074.50 Loss/Yr.

Potential Savings

Preheat Make-up Water Cost:
• 180 F Boiler water temp – 55 F make-up water temp = 125 F temp rise
• 125 F temp rise = 125 BTUs/lb
• 125 BTU/lb. X 900#/hr. = 112,500 BTUs/lb. req'd.
• 112,500 BTU/hr. / 880 BTU/lb @ 100 PSIG = 128#/hr. consumed
• 128#/hr. X $5.00/1000 lbs. steam cost = $0.64/hr. cost
• $0.64/hr. X 24 hrs./day = $15.63/day cost
• $15.36/Day X 365 Days/Yr. = $5,606.40/yr. cost
Potential Savings

Total Potential Savings:

- Flash Loss = $39,420.00
- Make-up Water & Chemicals = $3,074.50
- Preheat Make-up Water = $5,606.40

$48,100.90/Year

Steam Cost Analysis

- Operating Conditions
  - 7.5 hours/day
  - 250 days/year
  - 1875 hours/year
  - 23,500#/hr steam load
  - $5.00/1000 gal. water & chemical cost
  - $0.84/gal. fuel oil cost
  - 55 F feed water temp.

- Condensate Dumped
  - $26,416.00/year make-up water & chemical cost
  - $8.22/1000 lbs. steam cost, or
  - $362,034.00 annual steam cost
  - $388,450.00 annual total steam cost
## Steam Cost Analysis

### Operating Conditions
- 7.5 hours/day
- 250 days/year
- 1875 hours/year
- 23,500#/hr steam load
- $5.00/1000 gal. water & chemical cost
- $0.84/gal. fuel oil cost
- 55°F feed water temp.

### Vented Pump
- $3,011.00/year make-up water & chemical cost
- $7.31/1000 lbs. steam cost, or
- $322,012.00 annual steam cost
- $325,023.00 annual total steam cost
- $63,427.00 (19.51%) Savings

### Closed Pump
- $0.00/year make-up water & chemical cost
- $6.50/1000 lbs. steam cost, or
- $286,609.00 annual steam cost
- $286,609.00 annual total steam cost
- $101,841.00 (35.53%) Savings
Steam Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Condensate Dumped</th>
<th>Vented Pump</th>
<th>Closed Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water &amp; Chemical</td>
<td>$26,416.00</td>
<td>$3,011</td>
<td>$0.00</td>
</tr>
<tr>
<td>Steam</td>
<td>$362,034.00</td>
<td>$322,012.00</td>
<td>$286,609.00</td>
</tr>
<tr>
<td>Total</td>
<td>$388,450.00</td>
<td>$325,023.00</td>
<td>$286,609.00</td>
</tr>
<tr>
<td><strong>Savings</strong></td>
<td></td>
<td><strong>$63,427.00</strong></td>
<td><strong>$101,841.00</strong></td>
</tr>
</tbody>
</table>

Boiler Feed Analysis

- **Operating Conditions**
  - 24 hours/day
  - 250 days/year
  - 500 HP boiler
  - 100 psig steam pressure process
  - 17,250 #/hr steam load
  - $6.02 steam cost
  - $3.24/1000 gal. water & chemical cost
  - 200 F feed water temp (0 psig)

- **Before**
  - 13.3% flash loss
  - 2294 #/hr flash loss
  - 55,000 #/day flash loss
- **Annual Costs**
  - $82,700.00 Steam
  - $5,300.00 water & chemicals
  - $2,030.00 electric boiler feed pump
  - $90,030.00 TOTAL
# Boiler Feed Analysis

## Operating Conditions
- 24 hours/day
- 250 days/year
- 500 HP boiler
- 100 psig steam pressure process
- 17,250 #/hr steam load
- $6.02 steam cost
- $3.24/1000 gal. water & chemical cost
- 277 F feed water temp (60 psig)

## After
- 3.5% flash loss
- 606 #/hr flash loss
- 14,500 #/day flash loss

## Annual Costs
- $21,800.00 Steam
- $1,400.00 water & chemicals
- $162.00 electric boiler feed pump
- $23,362.00 TOTAL

## Before vs After Costs

<table>
<thead>
<tr>
<th>Costs</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water &amp; Chemical</td>
<td>$5,300.00</td>
<td>$1,400.00</td>
</tr>
<tr>
<td>Steam</td>
<td>$82,700.00</td>
<td>$21,800.00</td>
</tr>
<tr>
<td>Electricity</td>
<td>$2,030.00</td>
<td>$162.00</td>
</tr>
<tr>
<td>Total</td>
<td>$90,030.00</td>
<td>$23,362.00</td>
</tr>
<tr>
<td>Savings</td>
<td></td>
<td>$66,662.00</td>
</tr>
</tbody>
</table>
Liqui-Mover® Pump Applications

Open System – LMV
Flash System – LMV

To Low Pressure Steam System

Make-Up Valve

Inlet

Receiver

Vent

Motive

Discharge

Trap - if required

LMV Series Liqui-Mover

Closed System
(Steam Trap/Pump Combination)

Inlet

Receiver

Vent

Motive

Discharge

Steam Trap

LMV Series Liqui-Mover
Open System – LMH

Inlets to Atmosphere Vent Line

Motive Pressure Inlet

PRV

Receiver

Equalizing Chamber

Discharge

Relay

Flash System – LMH

Make-Up Valve

To Low Pressure Steam System

Motive Pressure Inlet

Solenoid Valve 2-Way Normally-Closed (May be required)

Receiver

Equalizing Chamber

Relay

Discharge

Vent Line
Closed System – LMH

Closed System with 2-way Valve
Sump Pit – LMV

Compressed Air Motive

Screen Covered Inlet

Liqui-Mover

Vent to Atmosphere

Pump Discharge

LMV Series Liqui-Mover

Modulating Steam Valve

Steam Supply

Heating Coils

Steam Trap - If Required

Condensate Return Header

Control Panel

Vent

Condensate Discharge

Steam

Pasteurizers
Steam Absorption Liquid Chillers

Condenser
Generator
Evaporator
Absorber
Steam Control Valve
Vacuum Breaker
Trap
When Specified
3-Way Electric Pneumatic Valve or Switch
Relief Valve
Air Eliminator
Receiver
Control Panel
Condensate Discharge

Steam Supply
Vent
Cylinder Operated Steam Valve

Steam Turbine

Turbine Casing 28” Max. Vacuum
Condenser Chamber 28” Max. Vacuum
Hot Well
Turbine Room Floor
Condensate Chamber Pump Suction
Discharge
Basement Floor
VATS – Before

VATS – After
Flash System – Before

Flash Steam

30,000 pph

Return

185 psig Condensate from Processes

High Pressure Receiver (60 psig)

Pump

Discharge to Boiler Room

27,000 pph

3000 pph

Flash System – Dual Pumps

Compressor Cooling Water

Heat Exchanger

Drain

Flash for Winter Heating

185 psig Condensate from Processes

Return

High Pressure Receiver (60 psig)

Low Pressure Condensate Returns

Low Pressure Receiver

Discharge to Boiler Room

Liqui-Mover

Liqui-Mover
Alternating System

Boiler Feed System
Compressed Air as Backup

- **Air Supply**
- **Steam Supply**
- **Low Pressure Switch**
- **Ball Valve 2-Way Normally Closed**
- **3-Way Valve**
- **Level Control**
- **Pump**
- **Condensate Discharge**
- **Vent**
- **Condensate Return**
# LMH Series – Boiler Feed System

## Target Industries

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Air Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol Plants</td>
<td>Sewage Plants</td>
</tr>
<tr>
<td>Food</td>
<td>Hotels/Casinos</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Hospitals</td>
</tr>
<tr>
<td>Textile</td>
<td>Colleges/Schools</td>
</tr>
<tr>
<td>Paper</td>
<td>Museums</td>
</tr>
<tr>
<td>Corrugating</td>
<td>Engineering Firms</td>
</tr>
<tr>
<td>Petroleum</td>
<td>Contractors/Consultants</td>
</tr>
<tr>
<td>Chemical/Pharmaceutical</td>
<td>Jobbers</td>
</tr>
<tr>
<td>Rubber/Plastics</td>
<td>Lumber Products</td>
</tr>
<tr>
<td>Automotive</td>
<td>Printing</td>
</tr>
<tr>
<td>Tire Plants</td>
<td>Laundries</td>
</tr>
<tr>
<td>Railroad</td>
<td>Government Buildings</td>
</tr>
</tbody>
</table>
# Typical Applications

<table>
<thead>
<tr>
<th>Grain Dryers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookers</td>
</tr>
<tr>
<td>Steam Coils - Fresh Air, Unit Heaters, Pocket Vent</td>
</tr>
<tr>
<td>Water Coils</td>
</tr>
<tr>
<td>Shell and Tube Heat Exchanger</td>
</tr>
<tr>
<td>Plate and Frame Heat Exchanger</td>
</tr>
<tr>
<td>Parts Washer - Submerged Steam Coils or P. &amp; F.</td>
</tr>
<tr>
<td>Kilns/Ovens - Steam Coils</td>
</tr>
<tr>
<td>Dry Cans/Slashers</td>
</tr>
<tr>
<td>Steam Chests - Corrugators</td>
</tr>
<tr>
<td>Distillation Towers/Columns</td>
</tr>
<tr>
<td>Tank Farms</td>
</tr>
<tr>
<td>Tank Cars - Rail Cars</td>
</tr>
<tr>
<td>Sterilizers</td>
</tr>
<tr>
<td>Presses - Tire Plants, Plywood Plants, etc.</td>
</tr>
<tr>
<td>Absorption Machines</td>
</tr>
<tr>
<td>Pasteurizers</td>
</tr>
<tr>
<td>Boiler Feed Pump</td>
</tr>
</tbody>
</table>
“Stall” and How to Eliminate It

Kadant Johnson is a Resource

- Steam and condensate expertise
- Product application expertise
- Systems integration expertise
- Global technical and service support
- Pressure-power pump innovator
Application Expertise

• Trapped systems
• Temperature control valves
• Sizing of flash tanks and receivers
• Vent line sizing
• Pump sizing and application
• System configuration
• Equipment recommendations
• Steam and condensate handling
• R.O.I. Calculations

Stall

A condition in which heat transfer equipment is unable to drain condensate and becomes flooded, or when system pressure is inadequate to drain condensate
Effects of Stall

- Water hammer
- Frozen steam coils
- Poor temperature control
- Control valve hunting
- Reduction in heat transfer capacity
- Corrosion due to cooled condensate and carbonic acid formation

Typical (Ineffective) System Design
Typical “Fix”

Float Level Control

Fill  Pump  Equalize
Typical (Ineffective) System Design

Pressure Power Pump – Closed System
LMHT Pump/Trap Combination

Probe Level Control

Fill  Pump  Equalize
LMH Pump/Trap Combination

Pressure Power Pump – Closed System
LMH Pump/Steam Trap System

Dual Pump Station

- LMH-20/50-LRSP
  - (2) Pump Stations
  - Common Skid
  - Flash Separators
  - Pump/Trap Feature
  - Space Limitations
Pressure Power Pumps

Fluid Handling Accessories

- Valves
- Vacuum breakers
- Sight flow indicators
- Separators
Proper Steam Trapping

Single Coil

F & T Trap

Vacuum Breaker

Control Valve

Air Vent
Multiple Coils, Group Trapped

Multiple Coils
5750 SBA F
Self-Supporting Rotary Joint with Cantilever Stationary Syphon

Ready for Order Date: Now!
Ready to Ship Date: 15 April 1999*

*for small quantities or special circumstances, consult with the factory.

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15 Jan 99</td>
<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>20 Nov 02</td>
<td>5, 7</td>
<td>Added vacuum service conditions and sales tools</td>
</tr>
<tr>
<td>C</td>
<td>30 Dec 04</td>
<td>All</td>
<td>Update name to Kadant Johnson</td>
</tr>
</tbody>
</table>
**Product Overview**

The 5750 SBAF is a self-supporting rotary joint with a cantilever stationary syphon designed for open gear paper machines. The joint is lighter and more compact than alternative joints, and it includes a revolutionary patent pending safety mechanism to prevent damage beyond the joint in the unlikely event that a bearing failure occurs.

**Designation**

The 5750 series identifies the joint as having a design style similar to the Kadant Johnson 5000 series impact joints. The letter designations are defined as:

- **S** - self-supporting joint
- **B** - balanced seal
- **A** - a joint with 90° angle head; inlet is 180° from outlet, or can be rotated to same plane
- **F** - flanged, rather than screwed, connections on inlet and outlet

Other head configurations are optionally available.

**Unique Selling Proposition**

*Reduces the cost-per-ton for producing paper on open gear paper machines.*

The 5750 SBAF joint is a self-supporting rotary joint that is sold with a cantilever stationary syphon and Turbulator bars to enable the design of a steam system that supports increasing the speed of open gear paper machines to profitable and competitive rates, while maintaining or increasing the quality of the paper, reducing energy consumption, and reducing maintenance costs.

The system operates effectively with lower blow-through steam and lower differential pressures than rotary syphon systems, while maintaining greater stability than a conventional slow speed stationary syphon. The syphon is rugged enough to withstand the forces due to higher speeds and turbulent condensate up to 4,000 fpm (1220 mpm).

Because of reduced wear, and reduced maintenance costs, the 5750 SBAF joint and syphon system provides a rapid and significant return on the cost of purchasing and installing it, and improves the return on the paper machine asset.

**Value Proposition**

**Key Selling Points**

<table>
<thead>
<tr>
<th>Joint</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact, lightweight</td>
<td>Easier installation and maintenance - the joint is easily installed by two people</td>
</tr>
<tr>
<td>Rotating body attached to roll</td>
<td>Strong support for body provides greater stability for syphon with compact design</td>
</tr>
<tr>
<td>Tapered roller bearings</td>
<td>Long life, high stiffness for syphon stability.</td>
</tr>
<tr>
<td>Insulating sleeve for bearings</td>
<td>Protects rotary joint bearings against process fluid heat for long life. (patent pending)</td>
</tr>
<tr>
<td>Balanced seal</td>
<td>Extended seal life - properly installed joints with similar designs show little seal wear after two years of operation.</td>
</tr>
<tr>
<td>Safety mechanism</td>
<td>Protects stationary piping from damage if bearings seize. (patent pending)</td>
</tr>
<tr>
<td>Self-supporting</td>
<td>The joint will not experience the wear due to oscillations and alignment problems caused by mounting on an external frame.</td>
</tr>
</tbody>
</table>
Syphon

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light weight</td>
<td>Easier installation</td>
</tr>
<tr>
<td>Reduced blow-through steam</td>
<td>Compared to rotating syphons, or rotary scoop syphons, the system will use less blow-through steam.</td>
</tr>
<tr>
<td>Reduced differential pressure</td>
<td>The system operates with a lower differential pressure than rotary syphons or rotary scoop syphons. Less (or no) vacuum is required on the first steam section.</td>
</tr>
<tr>
<td>Rugged design</td>
<td>The cantilever stationary syphon provides all the advantages of a high performance stationary syphon through all ranges of condensate behavior (puddling, cascading, rimming) while maintaining exceptional strength and stability. The possibility of syphon breakage is dramatically reduced.</td>
</tr>
<tr>
<td>Curved elbow</td>
<td>Aesthetically pleasing; suggests smoother flow of fluids.</td>
</tr>
</tbody>
</table>

Value

*Increased runnability and system flexibility*

An open gear paper machine with a steam system designed to take advantage of the 5750 SBAF self-supporting rotary joint and cantilever stationary syphon and Turbulator bars will provide improved runnability and increased paper quality at significantly higher speeds. The 5750 SBAF is designed to operate at machine speeds of up to 4000 fpm (1220 mpm). The recommended differential pressure and blow through steam is constant for all machine speeds. This allows system flexibility for running various grades of paper at various steam pressures.

*Reduced Steam Usage*

The system will use less blow-through steam than typical open gear arrangements with conventional stationary syphons, rotary syphons, or rotary scoop syphons. At higher speeds, a stationary syphon does not require the increased blow-through steam and increased differential pressure to overcome centrifugal force as does a rotary syphon.

*Reduced Maintenance Costs*

Maintenance costs will be reduced by:

- the extended life of the balanced seal (expected to be 2-3 years of operation)
- rugged syphon reduces the possibility of syphon breakage
- joint design reduces possibility of seized bearings or other failure
- safety mechanism prevents damage to flex hoses and piping in the unlikely event of seized bearings.

*Improved Return on Assets*

Because of increased production, reduced steam usage, and reduced maintenance costs, an open gear paper machine with the 5750 rotary joint with cantilever stationary syphon and Turbulator bars will generate a significantly improved return on the operation of the paper machine.
Safety Mechanism

In addition to preventing damage to flex hoses and piping associated with the joint, the safety mechanism allows the joint to continue running safely until a shutdown can be scheduled. The o-ring in the safety mechanism provides a temporary seal which will eventually leak a small amount through weep holes. While no specific guarantees can be made about the life of the temporary seal, leakage when the o-ring fails will be minor. Based on testing by JOCO R&D, the safety mechanism will provide adequate sealing and a safe installation until the machine can be conveniently shut down for repair.

Kadant Johnson recommends the mill valve off the affected dryer as soon as steam leakage is observed. The temporary seal is not intended to allow continued production operation of the dryer, but to prevent external damage.
Product Operating Principles

The body is attached to, and rotates with, the journal. The nipple is attached to the head with a retaining ring and guide (bushing), and is prevented from rotating during normal operation by shear pins. The joint uses tapered bearings to support itself while minimizing torque and allowing a small amount of radial misalignment. The main seal is a balanced seal design that minimizes wear on the seal ring.

In the unlikely event that the bearings fail and the nipple seizes to the body, the shear pins fail, and the nipple turns with the roll. Forces on the stationary piping are minimal, while the failure will be indicated by leakage of process fluid through weep holes in the retaining ring. The safety mechanism prevents damage to flexible hoses and piping connected to the joint.

Operating Conditions

Maximum Conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>150 psig (10 bar)</td>
</tr>
<tr>
<td>Temperature</td>
<td>367°F (186°C)</td>
</tr>
<tr>
<td>Speed</td>
<td>1000 rpm</td>
</tr>
<tr>
<td>Service</td>
<td>steam/condensate, water</td>
</tr>
</tbody>
</table>

Maximum limits vary in relation to changes in RPM, pressure, and temperature.

Consult Kadant Johnson for safe limitations under specific application conditions.

For applications exceeding the above maximum conditions, consult with Kadant Johnson.

Standard Configuration

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50 psig sat. steam</td>
<td>298°F (148°C)</td>
</tr>
<tr>
<td>298°F (148°C)</td>
<td>4000 fpm (1220 mpm)</td>
</tr>
<tr>
<td>4000 fpm (1220 mpm)</td>
<td>1000 lb/hr (455 kg/hr)</td>
</tr>
</tbody>
</table>

High Temperature Configuration

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>150 psig sat. steam</td>
<td>367°F (186°C)</td>
</tr>
<tr>
<td>367°F (186°C)</td>
<td>4000 fpm (1220 mpm)</td>
</tr>
<tr>
<td>4000 fpm (1220 mpm)</td>
<td>1000 lb/hr + (455 kg/hr), depending on pressure</td>
</tr>
</tbody>
</table>

The 5750SBAF joint is capable of operating with 10 psig vacuum (4.7 psia) or 20.3" Hg when the o-ring version of the seal package is used. The cup seal version of the seal package cannot be used for vacuum service.
### Design Features

#### Joint

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Threaded or flanged M and P connections</td>
</tr>
<tr>
<td>Materials</td>
<td>Ductile iron</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Refer to attached assembly drawing.</td>
</tr>
<tr>
<td>Weight</td>
<td>Easily installed by two people.</td>
</tr>
<tr>
<td>Size</td>
<td>K = 3.5”</td>
</tr>
<tr>
<td>ASME Code</td>
<td>Designed in accordance with ASME Boiler Code.</td>
</tr>
<tr>
<td>Safety mechanism</td>
<td>Patent-pending design. Shear pins break if nipple seizes to rotating body. Leakage past guide and retaining ring indicates pin shear due to seizure.</td>
</tr>
<tr>
<td>Bearings</td>
<td>Tapered; syphon support tube includes “insulating sleeve” to protect bearings from heat of process fluids.</td>
</tr>
<tr>
<td>Grease fittings and cast grease passages</td>
<td>Passageways for greasing the bearings while the joint is in operation are cast into the nipple. Grease fittings are attached to the nipple and remain stationary while the joint is in operation.</td>
</tr>
</tbody>
</table>

#### Syphon

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Pipe</td>
<td>Curved, 1” sch. 80 standard, or 1-1/4” optional</td>
</tr>
<tr>
<td>Support Tube</td>
<td>2-1/2” ID for maximum steam flow capacity</td>
</tr>
<tr>
<td>Pick-up shoe</td>
<td>Ductile iron or Teflon</td>
</tr>
<tr>
<td>Vertical Support</td>
<td>Light weight, angle bracket</td>
</tr>
<tr>
<td>Blow-through steam</td>
<td>5% - 10%, depending on paper grade</td>
</tr>
<tr>
<td>Differential pressure</td>
<td>3-5 psig</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Refer to attached assembly drawing.</td>
</tr>
</tbody>
</table>

#### Installation

As with all self-supporting joints, the 5750 SBAF is sensitive to hose loading. **Kadant Johnson strongly recommends using two flexible hoses per connection to ensure maximum bearing life.**

Because the cantilevered syphon is mounted to the rotary joint, **it is also very important to accurately align the joint with the axis of rotation of the dryer.** Proper alignment will ensure that the designed syphon clearance is maintained inside the dryer shell. Kadant Johnson can perform this service or provide consulting if desired by the customer.
Targeted Customers & Applications

Paper industry; open gear paper machines. Target customers may be either rotary or stationary syphon with current installation. Other characteristics of targeted customers:

- The customer has recently canceled or delayed capital spending plans to replace old paper machines or add new paper machines to their asset base.
- The customer has an old open gear paper machine that is not operating to the limits of the drive system, or has recently upgraded the drive system to allow for increased speed.
- The customer has an open gear paper machine that is dryer-limited.
- The customer has had problems with syphon breakage.
- The customer is running a wide range of paper grades.

Sales Collateral / Reference Material

Bulletins / Brochures

A one sheet (printed front and back) flyer to leave with customers is available for order from the Kadant Johnson Marketing Department

PowerPoint Sales Presentation

Download the latest sales presentation online in the members section at JOCO.com.

Simulated Failure Video CD

A video CD is available to demonstrate the effectiveness of the safety clutch mechanism.

Reference Accounts

Kadant Johnson has had a similar design concept (two joints) in operation at a customer site since January 1998. The customer’s open gear machine is drive limited to 1700 fpm (518 mpm). To date, there has been no failure with any component of the Kadant Johnson joint, and virtually no visible signs of seal wear.

Key features important to this customer are the safety mechanism and the ability to lubricate the bearings while the machine is in operation.
The primary competition for the 5750 SBAF will be a modified version of the Deublin FS100S rotary joint with a Deltasint stationary syphon and Turbosint turbulence bars. Kadant Johnson engineers have observed this design in operational trials at a customer site (two joints).

One of the Deublin test joints incurred a bearing failure (squeaking). The design of the test joint may make it difficult to prevent bearing failure (See weaknesses, below). Kadant Johnson engineers noted the following strengths and weaknesses of the Deublin trial joints:

**Strengths**
- Cost of manufacturing. The nipple and head is fabricated in one piece. It is uncertain whether or not Deublin will pass this savings on to the customer.
- Aggressive marketing through Beloit MillPro Services. Papermakers have many old Beloit open gear paper machines still in operation.

**Weaknesses**
- No safety mechanism - a bearing failure (more likely with this design) will result in significant damage to flex hoses and stationary piping.
- There is no steam sleeve to protect bearings from the heat of the process fluid. As a result, the bearings require very expensive grease for all applications.
- The seal surface is exposed during installation of the joint. This exposure risks contamination and damage during installation that could cause early failure of the seal.
- The joint uses ball bearings, which prevents rigid mounting of the stationary syphon.

**Threats**
- Because of the weak market for new paper machines, Beloit has stated that it will aggressively pursue repair business. Kadant Johnson has received reports of MillPro Services trying to lock in repair business by recommending (almost requiring) a bundle of services which only it can provide for its machines.

**Opportunities**
- Reduced cost per ton of paper produced. The 5750 SBAF extends the life of open gear paper machines, permits higher operating speeds, and reduces energy consumption.
- Kadant Johnson competitive advantage. Both Kadant Johnson and Deublin are introducing similar products, however Kadant Johnson has a stronger position in the paper industry and a superior product. Deublin will compete strongly against the 5750 SBAF - *make sure you get to the customer first with this exciting new joint and syphon!*
- Reduced capital expenditures. Papermakers are trying to get even more life out of older, open gear paper machines since little capital is available to replace aging mills or machines. The 5750, along with a complete steam system redesign, offers immediate financial advantage to the papermaker.
**Professional Services**

One of the most effective ways to sell rotary joints and associate components is by *leading with services*. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the 5750 SBAF rotary joint, cantilever stationary syphon and Turbulator bars for their specific papermaking application.

Kadant Johnson Systems™ is the single source for dryer and drainage systems and dryer section optimization. Kadant Johnson’s papermaking process knowledge from machine surveys and system design to advanced control design and installation services, places it in a unique position to offer the highest level of support to the paper industry. Contact Kadant Johnson for assistance in qualifying prospects and proposing services in the following areas:

- Dryer Performance Studies
- Dryer Rebuild Studies
- Steam and Condensate System Studies
- Hood and Dryer Air Studies
- Steam and Condensate Design and Engineering Services

**Installation & Rebuild Services**

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

**Training & Education Services**

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
-Troubleshooting and preventive maintenance sessions
Ordering Information

<table>
<thead>
<tr>
<th>Ready for Order:</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Ship:</td>
<td>15 April 1999*</td>
</tr>
</tbody>
</table>

*for small quantities or special circumstances, consult with the factory.

Lead Time

The standard lead time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until delivery of the product to the customer.

The standard lead time for a complete, standard model 5750SBAF joint and cantilever stationary syphon is:

4 weeks

Pricing

Pricing for the 5750SBAF is available on a separately enclosed page. Prices are subject to change without notice.

Required Information to Place an Order

- Flow calculations to show the system has the required capacity.
- Journal ID sufficient to allow 3-1/2” support tube.
- Journal bolt pattern and pilot dimension.
- Inlet/Outlet connection size and configuration.
- Dryer/journal dimensions to facilitate calculation of support tube length and vertical leg length (drawings preferred - refer to Kadant Johnson drawings A97-16-03-19 and AB97-16-03-19).
- Balance weight locations.
- Mounting location for torque lug.
- Individual pressure control if mixing stationary syphons and rotary syphons in one dryer section.
- Review area that the joint will be mounted in to assure sufficient space exists.
- Determine the torque lug location (the customer provides a slotted torque bracket for the lug to slide into).
- If the journal ID requires a support tube diameter less than 3-1/2”, Kadant Johnson can reduce the nipple ID if the flow capacity remains high enough for the application.

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.
5750SBAF™ Rotary Joint and Stationary Syphon

5750SBAF Product Overview

- Rotating body
- Tapered roller bearings
- Patent pending built-in insulating sleeve
- Balanced seal
- Safety mechanism
- Operating conditions
  - Up to 150 psig
  - Up to 367°F
  - Up to 1000 rpm
5750SBAF Product Overview

- Body rotates
- Head and nipple are fixed

Safety mechanism engaged

Body and nipple rotate
Kadant Johnson Stationary Syphons

- High and low speed applications
- Narrow profile for minimal resistance
- Ductile iron is sacrificial material
- Low vibration
- Low deflection
- High stiffness and natural frequency
Kadant Johnson Stationary Syphons

- Large diameter support tube (high tune)
- Sweep syphon elbow
- Rigid mounting

Cantilever Stationary Syphon

- Taper
- Threaded Syphon support
- Horizontal Pipe
Cantilever Stationary Syphon

- Bent Horizontal Pipe
- Clamp
- Light weight vertical support
- Clamp
- Syphon foot

What makes the 5750SBAF different?

- Rotating body
- Designed for limited dry running
- Compact and lightweight design
- Safety mechanism
- Low torque operation
How does the system reduce cost-per-ton?

- Balanced seal reduces friction and seal wear resulting in reduced maintenance downtime
- Built-in insulating sleeve protects bearings from high heat resulting in longer service
- Reductions in motive steam consumption and venting to condensers saves energy
Bearing Cover Inserted Rotary Joint (BCI)

Continuous Casters and Tunnel Furnaces

- RX rotary unions
- C-Cast rotary joints
- BCI rotary joints
- OTS rotary joints
Unique BCI Features

- Eliminates flex hoses
- Eliminates flex hose loading on joint
- Rotary joint is protected from break-outs
- Roll journal is protected from break-outs
- Permanently lubricated bearing surfaces
- Single- and dual-flow units identical
- Easy to install – four bolts
- Self-centering design
- Handles misalignment
- Field repairable - fast and inexpensive
- Reduced caster maintenance
BCI Design Cross-Section

Outlet

Inlet

Handles Misalignment

- Misalignment
  - Radial (3 mm)
  - Axial (10 mm)
  - Angular (1.5°)

- Short length
  - CJI is 75 mm
  - BCI is 65 mm
Radial Misalignment

- From bearing housing and bearing clearances
- Self-centering design
- No side loading is generated due to this misalignment
- Handles ±1.6 mm of radial misalignment

Axial Misalignment

- From thermal growth
- Handles 10.5 mm of axial movement
- Maximum axial movement 13.67 mm
Angular Misalignment

- From roll deflection
- Handles ± 0.75° of angular misalignment
- BCI load = CJI load with 1° of misalignment
- BCI load = CJI hose load with 2° misalignment

BCI – Long Seal Life

- Seal life exceeds CJI model
- Hose loading has been eliminated
- Uses proven nipple-body interface
- Lower load on bearing area
- Protected by the bearing cover
**Unique BCI Features**

- Tolerates dirty water with varying pH values
- Corrosion-resistant (stainless, bronze, brass, EPR, Nitrile)
- Thrust bearings protect the bearing area from contamination

**Unique Features**

- High $C_v$ rating
  - Smooth flow passages
  - Large flow area passages
- Simple design
  - Two rotating parts (nipple & insert)
  - Single-flow and dual-flow designs
- Quad seal technology
## Unique Features

- **Low cost repairs**
- **Easy installation**
  - Four bolts to install
  - One-piece assembly
- **Fast repair**
  - Rotary joint removes as one piece
  - Jacking screws on head eases removal
  - Rebuilt without removing the bearing cover
  - Clocked bolt ensures proper installation
  - Proven concept and components

## Unique Features

- **Self-centering rotary joint**
  - Rotary joint compensates for cover centerline to roll centerline misalignment with no addition loading
- **Dual flow and single flow are the same**
- **Permanently lubricated bearing**
- **No flat mechanical seals to misalign**
- **Customer rebuilds**
  - Rebuild procedure very similar to CJI
Accelerated Life Testing

- 6.8 bar (100 psig)
- 27 C (80 F)
- 25 rpm

- Axial 10.2 mm
- Radial 1.0 mm
- Angular > 1.5°
- Run-out 0.15 mm

Test Results

- Five joints
- Average life:
  - Over 4,000 hours (CJI)
  - Over 7,300 hours (BCI)
- Specific life:
  - Lowest 4,886 hours
  - Longest 12,198 hours
BCI Field Trial

- Four BCI rotary joints – single flow configuration
- Installed September 2002
- Segment 5-9 (position 6) SMS caster
- 900,000 tons
- 1851 continuous heats

Product Support OEM/End-User

- Global manufacturing capability
- Global sales offices
- One rotary joint type to stock
  - Single-flow applications
  - Dual-flow applications
BCI Summary

• Based on field proven CJI design
• Eliminates flex-hoses
• Provides break-out protection
• Seal life exceeds CJI rotary joint
• Simple installation (four bolts)
• Low maintenance cost
• Field repairable
• Easy repair
  – Remove the head and body
  – Clean, replace seals, and re-grease
  – Re-install
C-Cast™ Rotary Unions

Continuous Casters and Tunnel Furnaces

- RX rotary unions
- C-Cast rotary unions
- BCI rotary joints
- OTS rotary joints
C-Cast Rotary Union

- Introduced in 1992
- Single and dual flow
- Simple quad-ring sealing
- No mechanical seals
- Ceramic coating option

C-Cast Flow Path

Dual-flow

Single-flow
Journal Inserted CJI Rotary Union

- CJI Body (Rotates with roll)
- Nipple (Stationary)
- Head (Stationary)

Nipple (Stationary)

Thrust bearings protect seals from dirt

Advanced coating on Quad-ring seals

Greased journal bearing design
C-Cast Rotary Union Configurations

External mounted with threads

Internal mounted with flange

Design Parameters

- Up to 150 psig
- Up to 250°F
- Up to 100 RPM
- Sizes ½” to 1-1/2”
- Water service
December 10, 2007

**CorrPro™ Rotary Joint Application Summary**

**Product Focus**

Steam Heated Rolls for the Corrugating and other Industrial Applications

The CorrPro product line was originally designed for steam-heated rolls on corrugating equipment. This rotary joint design was developed using PT steam joint technology introduced in 1991 for paper machine applications. The features and benefits are described in the New Product Introduction (NPI). The energized seal configuration is the standard offering. Currently there is an installed base of approximately 2500 CorrPro rotary joints.

**CorrPro Cantilevered Stationary Configuration**

The CorrPro CASC product line is for stationary syphon applications. Drawing LE1557 shows the cantilevered syphon with locking elbow.

**CorrPro Gun Drilled or Tri-Pass Roll Configuration**

The CorrPro CNA configuration features a rotary syphon typically used with Tri-Pass, or gun drilled roll applications. Drawing LE1687 shows the driven horizontal pipe with the tube adapter.

**2500 LJ-PT™ Rod-Supported Configuration**

The 2500 LJ-PT rotary joint is configured with a stationary syphon. This design is similar to LE1598. The 2500 LJ-PT rotary joint is rated for steam pressures up to 225 psig and speeds to 400 rpm. This is a very versatile design suitable for most rod-supported installations. It is often used with bent tube style stationary syphons.
**Product Information**

The CorrPro rotary joint and cantilevered stationary syphon is designed to operate at the conditions per drawing A46092, Symbol No. A97-16-3-22.

See the Kadant Intranet for the CorrPro NPI showing additional product information. The NPI includes: product overview, sales strategy, product description, targeted customers, applications, competition and frequently asked questions.

See Kadant Intranet for the Power Point presentation.

**Technical Description**

The CorrPro rotary joint is a rigidly mounted joint with ring bracket support. This is a piston style joint where the nipple moves in relation to the end cap to accommodate seal ring wear. This is a balanced seal design that reduces the seal loading force. For example, a 9500 CorrPro rotary joint operating at 175 psig will have a thrust load on the bracket of 1,256 lbs (f), and a seal load of 396 lbs (f).

The standard CorrPro rotary joint is designed for up to 0.28” (7mm) of thermal expansion. We also have a design to accommodate up to .47” (12mm) of thermal expansion.

A reverse flow design is also available.

The 2500 LJ-PT rotary joint is a rod-supported configuration that utilizes the CorrPro style seal package as described above.

**Product Implementation**

The installation of CorrPro equipment starts with determining the make, model, roll type and roll location of the equipment. Syphon specifications, ring bracket mounting data, distance to end of journal and the journal dimensions are critical. The ring bracket may be mounted to the existing bearing covers. We typically mount the ring bracket with fasteners that also attach the bearing cover to the bearing housing. This mounting surface needs to suitable for mounting the ring
Conversion from equipment with lug style joints may require a special ring bracket or additional filler flanges.

If information is not readily available to design a ring bracket, dimensional measurements must be obtained. If alternate sources of measurement information are exhausted, a Field Service person may be required to collect measurements during a shutdown. They will measure the existing equipment to obtain the required dimensional data.

Detailed drawings of the existing equipment are desired. Information required include:

- Roll assembly drawing
- Journal detail drawing
- Roll shell detail drawing
- Roll bearing housing and cover detail drawings
- Drawing showing the position of the outboard journal end in relation to the existing bearing housing and cover

The critical dimension when installing a CorrPro rotary joint is the “Set-up” dimension. The “Set-up” dimension is shown on the assembly drawing and the joint drawing. The “Set-up” dimension is the distance between the mounting face of the ring bracket and the end of the journal. The typical “Set-up” dimension is 1.3” (32 mm). The tolerance for the set-up dimension is +/- .062” (1.6mm).

See the Intranet for detailed “Installation Instructions”.

The make and model of the equipment and roll location are needed to design the 2500LJ-PT installation. Also required are the existing support rod diameters, rod spacing, distance from the end of journal to the support rod mounting, the mounting configuration and the journal diameter. The support rods need to be evaluated to determine if they can support the thrust loads with this joint. We usually replace the existing .75” (19 mm) rods with larger 1” (25 mm) diameter units.

Detailed drawings of the existing equipment are desired as described above.
Operating Issues and Problem Solving

The following are issues we have experienced during the installation and operation of CorrPro equipment:

The installation is dependent on the accuracy of the machine measurements taken for the existing installation.

Another potential problem is with the roll changing position in relation to the bearing housing. This has occurred on rolls configured with straight bearing seats and tapered adapters for tapered fit bearings. The bearings were removed from the roll and re-installed with the bearing in a different position on the journal. This moved the journal end position in relation to the bearing housing. In one case the journal end moved away from the joint more than 0.28" (7mm) resulting a major steam leak.

We have experienced a failure on one CorrPro locking elbow due to vibration of the syphon assembly. If recurring failures occur, contact the factory regarding measuring the vibration to help identify the root cause of the problem.

Competition

There is no direct competitor for this design of rotary joint in the Corrugating market. The most significant issue to overcome when promoting this product is the price. The value proposition should be discussed with the customer.

We have a proven record of product performance and parts availability that will outperform the OEM’s.

See the NPI for more details regarding the competition.
CorrPro™
Rotary Joint and Syphon System

General Customer Availability:

<p>| | |</p>
<table>
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<th></th>
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<tbody>
<tr>
<td>Ready for Order Date:</td>
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<tr>
<td>Ready to Ship Date:</td>
<td>18 February 2000</td>
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The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

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<td>C</td>
<td>22 Jun 2009</td>
<td>All</td>
<td>Design modifications (pp. 2-3); General updates</td>
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**Product Description**

The CorrPro™ rotary joint is a ring bracket-mounted steam joint designed for smaller rolls operating at higher steam pressures and rotational speeds. Originally developed for the corrugating industry and currently the standard offering to BHS, the CorrPro rotary joint can be applied to most steam heated rolls that require a high pressure, high speed rotary joint.

The CorrPro rotary joint is available with a stationary or rotating syphon and in 1½” size.

**Designation**

9500CASC-PT (for a stationary syphon)
9500CAN-PT (for a rotating syphon)

- **9500** Size – 1 ½”
- **C** Corrugating line
- **A** Head configuration
- **SC** Stationary cantilever syphon
- **N** Rotating horizontal pipe
- **-PT** Piston type

The maximum thermal expansion of the original CorrPro rotary joint was 7 mm. Recently, a 12 mm version was developed specifically for BHS. The original CorrPro design accepts 7 mm thermal expansion while the current 12 mm design can accept up to 12 mm thermal expansion. The rotary joint components differ for the 7 mm and 12 mm designs and are not interchangeable, with the exception of the head and seals.
The 12 mm CorrPro rotary joint includes a wear indicator that displays seal condition for the rotary joint. The indicator communicates improper set-up, seal condition in hot or cold state, and seal condition with or without thermal expansion. The product tag indicates the seal wear status in hot (i.e., steamed) and cold (e.g., pre-startup) conditions.

9500CASC-PT rotary joints installed on a single facer.
**Unique Selling Proposition**

The Kadant Johnson CorrPro rotary joint and syphon system for corrugating machines reduces cost-per-ton. A balanced seal and patented locking syphon elbow can provide years of trouble-free service resulting in less downtime due to joint and syphon maintenance. Direct savings result from reduced maintenance time and materials costs.

The joint operating torque is reduced by nearly 60% compared to traditional pressure joints. This results in lower energy consumption and increased uptime from longer seal life. The design is compact and lightweight, and requires no machine or equipment modifications. Increased uptime and system flexibility add up to significant savings and lower cost-per-ton.

**Value Proposition**

### Rotary Joint

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustable head precisely sets syphon clearance from outside the roll</td>
<td>Increases heat transfer when condensate is rimming, improves cross-machine temperature profile, and eliminates “trial and error” syphon installations</td>
</tr>
<tr>
<td>Antimony seal ring</td>
<td>Increased seal life</td>
</tr>
<tr>
<td>Piston type design</td>
<td>Allows for higher speeds and pressures</td>
</tr>
<tr>
<td>Balanced seal design</td>
<td>Minimizes seal loading and seal wear, reduces torque</td>
</tr>
<tr>
<td>Seal ring wear indicator</td>
<td>Allows on-machine measurement of seal ring wear</td>
</tr>
<tr>
<td>Flexibility in mounting</td>
<td>Bracket mounting accommodates most corrugator rolls</td>
</tr>
<tr>
<td>Compact</td>
<td>Fits inside typical enclosures on corrugating machines</td>
</tr>
</tbody>
</table>

### Syphon

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional rotating pipe syphon</td>
<td>Designed for peripheral drilled rolls</td>
</tr>
<tr>
<td>Optional cantilever syphon</td>
<td>Allows on machine adjustment of the syphon clearance to the roll</td>
</tr>
<tr>
<td>Cantilever syphon locked in 6 o'clock position</td>
<td>Allows condensate to evacuate the roll even while the machine is down; prevents “banana” shaped rolls and waste when the machine is re-started</td>
</tr>
<tr>
<td>Patented locking elbow</td>
<td>Firmly holds elbow in locked position, adds strength and rigidity to vertical leg of syphon, and increases operating life significantly</td>
</tr>
<tr>
<td>Stainless steel syphon elbow</td>
<td>Resists erosion, corrosion, and galling (by use of Nitronic 60®)</td>
</tr>
<tr>
<td>Harmonically tuned</td>
<td>Design accounts for unique vibrations and harmonics generated in corrugating machines and significantly extends life of syphon system.</td>
</tr>
<tr>
<td>Syphon elbow - straight threaded vertical leg</td>
<td>Allows additional adjustment of syphon height in addition to adjusting screw on rotary joint head</td>
</tr>
<tr>
<td>1” horizontal pipe with 0.75° cross-sectional flow area</td>
<td>Allows high flow rates in the most demanding application</td>
</tr>
</tbody>
</table>
Product Description

Operating Conditions

Maximum Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>20 bar (300 psig)</td>
</tr>
<tr>
<td>Temperature</td>
<td>232°C (450°F)</td>
</tr>
<tr>
<td>Speed</td>
<td>600 rpm</td>
</tr>
<tr>
<td>Service</td>
<td>steam/condensate</td>
</tr>
<tr>
<td>Flow Capacity</td>
<td>Condensing rates up to 455 kg/hr (1,000 lbs/hr)</td>
</tr>
</tbody>
</table>

Maximum limits vary in relation to changes in RPM, pressure, and temperature.

Consult Kadant Johnson for safe limitations under specific application conditions.

Installation Notes

Installation and repair instructions are available online from kadant.com or from Kadant Johnson Marketing.

Ensure that there will be enough clearance around the installed joint to accommodate the ring bracket. This may be a problem on some MHI cartridge rolls.

As part of proper steam system design, a Kadant Johnson vacuum breaker should be installed upstream from the rotary joint to prevent damage to the roll, joint, or piping during shutdowns.

9500CNA-PT rotary joints installed on a synthetic fiber line.
Targeted Customers and Applications

The CorrPro rotary joint is targeted at higher speed corrugating machines, up to 600 rpm. The product can also be applied to other steam-heated rolls.

During the production of corrugated board, moisture and temperature are critical for proper manufacturing. Corrugators have a limited amount of heating surface. Additionally, the linerboard and fluting sheet must have similar moisture content as they come together to prevent warping of the final product.

A problem with linerboard "blistering" costs thousands of dollars in scrap each year. If the syphon is not at the 6-o'clock position - especially in the single facer and pre-heater rolls on shut down - a puddle forms at the bottom of the roll. The puddle causes a portion of the roll to be colder than other parts. On re-start, this cold spot can have detrimental effects to the sheet, causing uneven glue setting which looks like a large blister across the sheet. Proper heat transfer is an important factor in controlling how much scrap is produced as a result of this problem. It becomes even more critical when this problem is combined with frequent stops and starts.

The CorrPro joint and syphon system design is created specifically for corrugators, but can be used on any roll that accepts a ring bracket-mounted rotary joint. Note: Peripheral drilled rolls in the corrugating industry requiring the rotating pipe version 9500CAN-PT.

Qualifying questions:

- Is there a problem or concern with (liner) blistering following temporary stops or roll changes?
- Is there a problem or concern with seal wear?
- Is there a problem or concern with syphon stability or syphon breakage?
- Is there a problem with high steam consumption?
- Is there a problem with excess condensate in the roll?
- Is the corrugator looking for extended joint life?

Do NOT target:

- Belt DRIVEN rolls (Belted rolls on BHS machines are good targets).
- Rolls on Langston XD machines that use fingers on the fluting roll (lateral adjustment of the roll does not permit using the CorrPro joint).
- The very small diameter rolls on Marquip machines.

Other possible applications:

- SHW calender rolls that are peripherally drilled
- Synthetic fiber production (e.g., DuPont)
Selling Strategy

Determine what kind of corrugating machinery the prospect is using. Determine the problems the prospect currently fights. Emphasize the anticipated cost savings of using the CorrPro rotary joint and syphon system.

In talking to production supervisors, focus on:

- Performance due to adjustable syphon clearance - These individuals are not likely to be familiar with the concepts of puddling, cascading, and rimming. Explain Kadant Johnson’s research and expertise in condensate handling and steam systems.
- Seal life of PT style joints - These individuals are not likely to be familiar with the PT-style balanced seal design. Explain how the design extends seal life and reduces downtime.
- Six o’clock position of the stationary syphon - Explain how this will keep the roll evacuated, even when the machine is stopped. Positioning should prevent blistering when machine is restarted, thereby reducing waste and increasing production.
- Reduced torque results in energy savings

In talking to maintenance supervisors, focus on:

- Reduced maintenance cost due to extended seal life (2 to 3 times what is currently experienced)
- Ease of handling the joint for installation and maintenance
- Ease of adjusting the stationary syphon from outside the roll

Cross-selling and bundling opportunities:

Vacuum breakers - The CorrPro system does not provide leakage on shutdown to provide implicit vacuum protection. Check the customer’s steam system; if vacuum breakers are not already installed, offer to provide them to be installed upstream of the rotary joint in the steam system.

Flexible hose – The flex hose is applied to the inlet and outlet of all rotary joints.

Liqui-Mover® pumping traps – Liqui-Mover pumps can be applied in various areas in a corrugating plant, including returning condensate from the steam chests.

Doctor blades – Knives or doctor blades are used on glue rolls and on the converting operations within the boxplant. Look for flexo printing presses for doctor blade opportunities.

Sales Collateral / Reference Material

Bulletins / Brochures
  - Corrugating Industry bulletin
Sales Presentations
  - Download from KJ Intranet
Competition

To date, few vendors have produced a joint and syphon system that addresses the unique needs of the corrugating industry. Two trends have resulted in the industry:

1. Some OEM’s are waiting and working with joint and steam system vendors to produce a solution.
2. Some OEM’s are moving ahead with new designs that rely less on joint and steam system suppliers for heat transfer solutions.

Kadant Johnson estimates that it currently holds a 79% market share with corrugators in Europe, and 90% or greater market share in North America, Latin America, and Australia. Estimated market share in Africa is 75%. In Asia (other than China) the estimated market share is 60%, while in China it holds less than 10% of the market.

Because of the perceived urgent need to address the problems described previously, some corrugators have developed new roll systems that do not require syphons. As these machines penetrate the market, the need for syphons will be eroded. However, other corrugating machine manufacturers are designing systems that will benefit from this joint and syphon system.

In Germany, BHS expressed interest in Kadant Johnson’s prototype CorrPro system and has worked closely with Kadant Johnson during field trials, particularly on its new peripherally drilled rolls. BHS has purchased LJ/LN style joints from Kadant Johnson in the past. Kadant Johnson Italia has been approached by at least two corrugating machine manufacturers to design a solution to this problem. Italian machine makers Agnatti and Terdeca are also both pursuing drilled roll steam system designs. Massenzana is using Deublin joints.

MHI/Mitsubishi corrugators use Rocky joints for the Japanese domestic market, but by customer demand, use Kadant Johnson for machines bound for the U.S. or Europe. Price is a critical factor in the Japanese market - Rocky sells a 1-1/2” joint for approximately US$239 (1999 pricing) - below the cost of comparable purpose joints from Kadant Johnson. Isowa is using Kadant Johnson joints.

Refer to the SX New Product Introduction package for details on competitive rotary joints used in the corrugating industry, including the Deublin HPS.
Services

Professional Services

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Installation & Rebuild Services

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- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair, and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering, and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Ready for Order:</td>
<td>14 January 2000</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>18 February 2000</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until shipment of the product to the customer.

Standard lead time is 4 weeks after approval of engineering drawings. Actual lead time information is available in the Visual system.

Pricing

Refer to price sheets for current pricing.

Required Information to Place an Order

Every sale of a CorrPro system will require field engineering data. *Drawing AB97-16-03-20 (Roll Information Required for CorrPro Syphon Bracket and Joint) is required on ALL orders for CorrPro joints and syphon systems.*

Ordering Services

Kadant Johnson services are available for installation, training, and maintenance services. For a quote, contact Kadant Johnson.
CorrPro™ Rotary Joint and Syphon System

CorrPro Rotary Joint Overview

- Designed for both conventional steam heated and peripheral gun-drilled rolls
- Syphon is adjustable from outside the roll
- Patent-pending joint and syphon system
- Balanced seal design using AI technology
CorrPro Rotary Joint Overview

- Up to 300 psig
- Up to 450°F
- Up to 600 rpm

Bracket Supported

- Safety feature designed into joint
- 360° circular bracket
- Eliminates hose loading on joint
- Mounts directly to bearing cover
CorrPro Rotary Joint (Rotating Syphon Design)

CorrPro Rotary Joint (Stationary Syphon Design)
Adjusting the Syphon Clearance

1) Loosen Retaining Ring
2) Turn Adjusting Screw
3) Head will move independent of roll
4) Syphon will move with the head

Stationary Pipe Version

Adjusting the Syphon Clearance

- Optimizes syphon clearance tip-to-shell to increase heat transfer
- Improved temperature profile
- Syphon clearance guess-work is eliminated
Syphon Designs Available

90° Locking Elbow

Spring-Lock with Standard JOCO Elbow

Spring-Lock Syphon Elbow

- Utilize standard syphon elbow
- Increased robustness
- Collars and spring are stainless steel
- No tools required for installation
What makes CorrPro different?

- Adjustable syphon clearance from outside the roll
- Seal ring wear indicator
- Operating torque reduced by nearly 60%
- 90-degree locking elbow
- Syphon pick-up fixed in the six-o-clock position
- Bracket supported for extended life
- Balanced seal design using AI technology

Installations

- Preheaters
- Corrugating rolls
- Single Facers
- Double Facers
- Steam joints
- Syphon systems
- Flexible hose
Installations
ELS™ Rotary Joints

- Double-guide support
- Designed for single and dual flow
- Designed for stationary or rotating syphon pipe
- Used primarily with steam service
Type ELS Rotary Joint

- Inboard carbon guide
- Outboard carbon guide
- Stationary Pipe
- One-piece body and head
- Carbon seal ring
- Seal (wear) plate

Type ELS Rotating Components

- Nipple
- Seal Ring
Type ELS Flow Path

ELS Rotary Joints

Two internal carbon graphite guides are located on either side of the joint centroid.
ELS Rotary Joints

The guides are locked into place with the joint housing with either pins or keys.

ELS Rotary Joints

This arrangement directs the wear away from the body.
ELS Rotary Joints

This arrangement directs the wear away from the body and wear plate towards the nipple.
ELSN Rotary Joint for use with Rotating Syphon

Type ELSN Rotary Joint
Type ELSN Flow Path

ELS Rotary Joint Configurations

- ELSB for stationary syphon
- ELSN for rotating syphon
- ELSN with flanged connections
Design Parameters

- Up to 510 psig
- Up to 650°F
- Up to 200 RPM
- Sizes 1-1/4” to 10”
- Steam
- Hot Oil

Primary Applications

- Open gear paper machines
- Extruders and calenders (hot oil)
- Steam tube dryers
- Trunnion tube dryers
- Rendering plant cookers
- Soda ash dryers
Redesigned 4” and 5” ELSN Rotary Joints

ELSN Rotary Joint Redesign Overview

• Redesign of 4” and 5” completed in 2008
  – Eliminated assembly plate
  – Enhanced sealing capability for hot oil
  – Reduced overall weight
Redesigned ELSN Rotary Joint Features

- Unique seal geometry for thermal oil
- One-piece nipple accepts all syphon sizes
- Smooth-flow elbow
- Renewable seal plate
- O-ring and packing syphon seal options
- Two widely-spaced carbon guides support joint

Redesigned ELSN Rotary Joint Benefits

- Application-specific
- Flexible mounting configurations
- Increased reliability and performance
- No special installation tools required
# Design Specifications

<table>
<thead>
<tr>
<th></th>
<th>Steam</th>
<th>Thermal Oil</th>
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</thead>
<tbody>
<tr>
<td><strong>4” ELSN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Operating Pressure</td>
<td>300 psig (20 bar)</td>
<td>150 psig (10 bar)</td>
</tr>
<tr>
<td>Max Operating Temperature</td>
<td>500 F (260 C)</td>
<td>650 F (343 C)</td>
</tr>
<tr>
<td>Max Speed</td>
<td>130 RPM</td>
<td>130 RPM</td>
</tr>
<tr>
<td>Weight</td>
<td>195 lbs (89 kg)</td>
<td>195 lbs (89 kg)</td>
</tr>
</tbody>
</table>

| **5” ELSN** |       |             |
| Max Operating Pressure | 300 psig (20 bar) | 150 psig (10 bar) |
| Max Operating Temperature | 500 F (260 C) | 650 F (343 C) |
| Max Speed | 110 RPM | 110 RPM |
| Weight | 375 lbs (170 kg) | 375 lbs (170 kg) |

# Steam Design Specifics

- Syphon o-ring seal standard
- Optional packing gland and nut
- Stationary syphon option uses mounting plate
Hot Oil Design Specifics

- Optimized seal geometry
- Eliminated pressure taps, key, and a retaining ring
- Rotating inboard guide
- Tested on oil at temperature
- Stationary syphon option uses mounting plate

Primary Applications

- Extruders and calenders
- Steam tube dryers
- Trunnion tube dryers
- Rendering plant cookers
- Soda ash dryers
- Holo-flite dryers
- Rotary plastic molders
- Process dryers
- Distillers
Type G™ Rotary Unions

Type G™ Rotary Union Overview

- Precision rotary union
- Designed for coolant, air, and hydraulic oil
- Speeds up to 42,000 RPM
- Pressures up to 400 bar (5,800 psi)
- Temperatures up to 250F (120 C)
Engineered for Performance

- Based on 45 years of mechanical seal experience
- Seal optimization
- Smooth running
- Standard and custom designs

Seal flatness measured in lightbands ensures leak-free performance
Rotor concentricity is measured to allow vibration-free operation when mounted on the spindle.

Laser-etched seal faces create hydrodynamic grooves to improve seal performance.
Type GA™ General Purpose Rotary Union

- Ball bearings lubricated for life
- Hardened stainless steel rotor
- Anodized aluminum body
- Carbon graphite seal
- Bronze seal optional
- Air, hydraulic oil, or coolant applications

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (°F)</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>150</td>
<td>250</td>
<td>1,500</td>
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<tr>
<td>Coolant</td>
<td>1,000</td>
<td>250</td>
<td>3,500</td>
</tr>
<tr>
<td>Hydraulic Oil</td>
<td>1,500</td>
<td>250</td>
<td>3,500</td>
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</table>
Type GAl™ Internal Mounted Rotary Union

- Compact design mounted in shaft
- Hardened stainless steel rotor
- Anodized aluminum body
- Air, hydraulic oil, or coolant applications

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (°F)</th>
<th>RPM</th>
</tr>
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<tbody>
<tr>
<td>Air</td>
<td>150</td>
<td>250</td>
<td>1,500</td>
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<tr>
<td>Coolant</td>
<td>1,000</td>
<td>250</td>
<td>3,500</td>
</tr>
<tr>
<td>Hydraulic Oil</td>
<td>1,000</td>
<td>250</td>
<td>3,500</td>
</tr>
</tbody>
</table>
High-Speed Coolant Union Overview

- GFP / GFPA
- GFR / GFRA
- GFL / GFLA
- GFS / GFSA

Type GFR/GFRA™ High-Speed Coolant Union

- Labyrinth seals protect bearings
- Optimized seal balance ratio
- Anodized aluminum body
- Special seal design permits dry running
- Deep groove ball bearings
- Stainless steel rotor
- Springs located outside the flow path
Type GFR/GFRA™ High-Speed Coolant Union

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (F)</th>
<th>RPM</th>
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</thead>
<tbody>
<tr>
<td>Coolant</td>
<td>1,160</td>
<td>195</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Type GFL/GFLA™ Dry Run Coolant Union

- Labyrinth seals protect bearings
- Smooth running, no vibration
- Anodized aluminum body
- Special balanced seal design permits dry running
- Two angular contact bearings widely spaced
- Precision lapped seal faces
- Low heat generation
Type GFL/GFLA™ Dry Run Coolant Union

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (°F)</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant</td>
<td>1,160</td>
<td>195</td>
<td>15,000</td>
</tr>
<tr>
<td>Air</td>
<td>75</td>
<td>195</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Type GFS/GFSA™ Dry Run, High Speed Coolant Union

- Smooth running, no vibration
- Labyrinth seals protect bearings
- Optimized seal balance ratio
- Anodized aluminum body
- Special balanced seal design permits dry running
- Precision lapped seal faces
**Type GFS/GFSA™** Dry Run, High Speed Coolant Union

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (F)</th>
<th>RPM</th>
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</thead>
<tbody>
<tr>
<td>Coolant</td>
<td>1,160</td>
<td>195</td>
<td>20,000</td>
</tr>
<tr>
<td>Air</td>
<td>75</td>
<td>195</td>
<td>10,000</td>
</tr>
</tbody>
</table>

**Type GFP/GFPA™** Dry Run, High Speed Coolant Union

- Labyrinth seals protect bearings
- Optimized seal balance ratio
- Anodized aluminum body
- Smooth running, no vibration
- Precision lapped seal faces
- Three precision angular contact bearings
Type GFP/GFPA™ Dry Run, High-Speed Coolant Union

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (F)</th>
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<tbody>
<tr>
<td>Coolant</td>
<td>2,175</td>
<td>195</td>
<td>15,000</td>
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<tr>
<td>Air</td>
<td>75</td>
<td>195</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Type GHP/GHPA™ Dry Run, High Pressure Coolant Union

- Special balanced seal permits dry running
- Three precision angular contact bearings
- Labyrinth seals protect bearings
- Widely spaced bearings
- Smooth running, no vibration
- Octagon drawbar connection
- Low heat generation
Type GHP/GHPA™ Dry Run, High Pressure Coolant Union

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure (PSI)</th>
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<th>RPM</th>
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<tbody>
<tr>
<td>GHP/GHPA</td>
<td>2,175</td>
<td>195</td>
<td>24,000</td>
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<td>High-speed</td>
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<td>32,000</td>
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<table>
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<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>Temperature (F)</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>75</td>
<td>195</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Type GHS/GHSA™ Dry Run, High Speed Coolant Union

- Special balanced seal permits dry running
- Two precision angular contact bearings
- Labyrinth seals protect bearings
- Widely spaced bearings
- Smooth running, no vibration
- Octagon drawbar connection
- Low heat generation
Type GHS/GHSA Dry Run, High Speed Coolant Union

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure (PSI)</th>
<th>Temperature (F)</th>
<th>RPM</th>
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<td>GHS/GHSA</td>
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<th>RPM</th>
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<tr>
<td>Air</td>
<td>75</td>
<td>195</td>
<td>10,000</td>
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</table>

Type G/5485™ Coolant Union

- Two channel rotary union
- Aluminum body
- High speed for specific machine tool applications
- Stainless steel rotor
- Flanged connection
- Drain connection between passages
Type G/5485™ Coolant Union

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pressure (PSI)</th>
<th>RPM</th>
<th>Filtering (micron)</th>
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</thead>
<tbody>
<tr>
<td>Coolant</td>
<td>290</td>
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<tr>
<td>Hydraulic Oil</td>
<td>1,160</td>
<td>8,000</td>
<td>10</td>
</tr>
<tr>
<td>Air</td>
<td>145</td>
<td>8,000</td>
<td>20</td>
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</tbody>
</table>

Custom Designed Unions

- Application specific
- Bearing or bearingless options
- Pressures up to 2,200 psi
- Speeds up to 50,000 RPM
Type GM™ Multi-Passage Rotary Union

- Ball bearings lubricated for life
- Proprietary “slide” seal
- Hardened stainless steel rotor
- Designed for multi-station index tables
- 2-passage
- 4-passage
- 5-passage
November 27, 2007

IC Joint Application Summary

Product Focus

The Internally Compensated (IC) joint design was developed in the 1980’s to extend the operating life of rotary joints used on steam heated paper machine dryers. The operating life is a function of the pressure and velocity (“PV”) loading on the seal ring, which is a function of the steam pressure and machine speed. The IC design reduces the load on the seal ring by transferring a large portion of the pressure loading to the support structure.

Steam Heated Dryers

The IC product line is specifically designed for steam-heated dryers on enclosed gear paper machines. The IC product line can also be used in other industrial applications. The most common applications are found on synthetic fiber lines.

It is necessary to supply a rigid support for the IC joint. Common supports are rods, shelf style brackets, and ring brackets.

The IC product line has also been successfully applied to Yankee dryers where an external framework may be necessary to support the rotary joint. The external framework needs to withstand the thrust loads as well as the torque and weight of the joint while maintaining proper alignment of the joint. The IC product line features both rotary and stationary syphon configurations.

Product Information

The IC joint is designed to operate at the conditions listed on Kadant Johnson drawing A46094, Symbol No. A97-16-3-24.
Rod supported IC joints

Rod supported IC joints are available in sizes 1” through 7 ½”. They are available with and without thrust collars. The designs with thrust collars use the following nomenclature:
2(Joint Size)LNXXXW-IC or 2(Joint Size)LJXXXW-IC (for example 2700LNARWQ-IC or 2700LJARQW-IC).

The designs without thrust collars are used in single flow applications and use the following nomenclature: 8(Joint Size)LXXX (for example 8700L4AFZQ).

Shelf bracket mounted IC joints

Shelf bracket mounted IC joints are available in sizes 1.5” through 4”. They are available for dual flow service with either a rotary or stationary syphon. Through flow configurations are also available.

The designs for rotary syphons use the following nomenclature:
6(Joint Size) NAW-XX (for example 6700NAW-22).

The designs for stationary syphons use the following nomenclature:
6(Joint Size) XXXX (for example 6700JAW-1 or 6700AFYSPQ).

Ring bracket mounted IC joints:

Ring bracket mounted IC joints are available in sizes 2.5” through 3.5”. They are available for dual flow service with either a rotary or stationary syphon.

The designs for rotary syphons use the following nomenclature:
9(Joint Size) LNXXW-IC-XX (for example 9700LNARQW-IC-2).

See the Kadant Johnson intranet for the product literature showing additional product information, configurations available, installation, and repair instructions.

IC joint demonstration models are available and should be shipped to the customer’s facility early in the sales process. The full size model allows the customer to see and touch the actual
product. This is especially effective with maintenance personnel. We also have maintenance models in Three Rivers that can be disassembled and re-assembled for hands on training.

See Kadant Johnson intranet for the **Power Point** presentations.

**Technical Description**

The IC design increases seal life by decreasing the load on the seal ring and reducing the seal temperature. The traditional LN and LJ rotary joints allow the body to slowly move away from the machine to compensate for seal wear. In this scenario, the entire area of the rotary joint body applies loading forces to the seal ring. The IC joint increases seal life by reducing the loading forces applied to the seal ring, allowing the seal to generate less frictional heat. This is accomplished by locking the joint body in place so it does not move axially and by replacing the standard Type L nipple with a two-piece nipple design. This two-piece nipple design accomplishes two tasks: First, the nipple body moves to compensate for seal wear. Second, the smaller area of the nipple body applies a lower loading force to the seal ring, thereby increasing seal life.

This increased seal life can be estimated with the proprietary Kadant Johnson seal life program. The table below shows the impact of changing to an IC joint from a 3” (2700) L joint operating under the following conditions:

- Steam @150 psig
- Dryers turning at 75 rpm
- Green Streak seal rings.

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Load Area (in²)</th>
<th>Seal Load (lbs)</th>
<th>Thrust load (lbs)</th>
<th>Seal Ring Temperature (°F)</th>
<th>Seal Life (Months)</th>
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</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>14.7</td>
<td>2267</td>
<td>0</td>
<td>567</td>
<td>11</td>
</tr>
<tr>
<td>IC</td>
<td>5.1</td>
<td>825</td>
<td>1442</td>
<td>439</td>
<td>56</td>
</tr>
</tbody>
</table>

Table 1 – Typical L to IC Comparison
This table shows the decrease in seal load and the corresponding increase in thrust load with IC joints. The support mechanism (stands, rods, brackets) must be rigid enough to handle this thrust load. Also note that the IC joints are rigidly mounted. The body is firmly locked in place while the nipple body moves towards the wear plate to accommodate seal ring wear. This compensated design reduces the seal loading force. In the above example, a 2700 LN-IC operating at 150 psig will have a thrust load on the support of 1,442 lbs (f). The seal load is 825 lbs (f).

**Product Implementation**

IC joints can be applied anywhere external support for the rotary joint is available. IC joints can also be used to upgrade LN or LJ rotary joints to increase seal life. High steam pressure applications have the largest potential for having a dramatic improvement in seal life. Seal life calculations should be performed to determine the potential seal life increase available by upgrading the existing rotary joint to an IC rotary joint.

The installation of IC joints starts with determining the support type that will be used. Whenever possible, shelf or ring bracket mountings should be used. These arrangements are less subject to misalignment or hose loading. In most cases, the bearing cover will determine the mounting arrangement that can be used. Some bearing covers have support rod mounting bosses or integral cast brackets and some do not.

Detailed drawings of the existing equipment are desired (often required) for designing the IC joints for new applications. The drawings required include the following:

- Dryer assembly drawing
- Dryer journal detail drawing
- Dryer shell detail drawing
- Dryer bearing housing and cover detail drawings
- Drawing showing the position of the outboard journal end in relation to the existing bearing housing and cover.
- Existing Joint assembly drawing
Most mills do not have all the detailed drawings that are required for design. We can obtain the required dimensions during a shutdown or from spare parts in the storeroom.

**Support Rod Applications**

**New Installations:** Support rods should only be used for new applications when the customer has support rod mounting bosses cast into the existing bearing cover or the customer has other interferences that prevent shelf or ring bracket application (for example, chain-driven Yankee dryers). For applications with mounting bosses, the following dimensions will be required:

- Boss tapping (thread size, depth, and type)
- Distance from end of journal (the face) back to end of the boss.

Engineering will combine this information with journal flange and joint specific data (size and nipple length) to design new support rods of the proper length.

For new applications that will use support stands/framework, field measurements by Kadant Johnson technical services may be required. These applications are unique to each facility. We will work with the customer to help identify the loads and forces that the joint will exert on the support framework. It is the responsibility of the customer's mechanical or civil engineer to design and construct new framework for a support stand application.

**Existing Installations:** Existing LJ and LN applications need to be reviewed to determine if the current support rod arrangement can be used to lock the joint body in place and withstand the increased thrust load.

Locking the joint body in place can be accomplished by adding jam nuts behind the support lugs or by relocating the support stands (if present). New support rods can be supplied to accomplish this task.
The Kadant Johnson Applications group and the customer must review existing applications utilizing support stands. The purpose of this review is to determine if the existing framework and support stand configuration can handle the thrust load.

**Shelf Bracket Applications**

New shelf bracket applications require either an existing integral cast shelf bracket or a bearing cover suitable for the mounting of a shelf bracket. Detailed field dimensions are required for either scenario. For applications with existing shelf brackets, the dimensions required are found on Kadant Johnson drawing AB1625 symbol number AB-97-16-03-10. For applications without an integral bracket, Kadant Johnson Field Service can visit the mill site to measure for the customer or provide drawings of the dimensions required.

**Ring Bracket Applications**

Ring brackets provide the best support for an IC joint. Detailed field dimensions are required for ring bracket applications. Kadant Johnson Field Service can visit the mill site to measure for the customer or provide drawings of the dimensions required. The distance the journal sticks out past the bearing cover is a critical dimension for this application. This dimension must be measured on every dryer to insure proper product application.

**Operating Issues and Problem Solving**

The following are issues we have experienced during the installation and operation of IC joints. We have had reports of water in the lubrication oil. This is typically caused by steam leaking into the bearing housings. The geometry of the installation may direct the leak towards the labyrinth seals. The steam condenses and drains into the lubrication system. Review the equipment drawings to determine potential leak points. Observe equipment in operation to identify leak location. Review the “Water in Dryer Gear Lubrication Oil” document on the Kadant Johnson intranet.
Ring bracket mounted IC joints have been installed on machines with varying journal lengths. The journal length was not measured and recorded properly. These applications experience crushed seal rings. The outboard seal ring fractures when the journal sticks out further than expected. The inboard seal ring can be fractured when the journal does not stick out as far as expected.

Most other life related issues are caused by the installation of the equipment. Proper care must be taken on rod supported and shelf bracket applications to insure proper joint alignment and initial set up. Instruction IS-101-1 explains how to check rotary joint alignment. Instructions IS-2000LNIC-2 and IS-6000NIC-2 review proper joint setup of lug supported and bracket supported IC joints, respectively.

Guide TX-101-2 provides additional trouble shooting guidelines. This guide covers issues with flooded dryers, packing glands, horizontal pipes, steam sleeves and syphon equipment.

**Equipment Sizing**

The operating conditions are required to size the joint and syphon.

The joint is sized using the [Kadant Johnson Joint Sizing Program](#).

**Competition**

**DEUBLIN** The most significant competitor in North America is Deublin, located in Waukegan, Illinois. They have a full line of rotary joints and ancillary equipment that compete with Kadant Johnson in most markets. Deublin’s purchase of Sint provided them with a ring bracket mounted face seal joint. They have adapted this design to work with a rotary syphon. Applications of this joint have been very limited, as Deublin will most often push for conversion of the syphon to a high speed cantilever stationary design.
METSO Metso, formerly Valmet, is a global paper machine manufacturer based in Finland. They continue to manufacture spare parts for the Beloit CS rotary joint line.

VOITH Voith is also a manufacturer of paper machines based in Germany. They manufacture their own joints and syphons.

DUFF-NORTON Duff Norton manufactures a line of rotary joints that are interchangeable with Kadant Johnson products. They do not have significant presence in the steam heated dryer markets.

BARCO Barco manufactures a line of rotary joints that competes with Kadant Johnson products. The Barco’s product line focuses on self-supported rotary joints.

We have a proven record of product performance and parts availability that will outperform the equipment supplied by the OEM’s and after-market companies.
LN-IC™ Rotary Joint
Ring Bracket Conversion

LN Rotary Joint Series
LN-IC Rotary Joint

LN-IC Ring Bracket Conversion
LN-IC Conversion Advantages

- Rigid bracket mounting
- Internal seal load compensation
- Reduced torque and friction
- Designed for high pressure, high speed
- No piping modifications (LN ➔ LN-IC)
- Use same flexible hose, sight flow indicators, and syphon pipes
- Economical upgrade

LN-IC Conversion Common Components

- Head
- Body
- Thrust collar
- Assembly plate
- Seal rings
- Packing gland
- Nipple flange
- Journal flange
LN-IC Conversion New Components

- 360° ring bracket
- Wear (seal) plate
- Nipple assembly
LJ™ Rotary Joints

- Rod-supported
- Used primarily with steam service
- Designed for single and dual flow
- Stationary syphon service
- Sensitive to misalignment
LJ Rotary Joints

Type LJ Rotating Components
Type LJ Flow Path

LJ Rotary Joints

- The external rods support the rotary joint
- If not properly installed, the life of the seal rings is reduced
- Alignment is important to ensure long operating life
LJ Rotary Joint Configurations

Design Parameters

- Up to 510 psig (35 bar)
- Up to 650°F (343°C)
- Up to 200 RPM
- Sizes from ½” to 8”
- Steam service
Primary Applications

- Textile dry cans
- Food processing
- Steam tube dryers
- Trunnion tube dryers
- Corrugators
Rod-Supported Joints

- Designed for low to moderate speed machines
- Support rods help absorb hose loading
- Upgrades focus on extended life
  - Antimony seal rings (2x seal life)
  - Split wedge design to secure syphon pipe
  - Balanced PT seal that handles misalignment
  - Seal package insert for easy retrofit of LJ joint
LJ-PT Steam Joint

Ratings
- Maximum Pressure: 225 psig (15 bar)
- Maximum Temperature: 450°F (232°C)
- Maximum Speed: 400 RPM

<table>
<thead>
<tr>
<th>Size</th>
<th>M</th>
<th>P</th>
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<td>243</td>
<td>280</td>
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Features
- Balanced seal design with Al technology
- External rod-supported, locked in place
- Seal wear indicator
- Retrofit type LJ joints
- Adjustable syphon clearance option

Benefits
- Minimized seal loading and seal wear
- Increased reliability at higher speeds
- On-machine measurement of seal wear
- No piping modifications, easy upgrade
- Repeatable syphon clearance adjustment
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</tr>
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External support rod
Corrosion-resistant end cap
Stainless steel spring
Convex antimony seal ring
Seal plate compensates for sagittal misalignment
Pull flow area
Balanced seal loading
Split wedge syphon support
OTS Rotary Union

General Customer Availability

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediately</th>
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</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
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Record of Changes

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<td>03 Mar 2008</td>
<td>All</td>
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The OTS (Over-The-Shaft) rotary union is a custom-designed product that is used primarily for water-cooling. This product introduction includes both the mechanical seal and the soft seal OTS rotary union designs. Both versions of the OTS rotary union are available in a single- or dual-flow configuration for high- or low-speed cooling applications. OTS rotary unions are installed around the journal (shaft) and do not require any external support.

Both versions of the OTS rotary union are used for water applications and include a corrosion resistant construction, set screw driven nipple, and an external torque restraint feature on the body. The product is typically applied to driven rolls where a conventional rotary union (for example, an RX union) cannot be installed because of the drive shaft. OTS rotary unions could also applied to hydraulic oil and air applications that operate with in the temperature and pressure limits.

**Mechanical Seal Version**

The mechanical seal version is a bearing supported union with a body and nipple made of aluminum and stainless steel. This rotary union is rated up to 150 psi (10 bar), 220 F (105 C), and 750 RPM. The ball bearing support is designed for easy removal from the roll and is field repairable; it is recommended, however, that the unit be returned to the factory for service.

**Soft Seal Version**

The soft seal OTS is rated up to 150 psi (10 bar), 200 F (93 C), and 4 RPM. Unlike the mechanical seal version, the soft seal design features a Quad-Seal design and provides reliable sealing performance for low-speed applications. The body and nipple are made of bearing bronze and stainless steel. This version is generally lower in cost.

**Drawings**

Drawings are available for both versions and are available from Drawing '06 or Visual Manufacturing. The existing drawings should be used as examples but they are not the only available options. OTS applications are typically customized to suit the existing roll geometry and application conditions. Alternate sizes and multi-passage versions can be designed to suit customer needs.

**Symbol Number Examples for Assemblies and Repair Kits**

<table>
<thead>
<tr>
<th>Symbol Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0400-OTS</td>
<td>4&quot; OTS Union, dual flow, standard water service</td>
</tr>
<tr>
<td>RK-M0400OTS</td>
<td>Repair/Rebuild Kit</td>
</tr>
<tr>
<td>0472-OTS</td>
<td>4.72&quot; OTS Union, dual flow, standard water service</td>
</tr>
<tr>
<td>RK-0472-OTS</td>
<td>Repair Kit for bearings</td>
</tr>
<tr>
<td>RK-0472-OTS-1</td>
<td>Seal Repair Kit</td>
</tr>
</tbody>
</table>
**Product Overview**

**Unique Selling Proposition**

Kadant Johnson offers over-the-shaft custom unions for machinery that requires cooling on the drive side of driven rolls or for rolls that cannot accept an axially mounted union for other reasons. The first application came from an existing customer who was experiencing continual leakage problems with a competitor’s union, resulting in serious down time and maintenance costs. Kadant Johnson’s design was able to eliminate the problems and exceed customer expectations for serviceability and service life.

Kadant Johnson is a rotary union specialist with a rich history of making the best solutions possible. Our customers benefit from the improvements in their production processes resulting from Kadant’s innovative products, application expertise, and responsiveness.

**Customer Value**

**OTS Rotary Union with soft seal**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All stainless steel and bronze materials</td>
<td>Highly resistant to corrosion</td>
</tr>
<tr>
<td>Custom-designed and manufactured</td>
<td>Application flexibility</td>
</tr>
<tr>
<td>Quad-Seal with anti-friction coating</td>
<td>Proven long-term performance</td>
</tr>
<tr>
<td>Simple design, minimal components</td>
<td>Fast repair, long life</td>
</tr>
<tr>
<td>Thrust Washer</td>
<td>Protects body, capable of operating for more rebuilds</td>
</tr>
</tbody>
</table>

**OTS Rotary Union with mechanical seal**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two ball bearings</td>
<td>High speed capability</td>
</tr>
<tr>
<td>Dual mechanical seals</td>
<td>High speed capability, positive seal</td>
</tr>
<tr>
<td>Springs are located external to the flow</td>
<td>Allows the seal to travel freely, eliminates residue buildup in the spring nests</td>
</tr>
<tr>
<td>Differential pressure seal</td>
<td>Prevents inlet media from short circuiting to outlet media</td>
</tr>
<tr>
<td>Brass and stainless steel construction materials</td>
<td>Corrosion resistant</td>
</tr>
<tr>
<td>Aluminum Bearing Housing</td>
<td>Reduced weight for easy handling</td>
</tr>
</tbody>
</table>
Product Overview

Operating Conditions

Maximum Operating Conditions for the soft seal OTS Rotary Union

<table>
<thead>
<tr>
<th>Medium</th>
<th>Temperature</th>
<th>Pressure</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>93 C 200 F</td>
<td>10 bar 150 psi</td>
<td>4 RPM</td>
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</table>

Maximum Operation Conditions for the mechanical seal OTS Rotary Union

<table>
<thead>
<tr>
<th>Medium</th>
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<th>Pressure</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>105 C 220 F</td>
<td>10 bar 150 psi</td>
<td>750 RPM</td>
</tr>
</tbody>
</table>

Soft seal OTS rotary union with bearing bronze housing and stainless steel nipple.
Target Market and Applications

The soft seal OTS is targeted at industrial markets, with specific application to the steel industry. This particular union is applied to various types of driven rolls that require cooling through the drive side of the roll.

The mechanical seal OTS rotary union is targeted at other industrial markets, specifically the synthetic fiber industry and other industrial applications that require high-speed capability with an OTS type rotary union.

Both versions of the OTS rotary union can be used in slow speed water-cooling applications. Potential customers include machinery builders or end users that design their own machinery. Older paper machines that utilize a “line shaft” or “jack shaft” to drive the dryer sections may also provide a selling opportunity; the OTS rotary union, in this application, would be used for compressed air to actuate the drive clutches for the dryer sections.

Selling Strategy

When talking to prospective customers, focus on:

- Stainless steel, brass, and aluminum materials
- Easy removal and field repair
- Designed specifically for water service
- High and low speed versions
- Custom design capabilities
- Design features and benefits (listed above)

Sales Collateral / Reference Material

Bulletins / Brochures
- Metal Industry Catalog
- Installation Instructions
- Repair Instructions

Sales Presentations
- PowerPoint Presentation-OTS Rotary Union

Mechanical seal OTS rotary union

Soft seal OTS rotary union
Deublin Around-The-Shaft Unions  
for Air or Hydraulic Service  
*Extract from Deublin Engineering Catalog RU073 2008*

Deublin’s Around-The-Shaft union was created for single or multi passage. This union is available for shafts up to 8”. Custom designed for specific application and capable of handling high pressure and speed.

**Duff Norton 500 Series Around the Shaft Rotary Union**  
*Source: [www.duffnorton.com/products/specs/runion/500/Series500.pdf]*

Duff Norton’s version of the Around the Shaft union is used in conjunction with the customer’s shaft and retaining sleeve. The union is available in two configurations – high speed, low pressure or low speed, high-pressure applications. Their standard model is created from nickel treated carbon steel construction or is available in stainless steel.

- High Speed, Low Pressure rated up to 3,000 RPM and 175 psi  
- Low Speed, High Pressure rated up to 100 RPM and 5,800 psi
Rotary System 011 Series Over-the-Shaft Rotary Union

Source: www.rotarysystems.com/011.htm

Designed for multipurpose use. This swivel uses a hardened and ground shaft, impregnated Teflon seals, and two ball bearings. This union is offered in both 2 and 4 passages.

Max. Hydraulic: 7,000 psi
Max. Air: 500 psi
Max. Vacuum: 28” Hg
Max. Temp: 400 F
Professional Services

One of the most effective ways to sell rotary unions and associated components is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary union for the specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary union repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary union
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering, and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering

Ordering Information

General Customer Availability

<table>
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</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until the product is shipped to the customer.

OTS rotary union inquiries will be evaluated by quantity, operating conditions, competitive offerings, potential gross margin, and market potential. There is a significant amount of engineering time required to design and quote OTS rotary unions. Engineering and Sales management should be consulted for further information.

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.

Pricing

Consult factory for application-specific pricing. Special versions will be priced higher than standard configurations unless the order quantity is large. A typical OTS rotary union price ranges from $3,000 to $8,000.

Required Information to Order

A new product application form needs to be filled out when a customized unit is requested. Make sure to include different size joints, adding or eliminating of connections, changing the nipple to accommodate different roll geometry, and any other specifications necessary for application. This form can be found via the Kadant Johnson Intranet (search on “New Product Opportunity Form”).
May 2, 2007

**PTX Application Summary**

**Product Focus**

**Steam Heated Paper Dryers**

The PTX product line is specifically designed for steam heated dryers on enclosed gear paper machines. The PTX is the second-generation piston type joint with cantilever stationary syphon. The PTX was launched in November of 2000. The features and benefits are described in the **NPI**. The first generation PT joint was introduced in 1991. We have an installed base of over 20,000 piston style joints. This includes the PT and the PTX configurations.

The piston is sealed to the endcap with either two o-rings or an energized cup seal. The o-ring configuration is the standard offering. The o-ring version can be used at steam pressures up to and including 160 psig. This covers virtually all paper dryer applications. For pressures in excess of 160 psig consult Kadant Johnson Engineering.

The PTX joint cannot be used on open gear machines because the open gear is between the bearing housing and the journal end. An external framework is not suitable for mounting PTX joints.

**Swing Roll Configuration**

The PTX product line is also well suited for swing roll applications. A swing roll is designed to heat or cool a paper dryer. The roll can be switched between heating with steam or cooling with water by changing valve positions while the roll is in service. A typical swing roll configuration is shown on Kadant Johnson USA drawing **CL1388**.

**Cooling Roll Configuration**

The PTX joint can also be used for cooling roll applications. Drawing **LE1729** shows the
cantilever syphon with locking elbow. This design is for paper machine press rolls and other applications when vessel entry is not an option.

The PTX joint can also be configured with a rigid stationary syphon for cooling rolls. This design is similar to Kadant Johnson USA drawing CL1388.

**Product Information**

The PTX joint and cantilevered stationary syphon is designed to operate at the conditions per drawing A46090, Symbol No. A97-16-3-20.

See the Kadant Johnson corporate intranet for the PTX NPI showing additional product information. The NPI includes: product overview, sales strategy, product description, targeted customers and applications, competition, frequently asked questions, and sizing a PT support tube.

The PTX model should be shipped to the customer's facility early in the sales process. The full size model allows the customer to see and touch the actual product. This is especially effective with maintenance personnel. A maintenance model is available in Three Rivers that is disassembled and re-assembled for hands-on training.

See Kadant Johnson corporate intranet for the PowerPoint presentation.

**Technical Description**

The PTX is a rigidly mounted joint with ring bracket support. This is a piston style joint where the nipple moves in relation to the end cap to accommodate seal ring wear and thermal expansion of the dryer. The PTX joint is a balanced seal design that reduces the seal loading force. For example, a 9750 PTX operating at 150 psig will have a thrust load on the bracket of 4,214 lbs (f). The seal load is 847 lbs (f).
Product Implementation

The installation of PTX joints and syphons starts with determining the ring bracket mounting location, the journal bore size, and the requirement for insulating sleeves.

The ring bracket mounting location determines if new bearing covers are required. The ring bracket may be mounted to the existing bearing covers. We typically mount the ring bracket with fasteners that also attach the bearing cover to the bearing housing. This mounting surface needs to be suitable for mounting the ring bracket. The machines with lug style joints may require a cut out in the mounting pad to accommodate the support rod mounting bosses.

The machines with integral cast brackets will require new bearing housings. Kadant Johnson will measure the existing cover or available spare cover to obtain the required dimensional information. The best way to obtain the dimensional information is to ship a spare bearing cover to the factory. If a spare cover is not available, a Field Service person will measure a cover during a shutdown.

Detailed drawings of the existing equipment are desired. The drawings required include the following:

- Dryer assembly drawing
- Dryer journal and head detail drawings
- Balance weight location and projection into dryer
- Dryer shell detail drawing
- Dryer bearing housing and cover detail drawings
- Drawing showing the position of the outboard journal end in relation to the existing bearing housing and cover

Most mills do not have these detailed drawings. When this is the case, Kadant Johnson will obtain the required dimensions during a shutdown. We will need to enter a dryer to obtain balance weight information. The balance weight information is usually not shown on the drawings and needs to be verified.
The critical dimension when installing a PTX joint is the “X” dimension. The “X” dimension is shown on the assembly drawing and the joint drawing. The “X” dimension is the distance that the nipple extends out from the endcap. It is measured from the spring side of the nipple flange to the end of the end cap. The typical “X” dimension is .5” (13 mm) with a tolerance of +/- 0.25” (6.3 mm). The Kadant Johnson assembly drawing should be consulted for specific installations.

The use of PTX joints with SKF “CARB” bearings requires a different “X” dimension per drawing A47994. The CARB is a toroidal roller bearing. This bearing type is typically used on the tending side of paper machine dryers. The CARB bearing eliminates the need for rocker style bearing housings. The key difference is thermal expansion changes the journal end location in relation to the bearing housing. Therefore the “X” dimension is larger when the dryer is cold and is reduced in operation due to thermal expansion of the dryer.

See the Kadant Johnson corporate intranet for detailed “Installation Instructions”.

**Equipment Sizing**

The operating conditions are required to size the joint and syphon. Steam flow rates and steam pressures dictate the minimum size of the joint. The required support tube stiffness dictates the size of the support tube and (perhaps) the resulting joint size. Felt roll diameters with present and future operating speeds, with minimum and maximum operating speeds are needed to determine the support tube stiffness requirement. This information is required to determine the size of the cantilevered syphon support tube.

The joint is sized for steam flow capacity using the **Kadant Johnson Joint Sizing Program**.

An external orifice plate is used to optimize the syphon flow characteristics. This plate is fitted between the head of the joint and the flexible metal hose.
Offset Syphon Position

The syphon position is offset in the direction of dryer rotation when the operating machine speed is in a non-rimming condition.

The following are the guidelines for positioning the vertical leg of stationary syphons with PTX joints:

- For dryers with bars, the syphon should be offset at operating speeds between 500 and 1000 FPM.
- For dryer without bars, the syphon should be offset at operating speed between 500 and 1600 FPM.
- For all other applications, the syphon should be positioned in the 6 o'clock position.

Competition

There are three significant competitors in North America:

1. Deublin (located in Waukegan, Illinois) has a full line of rotary joints and ancillary equipment that competes with Kadant Johnson in most markets. Deublin’s purchase of Sint (Italy) provided them with a ring bracket mounted face seal joint with a stationary syphon.

2. Metso, formerly Valmet, is a global paper machine manufacturer based in Finland. They manufacture their own joint for their paper dryer applications.

3. Voith is also a manufacturer of paper machines based in Germany. They manufacture their own joints and syphons.

Kadant Johnson has a proven record of product performance and parts availability that will outperform the OEM joints and syphons.

See the NPI for more details regarding the competition.
International Paper

International Paper has identified several application standards for dryer hardware. These standards are shown on Kadant Johnson USA drawing C2467, and summarized below.

Kadant Johnson developed product standards in conjunction with the International Paper Manufacturing Technology Center for Air and Drying System Optimization. These standards apply to all International Paper projects that require IP corporate capital review.

The following summarizes these standards, as well as the reasoning behind the selections. All Kadant Johnson sites should follow these standards when quoting Kadant Johnson products to International Paper for major capital projects.

Turbulator Bar Standards - Projects for International Paper

1. **Bar material**: Carbon steel bars – 0.5” x 1.0” cross section

   Note: The Kadant Johnson carbon steel Turbulator bars will provide the same heat transfer performance as the Kadant Johnson stainless steel Turbulator Tube bars (similar cross-section) when both are operated under the same conditions (the same syphon clearance and syphon shoe design).

2. **Bar count**: (18) axial bars in 5’ (1.5 m) diameter dryers
   (21) axial bars in 6’ (1.8 m) diameter dryers

   Note: Each of the hoop segments are identical, the optimum condensate depth remains similar for both 5’ and 6’ dryers, and the heat transfer rate is high over a wide range of operating conditions.

3. **Hoop segments**: Carbon steel 0.375” x 2” cross-section, bent ends and gussets

   Note: The hoop ends are bent to 90° to form a one-piece solid support for the compression bolts. Each end is reinforced with two 2”x2” gussets (ribs). Differential thermal expansion of the hoop will be taken up by bending of the hoop at the end of the gussets rather than by flexing of the bent ends.

4. **Hoop tensioning**: M16 x 2 compression bolt with two locking nuts

   Note: These compression bolts can be installed using a pneumatic driver. They have a long travel to facilitate installation. The nuts can be secured by upsetting the threads (with a
hammer and chisel) or by using the second nut to lock it in place. Kadant Johnson and International Paper both prefer the latter method.

5. **Bar connections**: Captured carbon steel pins

Note: These pins are stepped so that they are captured inside the Turbulator bar when they are installed. They have a larger cross-sectional (shear) area than the equivalent WhizLock bolt and are easier to install. There is no risk of cross threading, under-tightening, or over-tightening.

6. **End-gaps for bars**: 10-15 mm (approximately 0.5”)

Note: The mid-shell (average) temperature of the dryer is less than the operating temperature of the Turbulator bars. As a result, the bars will grow axially more than the dryer shell. The small gap between the ends of the bars allows this expansion to occur without having the bars buckle or slide along the dryer surface when the dryer is heated. The gap also facilitates the installation and alignment of independent segments.

**Stationary Shoe Standards – Projects for International Paper**

1. **Shoe material**: Fully-annealed ductile iron

Note: Ductile iron has a high tensile strength, but it will not damage the dryer shell if it is fully annealed.

2. **Shoe contour**: Wide face, large internal flow area, large flow radius

Note: This is a new syphon shoe contour for Kadant Johnson. It is to be proposed for all capital projects for International Paper. The large flow area and increased radius reduce the tendency for erosion of the ductile iron material.

3. **Shoe thickness**: Heavy wall along the back of the “throat”

Note: Ductile iron will erode / corrode, more so in dryers with aggressive condensate (acidic) and high differential pressures (high blow through flow rates). As such, it is considered a consumable syphon component. The increased wall thickness in the throat, however, allows for more erosion before the shoe must be replaced. This, coupled with the increased flow area and larger radius, will provide acceptable service life in most commercial applications.

4. **Shoe clamp**: Double-bolted, double-cut

Note: This clamping mechanism has been a very successful design for stationary syphon shoes. It prevents the syphon shoe from slipping down the vertical syphon pipe or rotating
on the syphon pipe. This design has been adapted to the new shoe.

5. **Clamp orientation**: Circumferential orientation

   Note: The circumferential orientation of the syphon shoe clamp reduces the potential for mechanical interference with balance weights on the dryer head or connections on the Turbulator hoops. It also reduces the frontal area of the shoe to minimize drag in the event of heavy drying flooding.

6. **Safety stop**: Stainless steel bolt threaded into the shoe, through the syphon pipe

   Note: The double-bolt, double-cut syphon shoe clamp is a positive method of securing the shoe. The stainless steel safety bolt provides back-up protection in the event the two bolts fail. The safety bolt prevents the shoe from dropping and prevents it from rotating on the syphon pipe.

7. **Shoe angle**: Straight radial or 60° angle

   Note: Kadant Johnson will have three standard stationary syphon shoes for International Paper: Radial straight, right-hand angled, and left-hand angled. The selection will be machine-specific. The shoe that allows the least distance to the dryer shell flange, with the shortest support tube, will be used.

8. **Syphon shoe clearance**: 6 mm (0.25“)

   Note: For paper dryers operating above the rimming speed (about 300 mpm, 980 fpm), neither Kadant Johnson nor International Paper would recommend using a cantilever stationary syphon without dryer bars. For paper dryers with Turbulator bars, the syphon clearance should be set at 6 mm (cold clearance). This is the maximum allowable syphon clearance for International Paper projects and it provides high heat transfer rates and uniform cross-machine temperature profiles. The minimum allowable syphon clearance for International Paper is 4 mm (0.16“).

9. **Syphon designation**: HDDS

   Note: The abbreviated name for this syphon shoe is HDDS, “Heavy Duty Ductile Stationary”.

**Syphon Support System – Projects for International Paper**

1. **Support tube construction**: One-piece carbon steel construction

   Note: The syphon horizontal support tube is machined from one-piece. If a welded segment is required, it will not be in a high-stress, high-load area.
2. **Support tube clearance**: 5 mm

   Note: It is recommended that the clearance between the stationary support tube and any rotating component be at least 5 mm (0.2"). The minimum allowable clearance is 3.8 mm (0.15"). This requirement applies to the entire length of the support tube. The minimum allowable clearance requirement cannot be compromised.

3. **Support tube contour**: Tapered tube

   Note: The tapered tube provides more clearance between the tube and the journal bore / dryer journal insulating sleeve. The taper also reduces the weight, increases the natural frequency, reduces the bending stress, and increases the flow area outside the tube.

4. **Support Tube Attachment**: Tapered seat and hollow bolt tensioning

   Note: A single large-bore hollow bolt is used to lock the horizontal support tube into the tapered seat in the body of the rotary joint. This bolt is used in place of the conventional capscrews that are prone to failure.

5. **Vertical support**: Fully-annealed, one-piece, cast ductile iron bracket

   Note: The contoured cast bracket provides increased clearance to the dryer head (for the dryer manhole and balance weights) and increased operating reliability (no welds).

6. **Axial syphon adjustment**: Collar adjustment +/- 2"

   Note: The vertical support bracket can be moved toward the dryer head or away from the dryer head, to accommodate variations in the size and position of dryer balance weights or differences in dryer shell construction (flange contours).

7. **Syphon pipes**: Stainless steel tubing, heavy wall

   Note: Carbon steel pipes corrode in service and reduce the integrity of the syphon piping. The stainless steel tubing will not corrode. The heavy wall of the tubing provides increased bending stiffness to the syphon pipe that extends below the bottom clamp of the vertical support bracket.

8. **Flow passages**: The selection of flow configuration will be machine-specific.

   International Paper prefers that the supply steam flows into the dryer only through the inside of the horizontal support tube (in the annulus between the horizontal syphon pipe and the horizontal support tube).
To accomplish this, there should be steam ports in the horizontal support tube, but not in the rotary joint body. This may not be possible to do in a dryer that has a small diameter journal bore, and still maintain the required 3.8 mm (0.15") clearance. Where this is possible, a special PTX body is required (one without steam ports in the body) for 9800 PTX applications. For 9750 PTX applications, a special horizontal support tube is required (one with steam ports in the tube) and a full-length horizontal syphon pipe.

Note: The 9750 PTX joint is generally used for dryers with low steam flow rates, with small diameter support tubes when the dryer journal bore is limited in size. In the standard 9750 PTX joint, steam flows into the dryer through the annulus between the horizontal support tube and the dryer journal (or insulating sleeve). This makes the best use of the limited flow area through small dryer journal bores and minimizes the amount of cantilevered weight. This PTX configuration should be used if needed to provide the required clearance between the support tube and the rotating components.

The 9800 PTX joint is generally used for dryers with large steam flow rates, with larger diameter support tubes, when the dryer journal bore is large enough for both an insulating sleeve and a large diameter support tube. In the standard 9800 PTX joint, steam flows into the dryer through an annulus between the dryer journal/insulating sleeve and the horizontal support tube and between the horizontal support tube and the horizontal syphon pipe. This makes use of all of the possible flow area. This PTX configuration should be used if needed to provide additional flow area for large-condensing rate dryers.

Kadant Johnson can provide any of these configurations. The selection for any specific order depends on the flow requirements and the diameter of the dryer journal bore.

**Sales Notes:**

1. Kadant Johnson Sales should use the above specifications for all proposals for major capital projects for International Paper.

2. In order to provide consistency of product offerings and product performance, all proposals for major capital projects for International Paper (in all territories) be sent to Tim Rourke prior to sending to International Paper. In general, for such projects, alternative equipment configurations should not be proposed.

3. If local mill preferences require modification of the proposal, review the requirements with Tim Rourke (Kadant Johnson Product Applications Manager).

4. Tim Rourke will serve as the technical coordinator between Kadant Johnson and the Corporate Technology Group of International Paper. He will serve as a clearinghouse for sharing Kadant Johnson developments, communicating changes to the International Paper requirements, and coordinating service and technical support.
May 2, 2007
PTX Application Summary

Operating Issues and Problem Solving

The following are issues that have been experienced during the installation and operation of PTX equipment.

A customer reported bearing failures following the implementation of PTX joints and stationary syphons. The initial request from the mill was to advise the thrust load provided by the ring bracket mounted joints. The 9750 joint operating at 150 psig exerts a thrust load of 4,214 lbs (f). The dryer bearing for this machine would accommodate a thrust load of approximately 50,000 lbs (f). The bearing supplier and other technical resources confirmed that the relatively small thrust load from the joint would have no negative impact on dryer bearing life. The final analysis
showed the bearing failures were due to problems with the bearing lubrication flow control devices.

Another customer reported water in the lubrication oil. This is typically caused by steam leaking into the bearing housings. The geometry of the installation may direct the leak towards the labyrinth seals. The steam condenses and drains into the lubrication system. Review the equipment drawings to determine potential leak points. Observe equipment in operation to identify leak location. Review the “Water in Dryer Gear Lubrication Oil” document on the intranet.

In another installation, a PTX joint was installed with the “X” dimension at 0. The X dimension was not measured properly. It was mistakenly measured from the end of the nipple to the wear plate. The joints experienced excessive heat at start-up. The heat dissipated after the seal ring wore in and provided some clearance. The joints operated without leaking, but this will not always be the case.
9550 and 9700 PT Rotary Joint and Stationary Syphon

General Customer Availability:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Order Date:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
<th>Revision</th>
<th>Mark</th>
<th>Date</th>
<th>Page</th>
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<tbody>
<tr>
<td>A</td>
<td>---</td>
<td>17 March 2006</td>
<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>---</td>
<td>12 January 2007</td>
<td>All</td>
<td>Update to include 9550</td>
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**Product Overview**

The Kadant Johnson small PT joint (9550 and 9700) was designed to fill a market need for a smaller rotary joint and cantilever syphon for application to slow-speed paper dryers. Initial demand came from paper OEMs in China, where competitive pricing was very important.

More recently, similar applications have been identified outside of China including India, Indonesia, and other Pan-Asian countries, as well as Europe and North America.

The 9750 and 9800 PTX joints are the “gold standard” when it comes to steam joint and stationary syphon systems. It is the preferred product for paper machine dryer sections. However, there are some cases where the application does not require such a robust product and competitive pricing does not allow for a premium product. In these cases, a 9550 or 9700 PT joint may be an option to consider.

Specific features of the 9550/9700 PT joints and syphons include:

- The joint is offered with threaded or flanged connections.
- The cantilever stationary syphon uses a large hollow bolt and Teflon shoe.
- The syphon is designed with high natural frequency to reduce the potential for damage due to vibration, in low-speed applications.
- Axial adjustment of vertical syphon pipe allows fine-tuning the axial location of syphon shoe.
- The syphon assembly is available for 1.2 m (48”), 1.5 m (60”) and 1.8 m (72”) dryer diameters.

**Joint Size**

The small PT is available in 2” (9550) and 3” (9700) sizes, with either ASA (American) or DIN (European) flange drillings or threaded connections. Available steam (M) and condensate (P) connection sizes are listed below. The recommended sizes are listed first. The flow coefficient (Cv) for the 9550 PT joint and syphon is 5.3. The flow coefficient (Cv) for the 9700 PT joint and syphon is 12.7. For reference, the Cv for the 9750 PTX with a 76 mm syphon pipe is 26.9.

<table>
<thead>
<tr>
<th>Size</th>
<th>M – Threaded connection</th>
<th>M - ASA connection</th>
<th>M - DIN connection</th>
<th>P – Threaded connection</th>
<th>P - ASA connection</th>
<th>P - DIN connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>9700 (3”)</td>
<td>2.5” (2”)</td>
<td>2.5” (2”)</td>
<td>DN 65 (DN50) PN16</td>
<td>1.5” (1”, 1.25”)</td>
<td>1.5” (2”, 1.25”)</td>
<td>DN40 (DN50, DN32) PN16</td>
</tr>
<tr>
<td>9550 (2”)</td>
<td>2” (1.5”)</td>
<td>2” (1.5”)</td>
<td>DN50 (DN40)</td>
<td>1.25” (1”)</td>
<td>1.5” (1.25”)</td>
<td>DN40 (DN32)</td>
</tr>
</tbody>
</table>

**Syphon Clearance**

- Non-rimming dryers 6 mm (0.25”)*
- Rimming dryers 6 mm (0.25”)**

* The syphon orientation can be optimized for specific applications to reduce condensate load in the dryer.
** The syphon clearance can be optimized for specific applications with testing at the Research Center.

**Support Tube Size**

- Outside diameter 58 mm for the 9700; 38 mm for the 9550
- Inside diameter 28 mm for the 9700 and 22mm for 9550
- Length Depends on application
- Dryer diameters 1.5 m and 1.8 m (the 9550 can also be used in 1.2 m dryers)
Symbol Numbers

<table>
<thead>
<tr>
<th>Symbol Number</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>9700PT</td>
<td>3&quot; PT Rotary Joint with J2702 threaded head</td>
</tr>
<tr>
<td>9700PT-SF</td>
<td>3&quot; PT Rotary Joint, with sight glass head</td>
</tr>
<tr>
<td>9700PTF</td>
<td>3&quot; PT Rotary Joint with flanged connections</td>
</tr>
<tr>
<td>SS2300-1-60-1</td>
<td>Cantilever Stationary Syphon, 60&quot; dryer, Teflon shoe</td>
</tr>
<tr>
<td>SS2300-1-72-1</td>
<td>Cantilever Stationary Syphon, 72&quot; dryer, Teflon shoe</td>
</tr>
<tr>
<td>9550PT</td>
<td>2&quot; PT Rotary Joint with J2702 threaded head and threaded body</td>
</tr>
<tr>
<td>9550PTF</td>
<td>2&quot; PT Rotary Joint with flanged head and threaded body</td>
</tr>
<tr>
<td>SS2200-48</td>
<td>Cantilever Stationary Syphon, 48&quot; dryer, Teflon shoe</td>
</tr>
<tr>
<td>SS2200-60</td>
<td>Cantilever Stationary Syphon, 60&quot; dryer, Teflon shoe</td>
</tr>
<tr>
<td>SS2200-72</td>
<td>Cantilever Stationary Syphon, 72&quot; dryer, Teflon shoe</td>
</tr>
</tbody>
</table>

Syphon Pipe Size

- The standard syphon pipe for the 9550 PT joint is a 3/4" stainless steel pipe. The standard syphon pipe for the 9700 PT joint is a 1" stainless steel pipe. This is the largest size that will be needed for the applications where the 9550/9700 PT joint might be used.
- Kadant Johnson sizes orifice plates for the condensate pipes to provide the required flow resistance to limit the amount of blow-through with a normal operating differential pressure of 3-4 psi. This allows the flow resistance to be tailored for each dryer rather than selecting just one pipe size as a compromise between high blow-through and low blow-through dryers.
- The Teflon tip syphon shoe is available in 1" size.
Customer Value

The 9550/9700 PT joint and syphon system has the lower cost of a smaller size and competitive pricing, as well as the traditional value of the Kadant Johnson PT joint and syphon system:

- Bracket mounting to maintain alignment and minimize the effect of hose loading
- Piston seal loading with balanced pressure forces to maximize seal life
- External springs for vacuum and low-pressure applications
- Separate seal plate with hardened surfaces for long service life
- Stainless steel syphon pipes for long service life
- Teflon tipped syphon shoes for long life and dryer protection
- The small diameter support tube can fit through dryer journal bores that are too small for the 9750 and 9800 PT syphon support tubes

Financial savings

- Stationary syphons reduce steam usage by reducing the amount of blow-through compared to a rotating syphon design. The reduced blow-through is achieved during normal operation, as well as during machine upsets.
- Reduced blow-through and pressure differential can provide savings by:
  - Reducing the amount of motive steam required
  - Reducing the amount of steam that is vented
  - Reducing the amount of steam that goes to the condenser
  - Reducing the back pressure from power-generating turbine

Product performance

- The PT joint has been tested on the 1.5 m diameter dryer over a wide range of operating conditions in Kadant Johnson’s R&D Center.
- Syphon clearance has been optimized through R&D testing to produce the highest possible heat transfer performance when used with Turbulator bars.
- The stationary syphon does not require high differential pressure to evacuate condensate.
- The Kadant Johnson PT joint and stationary syphon assembly is used in paper machine dryers to ensure reliable removal of condensate.
- For high-speed dryers (any machine that runs over rimming speed), the syphon should be used with Kadant Johnson Turbulator bars. This ensures uniform dryer surface temperature profiles.

Ease of Installation

- One person can easily handle each of the 9550/9700 PT components / assemblies during installation.
- The horizontal support tube in the small PT joint can be easily slid into the journal bore and locked into position. There are no o-rings to be damaged. Most importantly, the joint does not rely on four small cap screws to hold the tube. A single massive hollow bolt holds the tube in position.
- The PT body can be positioned with the M-connection in any one of eight positions, as a standard offering. (Vertical, horizontal, and at 45-degree increments between these positions).
- The 9550/9700 PT joint uses a unique reverse seal ring design that allows for run-out and angular misalignment of the joint, as well as thermal expansion.
- The axial location of syphon shoe can be adjusted in the field by moving the vertical support for the bent syphon pipe assembly. The vertical support can be adjusted relative to the horizontal support tube over a range of 100 mm (+/- 50 mm from the design position).
**Reduced Maintenance**

- The syphon shoe is attached with a double-cut, double-bolted joint. This has been proven in numerous commercial installations to prevent slipping. Competitive setscrew systems are known to fail.
- The 9550 and 9700 PT joints have the same very long seal life as the Kadant Johnson 9750 and 9800 PT joints.

**Teflon Tip Syphon Shoe Features / Benefits**

- Investment cast stainless steel clamp pad resists erosion and corrosion.
- One-piece Teflon tip securely mounted to clamp pad.
- Converging entrance to syphon shoe improves flood recovery time and steady-state operation.
- Large syphon tip opening improves condensate flow rate into syphon pipe.
- Double-cut, double-bolt clamp secures syphon shoe in place.
Operating Conditions

Maximum Conditions:

Pressure: Up to 11 bar (160 psig)
Temperature: Up to 204°C (400°F)
Speed: Up to 300 rpm
- 600 mpm (2000 fpm) for the 9700
- 450 mpm (1500 fpm) for the 9550
Service: Steam/condensate, water

Note: Superheat in the supply steam should be limited to 28°C (50°F).

Note: Maximum limits vary in relation to changes in RPM, pressure, and temperature. The maximum operating speed may be further limited by support tube and syphon pipe vibration. Dryers that have shorter support tubes will have a higher speed capability. Consult Kadant Johnson for specific applications.
Operating Principles of the 9550/9700 PT Joint and Stationary Syphon

A rotary joint connects stationary piping to a rotating cylinder. A cantilever stationary syphon pipe extends through the joint to drain the condensate from inside the cylinder and out through the rotary joint. The differential pressure between the steam pressure inside the cylinder and the backpressure at the outlet forces condensate out of the dryer along with some uncondensed steam (blow-through).

With stationary syphons, high differential pressures and blow-through rates are not needed to propel condensate up the syphon and out of the cylinder. Once the condensate enters a stationary syphon, it is no longer subjected to centrifugal forces. This is why stationary syphons can operate with low, or in some cases, no pressure differentials. This also means the amount of differential pressure required to evacuate condensate does not increase as rotational speed increases, as it does with rotary syphons.

Joint and Support Tube Sizing

The rotary joint size is selected first on the basis of flow requirements, using the Kadant Johnson joint sizing program. The steam velocity is normally limited to 10,000 fpm (40 mps). The syphon support tube diameter is then selected from a few standard diameters, with the selection based on the stiffness requirement for the particular application. The support tube may require that a larger PTX joint be used, even though the smaller joint size has adequate flow capacity.

The support tube must have a high enough stiffness so that adjacent felt rolls and dryers do not cause it to vibrate during operation. The stiffness that is required for the support tube depends on the intended machine operating speed, felt roll diameters, length of the support tube, and weight of the cantilevered components.

The dryer journal should be at least 6 mm (0.25") larger than the support tube diameter. If an insulating sleeve is needed, the bore should be at least 25 mm (1") larger than the support tube diameter. If the journal bore is cored and not machined, more space should be allowed to account for possible core shift. The steam inlet flow area for the 9550/9700 PT is the area between the support tube O.D. and the journal I.D if the journal ID is smaller than the nipple ID.

Support tube vibration was measured on the Joco 4000 pilot dryer for the 9550/9700 PT and 9750 PTX stationary syphons. The results are shown in the figure below. As indicated by this figure, the syphon vibration is relatively low for the 9550/9700 PT joint (below 1 G) for speeds below 600 mpm. Above this speed, the vibration levels increase due to the heavy (6 mm) rimming condensate layer impacting the syphon shoe. By comparison, the 9750 PTX syphon vibration remained low to speeds over 1200 mpm.

![Graph V](image-url)
**Selling Strategy**

The target market for the small PT joint and stationary syphon system is the Paper Industry, for dryers that are running at rimming condensate speeds, particularly those with smaller dryer journal bores. The stationary syphons are also helpful in improving the stability of marginal steam and condensate systems.

**Unique Selling Proposition**

The Kadant Johnson PT and PTX rotary joints and stationary syphon systems have a long life, high reliability, and the best operating performance of any joint and syphon system available in the market. Kadant Johnson backs this up with the most knowledgeable and most experienced engineering and service support in the world, and these services are available worldwide.

**Selling Strategy**

**Production Supervisors - focus on:**

- 9550/9700 PT vs. Competition
  - High stiffness, designed to avoid machine-induced vibrations below the design speed
  - Accommodates thermal expansion of dryers mounted on floating bearings, such as CARB bearings
  - Accommodates run-out and angular misalignment
  - Adjustable positioning of syphon shoe facilitates proper installations
  - Syphon pick-up shoe material sacrificed in unlikely event shoe contacts dryer shell

- 9550/9700 PT vs. Rotary Syphon
  - Eliminates dryer flooding during operation; easy recovery of a flooded dryer
  - Reduced blow-through reduces load on steam system
  - Higher heat transfer rate
  - Improved runnability

- Integration with complete Systems offerings. Only Kadant Johnson can offer a complete system, including joints, syphons, system design, system hardware, and control. Specific operational results can be guaranteed if required by the customer.
  - Thermocompressor sizing should be reviewed
  - Pipe sizes and separator station sizing should be reviewed
  - Control system should be evaluated

**Maintenance Supervisors - focus on:**

- Accommodates run-out and up to 18° of angular misalignment of the seal
- Accommodates up to 5 mm thermal expansion for 9550PT. Accommodates up to 10 mm thermal expansion for 9700PT (for CARB bearings)
- Syphon adjustment for precise placement of pick-up shoe in the dryer
- Minimal maintenance is required – when necessary, seal replacement is easily done while the joint is mounted on the machine
- The syphon pipe and **shoe clamp pad** is stainless steel, to avoid erosion
Cross-selling Opportunities
Kadant Johnson Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration.

PT sales should always include appropriate elements of the Kadant Johnson Systems steam systems offerings. This includes dryer surveys, estimation of drying rate improvements, steam system reviews, installation services, Turbulator bar sales, thermocompressor sizing and sales, and Vortec vacuum generators.

Turbulator bars are strongly suggested for dryers that will operate close to or above rimming speed (that is, above 250-300 mpm).

When the Kadant Johnson Service and Technical Centers are involved in the projects, Kadant Johnson can offer the following bundling opportunities for the PT joint and stationary syphon system:

1. Complete seal life and maintenance improvement estimations and guarantees
2. Review existing steam and condensate systems (valves, thermocompressors, separator tanks)
3. Review / develop justification for the purchase of Turbulator bars (if applicable)
4. Installation services
5. Replacement bearing covers (engineering and manufacture)
6. Provide on-going service and sales support (through network of reps and direct sales force)
7. Conduct R&D testing of Kadant Johnson and competitive configurations
8. Conduct audit for future machine production limitations
9. Establish blow-through correlations for system design
10. Establish the optimum syphon clearances (consistent with the installed bar configuration)

Precluding Sales Objections
Kadant Johnson Sales should attempt to sell the positive features and benefits of the Kadant Johnson products, not the negative features of competitive products.

One of the Kadant Johnson competitors (Deublin) has been negative-selling its products. Rather than counter these sales tactics with similar negative selling, Kadant Johnson Sales should attempt to identify the negative selling strategies used by its competitors and address these items before the customers ask questions on them. That is, Kadant Johnson Sales should present its products, focusing on the positive aspects of the features that the competitors are using for negative selling. This precludes the objections to sales and keeps the presentation properly focused.

If you become aware of other negative selling strategies used by our competitors, please send the information to Kadant Johnson Global Marketing, to be shared with the rest of the organization.
Selling Strategy

Sales Collateral / Reference Material

Engineering Drawings

Available from your local engineering department.

Presentation Materials

Inside the Dryer Video – Cantilever Stationary Syphon with Turbulator Bars plus five other segments.

Vibration Simulation video clip showing vibration at various natural frequencies

Deublin FS syphon vibration video clip

Customer Reference Materials

Reference/User List – There are currently over 600 sets 9550 PT joints and syphons and 1400 sets 9700 PT joints and syphons in operation in paper mills throughout China, at speeds up to 550 mpm. A copy of the current reference list for the 9700 PT installations can be downloaded from the Intranet. Installation lists for the PTX are also available online. For more information about any specific customer, contact the Kadant Johnson Regional Sales Manager responsible for the account.

A technical paper titled “Vibration Characteristics in Cantilever Stationary Syphons” is available to present R&D studies on vibration and stationary syphons. This paper is available online in the Intranet or from Global Marketing.
## Feature / Function / Benefit Comparison

<table>
<thead>
<tr>
<th>Feature / Function</th>
<th>9550/9700 PT</th>
<th>PTX</th>
<th>Deublin FS</th>
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</thead>
<tbody>
<tr>
<td>Sizes</td>
<td>2”</td>
<td>3-1/2”</td>
<td>4”</td>
</tr>
<tr>
<td></td>
<td>3”</td>
<td>4”</td>
<td>5”</td>
</tr>
<tr>
<td>Weight</td>
<td>All components easily handled by one person</td>
<td>All components easily handled by one person</td>
<td>Some components require two persons</td>
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<tr>
<td>Maximum roll speed</td>
<td>300 rpm</td>
<td>500 rpm</td>
<td>400 rpm</td>
</tr>
<tr>
<td>Maximum Operating Pressure</td>
<td>160 psig (11 bar)</td>
<td>160 psig (11 bar)</td>
<td>150 psig (10 bar)</td>
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<tr>
<td>Maximum Operating Temperature</td>
<td>400°F (204°C)</td>
<td>450°F (232°C)</td>
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<td>2 to 4 psig (0.14 to 0.3 bar)</td>
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<td>Yes</td>
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<td>Pre-design analysis of syphon and cylinder frequencies</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>Accommodates axial, radial, and angular misalignment</td>
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<td>Yes</td>
<td>No</td>
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<tr>
<td>Seal Ring</td>
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<td>Flat face, balanced, in tension</td>
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<td>External Seal Ring Wear Indicator</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Syphon pick-up shoe material</td>
<td>Teflon (Ductile Iron option)</td>
<td>Teflon</td>
<td>Stainless Steel (Cast iron option)</td>
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<tr>
<td>Pick-up shoe placed under support for positioning close to dryer head</td>
<td>Straight shoe</td>
<td>Straight shoe (standard) 60° shoe (optional)</td>
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<td>Research testing and product demonstration</td>
<td>Yes - Accurate assessment of dryer improvements</td>
<td>Yes - Accurate assessment of dryer improvements</td>
<td>None</td>
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<tr>
<td>Installation and maintenance training available onsite</td>
<td>Yes</td>
<td>Yes</td>
<td>Very limited</td>
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</tbody>
</table>
Competitive Overview

Kadant Johnson 9550/9700 PT vs. Deublin FS Series

- Kadant Johnson can determine all blow-through and operating differential pressures directly from controlled R&D tests and field studies. Kadant Johnson does not rely on field measurements to know the performance of its equipment in customer applications. Deublin does not have an R&D center for testing and evaluating its joints. It relies on field trials and often under-sizes its joints and syphons.

- The design of the Kadant Johnson 9550/9700 PT syphon shoe connection has been proven in numerous commercial installations to prevent slipping. Deublin continues to use two setscrews to hold the shoe in place. These do not prevent slipping and rotation. Deublin's design is more likely to fail due to excessive vibration, resulting in shoe contact with the dryer shell.

- The Kadant Johnson stationary syphon shoe is made from Teflon with a stainless steel clamping pad. In the (unlikely) event that the shoe contacts the rotating dryer shell, the Kadant Johnson shoe will become a sacrificial material to minimize damage to the dryer shell. The Deublin shoe is stainless steel. It will cut a groove in the dryer shell when the shoe contacts the shell.

- The Kadant Johnson 9550/9700 PT seal ring design can accommodate both run-out and angular misalignment. The Deublin joint must be very carefully aligned, because it can accommodate only a limited amount of run-out and no angular misalignment. Since backside as well as front-side bearing housings tend to tip in the cross-machine direction in operation, there must be some allowance for angular misalignment. When this happens, the seal plate in the Deublin FS joint must "cock". This puts severe demands on its cup seal (the most critical elastomeric seal), often beyond its limits of flexibility. This deficiency was a severe problem with Beloit CS joints, and is a limitation on the life of the Deublin joint as well.

- The Kadant Johnson seal ring has been designed to operate under compression. The steam pressure and nipple face compresses the seal ring against the concave surface of the wear plate. By comparison, the Deublin seal ring is under tension, relying on the tensile strength of the carbon to withstand the steam pressure forces.

- The Deublin FS joint is not able to run dry at high speed. Deublin has been forced to develop a seal unloading mechanism in order to avoid excessive seal wear if the dryer must run without steam. The patented PT/PTX seal package doesn't require this "band-aid" approach because the seal design is much more robust than Deublin's. The Kadant Johnson PT seals will provide excellent life without having an unloading mechanism.

- The PTX joint has been designed to meet all of the demands of the paper industry. It can not only handle high pressures, high speeds, and misalignment, but also accommodate the thermal expansion of the dryer journal, even when used on the front side of large paper machines that have CARB or other similar floating bearings. The Deublin FS joint does not have this capability. Kadant Johnson PTX vs. Metso

- The Metso joint has the same type of flat face seal that Deublin uses, and therefore has the same problems noted above.
Professional Services

One of the most effective ways to sell rotary joints and associated components is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and stationary syphon for the specific application.

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
General Customer Availability

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Lead Time

- The 9550/9700 PT body is supplied from Kadant Johnson China. Delivery is typically 14 to 16 weeks from receipt of purchase order. Expedited delivery is available, but this adds to the cost of the product.
- Ring brackets, journal adapter flanges, support tubes, and insulating sleeves are typically custom designed for each application. The seal ring, wear plate, piston, head, and syphon shoe are standard parts.
- Delivery is subject to acceptance of PO by Kadant Johnson, based on prior order commitments.
- Delivery is subject to timely confirmation of dimensional information.

Pricing

Current list pricing should be obtained from the Kadant Johnson Manufacturing Center. Capital projects that include joints and syphons are generally subject to negotiation, both with the OEM suppliers and with paper mills. Current prices depend on the quantity ordered, whether bearing housing covers are required, whether the joints have sight flow heads, and whether insulating sleeves are required.

**Note:** Dryer bearing covers, journal insulating sleeves, and Turbulator bars are not included in the above joint and syphon system prices.

Required Information to Place an Order

To begin engineering for a 9550/9700 PT Joint & Stationary Syphon System, the following drawing sheets must be completed and provided to the factory with the order:

- A41650 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 1 of 3
- A41651 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 2 of 3
- AB7385 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 3 of 3
Frequently Asked Questions

1. What does “PT” stand for?

The PT joint is a “Piston Type” joint. The carbon seal ring seals against the end of this piston. The piston can move axially in the joint body (end cap) to facilitate installation, accommodate seal ring wear, and allow for thermal expansion of the journal.

2. Why not use the PTX joint instead of the 9550/9700 PT?

The 9550/9700 PT joint was designed to fill a market need for a smaller rotary joint with a competitive price. Initial demand came from paper OEMs in China. Later, competitive pressures developed increased interest in markets outside of China including India, Indonesia, and other Pan-Asian countries. The PTX is the “gold standard” when it comes to steam joint and stationary syphon systems. It is the preferred product for paper machine dryer sections. However, there are some cases where a “good enough” approach is all that is required and competitive pressure has reduced pricing to undesirable levels. In these cases, a 9550/9700 PT joint may be an option to consider.

3. What is the expected life of the 9550/9700 PT joint?

The 9550/9700 PT uses the same sealing system as the PT joint and is expected to have equal or longer life in commercial operation. The life depends primarily on the dryer speed and steam pressure. For most papermaking machines, the seal ring life will be in excess of three years.

4. How is the 9550/9700 PT joint mounted?

The 9550/9700 PT joint is mounted rigidly to the machine framework, typically with a ring bracket that extends from the face of the 9550/9700 PT joint to the bolt circle of the mating dryer bearing housing cover.

5. Is the 9550/9700 PT a single-flow or dual-flow joint?

The 9550/9700 PT can be supplied in either as a single flow or dual flow configuration.

6. Is the 9550/9700 PT joint mounted to the backside (drive side) or front side (tending side) of the paper machine?

The 9550/9700 PT joint can be used on either the front or backside of the dryer section. If the dryer has a dual-flow joint, it would be most common for the joint to be located on the backside of the machine. With single-flow joints, steam enters through one joint and condensate is evacuated through a joint on the other dryer journal. If the dryer has a single-flow, the condensate is generally removed through the front side journal.

7. How many sizes of 9550/9700 PT joints are there?

There are two sizes: 2” and 3”.

8. How is the size of the joint selected?

There are two selection criteria: For steam supply (in single-flow or dual-flow configurations), the flow velocity must be kept below specified limits, to minimize pressure loss and erosion. For condensate removal (in single-flow or dual-flow configurations), the diameter of the support tube must be large enough to avoid vibrations during operation.

9. How does the 9550/9700 PT joint handle misalignment?

The flat face on the seal ring accommodates journal run-out. The spherical face on the other side of the seal ring handles angular misalignment of up to $18^\circ$ – more than what is possible by other limitations of the joint and syphon installation. The seal ring is loaded against the piston.
10. How is the 9550/9700 PT cantilever syphon attached to the steam joint?

    The horizontal syphon pipe passes through and is supported by a long support tube. This tube extends from
    the joint body, through the journal, to the inside of the dryer. A vertical support bracket that extends from the
    end of the support tube to the lower end of the vertical pipe supports the vertical syphon pipe.

11. How is the support tube clamped in the 9550/9700 PT body?

    The support tube has a large-angle taper that mates with a similar taper in the 9550/9700 PT body. The tube
    is pulled into the body with a hollow bolt. This bolt has been designed as a stretch-element, to prevent the
    fatigue failures associated with joints that have four small cap screws holding the tube in place.

12. How is the size of the support tube determined?

    The support tube diameter is based on the stiffness requirement for the particular application. The stiffness
    required depends on the intended machine operating speed, felt roll diameters, length of the support tube,
    and weight of the cantilevered components.

13. What size dryer journal bore is required?

    The dryer journal should be at least 6 mm (0.25") larger than the support tube diameter. If an insulating
    sleeve is needed, the bore should be at least 25 mm (1") larger than the support tube diameter. If the journal
    bore is cored and not machined, more space should be allowed to account for possible core shift. The steam
    inlet flow area for the 9550/9700 PT is the area between the support tube O.D. and the journal I.D.

14. Is the 9550/9700 PT syphon shoe “handed”?

    No. The standard vertical syphon pipe has two bends so that the same syphon shoe can be used in dryers
    that are rotating either clock-wise or counter-clock-wise. That is, the standard syphon shoes are not “handed”.

15. How does the syphon shoe attach to the vertical pipe?

    The Kadant Johnson stationary syphon shoe is a two-piece cast assembly. The two-piece clamp uses two
    large cap screws to lock the syphon shoe in place. The force of the two cap screws goes directly into
    clamping the syphon, not into bending a split collar.

16. What is the material of the stationary syphon shoe (tip)?

    The Kadant Johnson syphon shoe is Teflon. If the shoe contacts the dryer (when, for example, the front dryer
    bearing housing falls off of its rockers), the shoe will be worn down, rather than damage the dryer shell. A
    stainless steel shoe, on the other hand, would quickly cut a groove in the dryer shell.

17. How is the vertical support bracket mounted to the support tube?

    The vertical support bracket is clamped with two u-type bolts.
PTX™ Steam Joints and Stationary Syphons

A unique design for superior performance

Kadant Johnson PT™ (Piston Type) Series

• Introduced in 1991
  – More than 12,000 in operation
• Incorporates latest seal technology
  – Extended seal life
  – Enhanced reliability
  – Improved maintenance
  – Accommodates thermal expansion
• PTX rotary joints use the PT seal technology
PTX Steam Joint

- Robust hollow bolt
- Eliminates cap screws
- Easy to install and remove
9800PTX Steam Joint

- Locking mechanism
- Secure fit in joint housing
- Machined tube
PTX Steam Joint

• Steam ports cast into body
• Allows for smooth steam flow
• Minimal pressure drop due to large flow area

PTX Steam Joint

• Piston absorbs axial misalignment
• Designed for use with CARB bearings
• Expansion up to 20mm
PTX Seal Technology

- Proven seal package
- Stainless steel insert
- Handles up to 18" of misalignment
- Compensates for axial movement
- Balanced seal

PTX Seal Technology

- Corrosion resistant parts
- Uniform seal face load
- Spherical face seal ring
- Tolerates misalignment
- Polished surface finish
PTX Installation and Maintenance Features

- Advanced seal package
- Lightweight, easy-to-handle
- No shims required
- External seal wear indicator
- Increased seal wear range
- Simple carbon replacement

PTX Steam Joint Distinctive Features

- Reversed seal – in compression
- Spring loaded design seals at low pressure (vacuum)
- Larger limits for misalignment
- Extended seal travel – CARB Bearings
- Large flow area through the rotary joint
- Support tubes use large hollow bolt to secure tube in place (no small capscrews)
PTX Steam Joint Applications

- Single-flow inlet rotary joints
- Single-flow outlet rotary joints
  - Rotary syphon system
  - Stationary syphon system
- Dual-flow rotary joints
  - Stationary syphon system

Cantilever Stationary Syphon

- Rigid mounting
- High and low speed applications
- Reliable
- Efficient
Cantilever Stationary Syphon

- Low vibration
- Low deflection
- High stiffness and natural frequency

Johnson Stationary Syphon Shoe Design

- Narrow profile for minimal resistance
- Teflon is sacrificial material
- Double-cut, double-bolted clamp secures shoe onto vertical pipe
Johnson Stationary Syphon Shoe Design

- Investment cast stainless steel clamp pad
- Stainless steel bolts welded to clamp pad
- Converging entrance
- Double-bolt double-cut clamp
- One-piece Teflon tip

Kadant Johnson Stationary Syphons

- Rigid mounting (radial, angular)
- Large diameter (high tune)
- Tapered support tube (stiffer)
- Sweep syphon elbow
- Axial adjustment range 100 mm
- Decreased cantilever weight more than 40%
Stationary Syphon Efficiency

Differential Pressure and Blow-Through

Turbulator® Tube™ Bars

- For speeds > 1000 fpm
- Condensate resonance
- Higher heat transfer
- Improved uniformity
Turbulator Tube Bars

- Axial bars inside the dryer cylinder
- Held in place by segmented hoops
- Increase condensate turbulence
- Improve heat transfer rate
- Improve heat transfer uniformity
- Improve runnability
Temperature Profile Comparison

- Stationary Syphon with dryer bars
- Rotating Syphon no dryer bars

Turbulator Tube Bars

Machine Speed vs Production Increase

% Increase in Production

Machine Speed (fpm/MPM)
Upgrade Kits for Beloit

CS Steamfits

Beloit CS Steamfit Design

- Adapter plate
- Carbon Ring
- Seal plate
- Load spring
- Steamfit CI body
Beloit CS Steamfit Design

- Steam cuts in cast iron body
  - Single stiff Rulon o-ring
- Steal face leaks
  - Only offset misalignment
- Low carbon ring life
  - 1980’s carbon technology
  - Narrow carbon face

CS Equipment Options

- Repair / Replace Parts ($)
  - Keep existing performance
- Upgrade Package ($$)
  - Improve seal life, reliability
- Replacement Package ($$$)
  - All-new components
CS Equipment Options

• Various Suppliers
  – Valmet (Beloit drawings)
  – Independent suppliers (pirate)
• Direct Replacement
  – No adapters required
• Known Performance
  – Previous Beloit technology

CS Upgrade Options

• Retain Major Existing Components:
  – Syphon and insulating sleeve
  – Steamfit body
• Upgrade to Kadant Johnson Sealing System
  – Longer seal life
  – Improved reliability
• Kadant Johnson Replacement Parts
  – Uses standard PT Series components
PT Upgrade Kits for CS Joints

- Simplex inlet
- Simplex rotary
- Simplex stationary
- Duplex stationary

PT Upgrade Kits for CS Joints

- Dual dynamic o-ring seal  
  - Protected primary seal
- Static body o-ring seal  
  - Reduced wear, steam-cuts
- Improved surface finish  
  - Decreased seal wear
PT Upgrade Kits for CS Joints

- Wide carbon face
  - Reduced contact pressure
- Kadant Johnson carbon
  - Harder surface material
- Hardened seal surface
  - Reduced wear rate

PT Upgrade Kits for CS Joints

- Corrosion-resistant parts
  - Reduced o-ring wear
- Distributed spring loading
  - Uniform seal face load
- Spherical face seal ring
  - Angular misalignment capability
- Flat face seal ring
  - Offset misalignment capability
PT Upgrade Kits for CS Joints

- Spring loading on seal
  - For low pressure applications
- Long piston pilot in end cap
  - Reduced o-ring stress, steam-cuts
- Polished surface finish
  - Decreased seal wear

PT Upgrade Kits for CS Joints

- Reduced seal loading pressure
- Reversed seal – in compression
- Seals under low pressure
- Thicker seal wear life
- Larger limits for misalignment
- Double o-ring seal for piston
- Retaining rings prevent metal contact
PT Upgrade Kits for CS Joints

• Installation
  – Pre-assembled seal package
  – Installed without compressing springs
• Maintenance
  – External indication of seal wear
  – Mechanical stop to prevent metal contact
  – Increased seal ring wear range
  – Ease of carbon replacement

PT Upgrade Kits for CS Joints

• Seal (adapter) plate
• Carbon seal ring
• Piston
• End cap
• Springs / Retaining Pins
• O-rings and gaskets
• Re-use cantilever horizontal pipe
• Re-use syphon pipe and shoe
Replacement Information

• Steamfit assembly drawing
  – From mill engineering records
• Steamfit mounting dimensions
  – Shelf or overhead bracket
  – Reference assembly drawing
• Spare steamfit adapter plate
  – To insure proper conversion
PTN™ & PTXN™ Rotary Joints

PT(X)N---What products are affected?

• PT(X)N is an upgrade for the following products:
  • 2 ½, 3, & 3 ½” rotary joints
  • L, LN, NAW, and 9750 PTX rotary joints
PTN Rotary Joint

Existing Lug Joint

New Condensate Seal Package

PT Seal Package

PTN Condensate Seal Package
PTN Condensate Seal Package

- Replaces packing in L and NAW joints when converting to a PT main seal package
- Uses S joint seal
- Direct replacement of assembly plate so you may re-use the body
- Same seal, spring are used in all three sizes

PTN Example

- Mill with a 2750 LN rotary joint
- Upgrade to a LNPT rotary joint
  - New
    - Main PT seal assembly plate
    - Main seal
    - Wearplate
    - New condensate seal package
  - Re-use
    - Syphon
    - Body
    - Head
PTN Example

• Another option is to add a ring bracket upgrade to the lug joints
  – Accomplished by adding material to the end cap which will allow the rotary joint to be attached by a bracket

GP Pennington PTN Installation

• PM3
• Linerboard Machine
• Speed: 800 FPM to 1300 FPM
• Maximum Operating Pressure: 125 PSI
• Total Cans: sixty-nine (69) Cans
• 60" OD x 234" Face
• Converting from 2750LN's to 9750PTN rotary joints
• Twelve (12) PTN conversion kits ordered
Drawing C2616  9750 PTN

GP Pennington 9750 PTN
What do we have so far?

2600/2700/2750 L(N) → 2600/2700/2750 PTN → 9600/9700/9750 PTN

NAW Rotary Joints

The exact upgrade used on the lug joints can be used on the 6700/6750 NAW joints
Now what do we have?

- 2600/2700/2750 L(N) → 2600/2700/2750 PTN → 9600/9700/9750 PTN
- 6700/6750 NAW → 6700/6750 PTN → 9700/9750 PTN
9750 PTXN Rotary Joint

Now what do we have?

- 2600/2700/2750 L(N)
- 6700/6750 NAW
- 9750 PTXN

- 2600/2700/2750 PTN
- 6700/6750 PTN
- 9750 PTX CSS

- 9600/9700/9750 PTN
- 9700/9750 PTN
December 20, 2007

RX Application Summary

Product Focus
The RX product line is a high-performance ball bearing rotary joint used in both the paper and industrial markets. The RX joint line is the second-generation ball bearing joint designed to replace the WR product line. Kadant Johnson classifies the 3/8”- 1-1/2” as small, the 2” – 3” as medium and the 4” – 6” as large when discussing the RX joint line. The features and benefits are described in the NPI.

Product Information
See the Kadant Johnson corporate intranet for the RX NPI showing additional product information. The NPI includes: product overview, sales strategy, product description, targeted customers and applications, competition, and frequently asked questions.

A 4200RX cut-away model is available to be shipped to a customer’s location during the early stages of the sale. This full size model allows the customer to see and touch the actual product. This is especially effective with maintenance personnel. The weight of the model is approximately 38 pounds.

See Kadant Johnson corporate intranet for the Power Point presentation.

Drawing AB10063 is the Application Sheet for the 2” – 6” RX joints.

Technical Description
The RX joint utilizes a cartridge. Each cartridge has been designed for a specific application. This allows the RX line to be very versatile, working in general water applications to high temperature hot oil applications. See the NPI for specific cartridge designations.
Kadant Johnson recommends the flow media be filtered. For hot oil applications the filter should remove particles 40 – 60 microns or smaller. This is equivalent to a 325 – 230 mesh screen. We suggest “standard” quality be used when operating RX joints on water. Standard water quality has hardness less than 10 grains per gallon, a solids content less than 200 ppm and a PH between 6.5 and 7.5. When water applications do not meet the standard qualifications, the “–2” cartridge should be used.

Saturated steam applications in the medium RX joints should use only the “–1” cartridge. This cartridge is equipped with grease fittings for re-greasing the bearings, which is the best practice for steam applications. Large RX joints are only recommended on saturated steam applications when the steam pressure is low.

The RX joint can also be used on air applications.

**Nomenclature**

The joint assembly drawings will have the cartridge specified in the symbol number. This number will appear after a dash directly following the joint size preceding any letter nomenclature.

For example:

4250RX-1 is a cartridge.

4250-1RXB2N is a joint assembly using the –1 cartridge which is now located immediately following the joint size number 4250.

4250RXB2N-1 is a joint assembly using the “standard water service” cartridge. There is no dash number following the 4250 joint size. The –1 at the end of the nomenclature in this joint assembly designates a flanged nipple configuration.
Product Implementation

A variety of nipple configurations are available in the medium size line. These configurations can be found in the NPI.

The large RX line has only a flanged nipple configuration for adapting to the customer’s equipment.

Once the nipple configuration has been determined, a filler flange may be required to mate the joint nipple to the existing flange or journal face.

The large RX joint line requiring tapered bearings utilize a two-piece nipple where the flange is press fit on the nipple tube. Flanges used on the large RX nipple tubes can be custom designed eliminating the need for a filler flange.

This may require field dimensions if drawings are not available for this equipment. The measurement worksheets for gathering the necessary dimensions are on the Application Drive, Field Service Drawing, Industrial Measurement Prints, named: Industrial Field Service Prints.

The RX can be supplied as a mono-flow or dual-flow style joint. Often times when the dual flow joint is specified, we are adapting to the existing horizontal pipe. We have good success by being able to configure our joints to capture the customer’s existing syphon pipe. If the customer’s existing syphon pipe is too short for the RX joint application, there are preferred two-piece horizontal pipe arrangements. See drawings SK1608, LB27, BL986 for examples.

See the Kadant Johnson corporate intranet for detailed “Installation Instructions”.

Equipment Sizing

The operating conditions are required to size the joint. Flow rates dictate the minimum size of the joint.

The joint is sized for flow capacity using the Kadant Johnson Joint Sizing Program.
The default specific gravity for hot oil is 0.85. Check the specific gravity for the heat transfer oil being used. This specific gravity changes per the operating temperature. Use the specific gravity for the average service temperature.

**Competition**

There are several competitors, two of which are:

1. Deublin, Waukegan, Illinois has a full line of rotary joints and ancillary equipment that competes with Kadant Johnson in most markets.

2. Barco, Barrington, Illinois also has a full line of products for the industrial markets.

See the XSI-0001 located on the Kadant Johnson Intranet for direct replacement information. Kadant Johnson has a proven record of product performance and parts availability that will outperform the OEM joints.

See the NPI for more details regarding the competition.

**Operating Issues and Problem Solving**

When replacing the competitors’ equipment, it is just as valuable to know the operating conditions and the installation configuration, as it is to know the competitors’ model number. Identifying the mode of failure is very useful as well. These factors all assist in determining the best product and installation configuration for the application.

Our Field Engineer was visiting a customer on an unrelated issue when they noticed the competitor’s joints leaking on a cooling roll application. After questioning the customer on the problems they were experiencing, they asked if they were interested in a new joint and horizontal pipe design. Evaluation of the joint showed the existing horizontal pipe was causing high torque in the joint head resulting in premature failure. The customer accepted our design and installed the rotary joint and horizontal pipe on another cooling roll. They are pleased with the design and performance. This design configuration can be seen on drawing LB27.
Type RX Rotary Union

General Customer Availability

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The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

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This new product introduction includes the ⅜” through 6” Type RX unions. The RX unions are high-performance ball bearing unions for water and thermal oil service. In some situations, the RX can be used on saturated steam and air applications.

Type RX rotary unions are available in single- and dual-flow configurations. Different configurations are available for lower-end (called standard) and higher-end (demanding) applications. The base union consists of a cartridge that includes the body (housing), bearings, seal package, and for sizes 2” and larger an assembly plate.

Bearing

The standard RX water union comes with deep groove ball bearings. The deep groove ball bearing version of the RX union is intended for water applications to retrofit the Deublin 55, 57, and 6000 series. The RX-1, RX-2, and RX-3 versions feature a bearing isolation seal (barrier seal) between the seal chamber and the bearing package to prevent moisture or contamination from entering the bearing area. These versions utilize shielded bearings. Shielded bearings allow re-lubrication for higher temperature applications. The large size RX (4”, 5” and 6”) is available with tapered roller bearings in the higher-end configurations. The tapered roller bearings have a sealed bearing cavity that will keep all debris and moisture from entering the bearing cavity. This type of bearing configuration also provides a longer bearing life and is smoother running.

Nipple (Rotor) Configurations

The small and medium size RX (⅜” through 3”) rotors are available in threaded, Q-flange, or integral flange.

The large RX sizes (4” to 6”) are only available with an integral flange. The integral nipple flange design was made to ensure a truer running union, to increase the flow area, and to make installation easier.

If you have a threaded application and there is no journal flange, you can convert to an integral flange by using a threaded adapter flange that will accept the flanged nipple. If you run across a quick release nipple flange design, in most cases you will be able to retrofit an integral nipple flange in its place by installing a journal flange. This allows you to use the standard integral flange nipple that is readily available and lower in cost than a special version would be.

To minimize delivery time and simplify the upgrade to Kadant Johnson unions, we have designed the integral nipple flange to match the standard Deublin 6000 series flange configuration.

Head Configurations

The RX union has single- and dual-flow configurations in both threaded and flanged connections. All heads for a specific size are interchangeable. It is recommended that all oil applications and higher temperature/pressure water applications use a flanged head for unions larger than 1½”. For dual-flow rotary supply pipe service, the elbow in the small and medium size RX unions comes with a brass bushing to accommodate a rotating supply pipe. For the large size RX unions, the flanged dual flow head comes with an antimony-impregnated carbon bushing for a rotating distribution pipe. The threaded dual flow head comes with a DU bushing for use with a rotating distribution pipe. The antimony bushing has more allowable wear and should be used on the higher speed applications.
### Material Specifications

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</tbody>
</table>

** Up to 300 F (149 C). Above 300 F (149 C) use Krytox grease.

*4200RXB2 2” dual flow rotary union with threaded rotor.*
Product Overview

Drawings

The drawing structure has been configured with cartridge sub-assemblies to reduce the time from order to manufacture. These drawings have all of the proprietary internal components called out on the bill of material. The cartridge drawings would normally not be distributed to customers or prospects. When an order is received, a customer drawing will be provided for the specific application. These drawings show all of the required interface dimensions. Drawings have been created for all of the standard configurations and are available from Drawing ’06 or Visual Manufacturing.

Symbol Number Examples for Assemblies, Cartridges, and Repair Kits

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4100RXA</td>
<td>1” Rotary union, single flow, standard water service</td>
</tr>
<tr>
<td>4100RX</td>
<td>1” Assembly of rotary union cartridge for standard water service</td>
</tr>
<tr>
<td>RK4100RX-SR</td>
<td>Repair kit for seal package</td>
</tr>
<tr>
<td>RK4100RX-BK</td>
<td>Repair kit for bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4100-1RXA</td>
<td>1” Rotary union, single flow, high-end water service</td>
</tr>
<tr>
<td>4100RX-1</td>
<td>1” Assembly of rotary union cartridge for high-end water service</td>
</tr>
<tr>
<td>RK4100RX-SR-1</td>
<td>Repair kit for seal package</td>
</tr>
<tr>
<td>RK4100RX-BK-1</td>
<td>Repair kit for bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4100-2RXA</td>
<td>1” Rotary union, single flow, standard oil service</td>
</tr>
<tr>
<td>4100RX-2</td>
<td>1” Assembly of rotary union cartridge for standard thermal oil/severe water service</td>
</tr>
<tr>
<td>RK4200RX-SR-2</td>
<td>Repair kit for seal package</td>
</tr>
<tr>
<td>RK4200RX-BK-2</td>
<td>Repair kit for bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4100-3RXA</td>
<td>1” Rotary union, single flow, high-temp oil service</td>
</tr>
<tr>
<td>4100RX-3</td>
<td>1” Assembly of rotary union cartridge for high-end thermal oil service</td>
</tr>
<tr>
<td>RK4100RX-SR-3</td>
<td>Repair kit for seal package</td>
</tr>
<tr>
<td>RK4100RX-BK-3</td>
<td>Repair kit for bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4250RXA</td>
<td>2½” Rotary union, single flow, standard water service</td>
</tr>
<tr>
<td>4250RX</td>
<td>2½” Assembly of Rotary union Cartridge for Standard Water Service</td>
</tr>
<tr>
<td>RK4250RX-SR</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4250RX-BK</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4250-1RXA</td>
<td>2½” Rotary union, single flow, high-end water service</td>
</tr>
<tr>
<td>4250RX-1</td>
<td>2½” Assembly of Rotary union Cartridge for High-End Water Service</td>
</tr>
<tr>
<td>RK4250RX-SR-1</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4250RX-BK-1</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4250-2RXA</td>
<td>2½” Rotary union, single flow, standard oil service</td>
</tr>
<tr>
<td>4250RX-2</td>
<td>2½” Assembly of Rotary union Cartridge for Standard Thermal Oil/Severe Water Service</td>
</tr>
<tr>
<td>RK4250RX-SR-2</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4250RX-BK-2</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4250-3RXA</td>
<td>2½” Rotary union, single flow, high-temp oil service</td>
</tr>
<tr>
<td>4250RX-3</td>
<td>2½” Assembly of Rotary union Cartridge for High-End Thermal Oil Service</td>
</tr>
<tr>
<td>RK4250RX-SR-3</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4250RX-BK-3</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4600RXAF</td>
<td>6” Rotary union, single flow, standard water service</td>
</tr>
<tr>
<td>4600RX</td>
<td>6” Assembly of Rotary union Cartridge for Standard Water Service</td>
</tr>
<tr>
<td>RK4600RX-SR</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4600RX-BK</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4600-1RXAF</td>
<td>6” Rotary union, single flow, high-end water service</td>
</tr>
<tr>
<td>4600RX-1</td>
<td>6” Assembly of Rotary union Cartridge for High-End Water Service</td>
</tr>
<tr>
<td>RK4600RX-SR-1</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4600RX-BK-1</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4600-2RXAF</td>
<td>6” Rotary union, single flow, standard oil service</td>
</tr>
<tr>
<td>4600RX-2</td>
<td>6” Assembly of Rotary union Cartridge for Standard Thermal Oil/Severe Water Service</td>
</tr>
<tr>
<td>RK4600RX-SR-2</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4600RX-BK-2</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
<tr>
<td>4600-3RXAF</td>
<td>6” Rotary union, single flow, high-temp oil service</td>
</tr>
<tr>
<td>4600RX-3</td>
<td>6” Assembly of Rotary union Cartridge for High-End Thermal Oil Service</td>
</tr>
<tr>
<td>RK4600RX-SR-3</td>
<td>Repair Kit for Seal Package</td>
</tr>
<tr>
<td>RK4600RX-BK-3</td>
<td>Repair Kit for Bearings (includes seal repair kit)</td>
</tr>
</tbody>
</table>
Product Overview

Unique Selling Proposition

Kadant offers a complete line of ball bearing unions for water and thermal oil service from \( \frac{3}{8} \)" to 6". The RX union is the first major advancement in ball-bearing supported rotary unions in several decades. Kadant Johnson is a rotary union specialist with a rich history of making the best solutions possible. Our customers benefit from improvements in their production processes resulting from Kadant’s innovative products, application expertise, and responsiveness.

Customer Value

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-machine seal replacement</td>
<td>Reduces down-time and cost of maintenance</td>
</tr>
<tr>
<td>Stainless steel rotor (( \frac{3}{8} )&quot; - 3&quot;)</td>
<td>Extended operating life with less corrosion potential on wetted parts</td>
</tr>
<tr>
<td>O-rings are fully captured in a gland</td>
<td>Risk of o-ring slipping out of place is eliminated; robust design</td>
</tr>
<tr>
<td>Springs located outside the flow area (not wetted by the fluid)</td>
<td>Increased flow area, eliminated problems associated with spring failure or build-up of debris from flow contacting the spring</td>
</tr>
<tr>
<td>Large internal flow area</td>
<td>May allow use of smaller nominal size union for easier installation and maintenance, and lower purchase price</td>
</tr>
<tr>
<td>Flanged inlet / outlet connections (2&quot; – 6&quot;)</td>
<td>No thread leakage for oil applications, eliminates NPT or BSPT threads on flexible hoses</td>
</tr>
<tr>
<td>Tapered roller bearings (4&quot; – 6&quot;)</td>
<td>Permits higher thrust load, improves alignment, longer life.</td>
</tr>
<tr>
<td>Flanged rotor connection identical to Deublin 6000 series unions (standard config)</td>
<td>Fast, economical conversion to Kadant Johnson RX union.</td>
</tr>
<tr>
<td>Integral flange rotor connection available</td>
<td>Quick installation, true running, mechanical stability</td>
</tr>
<tr>
<td>Standard seal package for water service</td>
<td>Carbon-to-Tungsten Carbide seal package is capable of running dry and requires no lubrication</td>
</tr>
<tr>
<td>High-end seal package for demanding applications</td>
<td>Silicone Carbide-to-Tungsten Carbide seal package provides long service life on demanding hot water and oil applications</td>
</tr>
<tr>
<td>Large vent holes; tapped for plugs or drip tubes</td>
<td>Controlled drainage of seal leakage</td>
</tr>
<tr>
<td>Bearing isolation seal barrier available</td>
<td>Forms a barrier between the seal package and the bearing cavity to reduce moisture permeation into the grease</td>
</tr>
<tr>
<td>Optional lip seal configuration</td>
<td>Prevents seal ring leakage from entering bearing cavity</td>
</tr>
</tbody>
</table>

![4075RXB2N rotary union with rotating supply pipe](image)
Operating Conditions (⅜” to 1½”)

RX (up to 220 F; 105 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>220 F</td>
<td>105 C</td>
<td>200 psi</td>
</tr>
</tbody>
</table>

RX-1 (up to 350 F; 177 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>350 F</td>
<td>177 C</td>
<td>200 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>350 F</td>
<td>177 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Steam*</td>
<td>350 F</td>
<td>177 C</td>
<td>120 psi</td>
</tr>
</tbody>
</table>

RX-2 (up to 400 F; 204 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>350 F</td>
<td>177 C</td>
<td>200 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>400 F</td>
<td>204 F</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

RX-3 (up to 450 F; 232 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>350 F</td>
<td>177 C</td>
<td>200 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>450 F</td>
<td>232 C</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

*Note: Applications above 300 F (145 C) must use Dupont Krytox (GPL227) grease.
Product Overview

Operating Conditions (2” to 3”)

RX (up to 220 F; 105 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>220 F 105 C</td>
<td>200 psi 13 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Oil</td>
<td>220 F 105 C</td>
<td>150 psi 10 bar</td>
<td>1,000 RPM</td>
</tr>
</tbody>
</table>

RX-1 (up to 350 F; 177 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>300 F 145 C</td>
<td>200 psi 13 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Water*</td>
<td>350 F 177 C</td>
<td>200 psi 13 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Oil</td>
<td>300 F 145 C</td>
<td>150 psi 10 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Oil*</td>
<td>350 F 177 C</td>
<td>150 psi 10 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Steam</td>
<td>300 F 145 C</td>
<td>52 psi 3.5 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Steam*</td>
<td>350 F 177 C</td>
<td>120 psi 8 bar</td>
<td>1,000 RPM</td>
</tr>
</tbody>
</table>

RX-2 (up to 400 F; 204 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>350 F 177 C</td>
<td>200 psi 13 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Oil*</td>
<td>400 F 204 F</td>
<td>150 psi 10 bar</td>
<td>1,000 RPM</td>
</tr>
</tbody>
</table>

RX-3 (up to 482 F; 250 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>350 F 177 C</td>
<td>200 psi 13 bar</td>
<td>1,000 RPM</td>
</tr>
<tr>
<td>Oil*</td>
<td>482 F 250 C</td>
<td>150 psi 10 bar</td>
<td>1,000 RPM</td>
</tr>
</tbody>
</table>

*Note: Applications above 300 F (145 C) must use DuPont Krytox (GPL227) grease.
## Operating Conditions (4” to 6”)

### RX (up to 300 F; 149 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>300 F</td>
<td>149 C</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

### RX-1 (up to 320 F; 160 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>300 F</td>
<td>145 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Water*</td>
<td>320 F</td>
<td>160 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Oil</td>
<td>300 F</td>
<td>145 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>320 F</td>
<td>160 C</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

### RX-2 (up to 400 F; 204 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>320 F</td>
<td>160 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>400 F</td>
<td>204 F</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

### RX-3 (up to 500 F; 260 C)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Max Temperature</th>
<th>Max Pressure</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water*</td>
<td>320 F</td>
<td>160 C</td>
<td>150 psi</td>
</tr>
<tr>
<td>Oil*</td>
<td>500 F</td>
<td>260 C</td>
<td>150 psi</td>
</tr>
</tbody>
</table>

*Note: Applications above 300 F (145 C) must use Dupont Krytox (GPL227) grease.*

---

![Rotary Union Diagram](image)
Selling Strategy

When talking to prospective customers, focus on:

- Design advantages and distinctions (listed above)
- Stainless steel nipple (¼" - 3") and assembly plate (2", 2½", and 3" sizes)
- Springs are not wetted (i.e., outside the flow area)
- On-machine repairability
- Modular design allows selecting the components/configuration that suits the application
- Technical support and service
- Retrofit capability to Deublin 6000 Series for 2" and larger sizes
- Retrofit capability to Deublin 55/57 Series for 1½" and smaller sizes

The RX unions are to be promoted as a premium product, and sold at a competitive price. No competitive union has features that are equal to those of the RX. If the application does not justify this premium offering, the WH union can be offered as a competitive, lower-cost option. It is important to maintain the premium position of the RX line.

Sales Collateral / Reference Material

Bulletins / Brochures
- RX Rotary Union Catalog
- Installation Instructions
- Repair Instructions

Sales Presentations
- PowerPoint Presentation – RX Rotary Union
Deublin 55/57 Series (3/8” to 2”)
Source: http://www.deublin.com/assets/pdf/55.pdf

Deublin’s 55 series is a general-purpose union for water, intermittent steam or oil. Sizes 3/8” to 1” have a stainless steel rotor (nipple). Larger sizes use carbon steel rotors. The standard seal material is bronze running against a carbon graphite counterseat.

Max Temperature: 120 C (250 F) [55 series]
Max Temperature: 90 C (194 F) [57 series]
Max Pressure: 51 bar (750 psi) [55 series]
Max Pressure: 10 bar (150 psi) [57 series]
Max RPM: 3,500

Comment from Kadant Johnson: The RX union has a much harder, more robust counterseat.

Deublin 6000 Series (3/8” to 4”)
Extract from Deublin Engineering Catalog 952B 1999

Deublin’s “cartridge” design allows on-the-machine replacement of seals. Its steel banded floating seal and heavy duty ball bearings make this union resistant to shock and vibration, suited for paper machine Calender and Super Calender rolls. Water service seals are carbon graphite-to-tungsten carbide. E.L.S. seals are silicon carbide-to-tungsten carbide. All unions have a fluoroelastomer diaphragm secondary seal.

Max temperature: Water 120 C (250 F) contact Deublin engineering for special models
Max Pressure: 10 bar (150 psi)
Max RPM: 750

Comments from Kadant Johnson
- M and P offset dimensions are the same (or slightly longer) than the standard RX.
- Standard flanged RX rotor is directly interchangeable with the 6000 series union.
- Temperatures are normally limited to values less than the RX.
Barco Type E75 RS (3/8” – 2”)
Source:  http://www.barcoseals.com/rotary_unions.htm

- Dry run capability
- Silicon carbide to carbon graphite mechanical seals
- Sizes from 3/8” to 2”
- Tapped vents accept drain line fitting or plug

Max temperature:  82 C (180 F) for permanently lubricated bearings
Max Pressure: 10 bar (150 psi)
Max RPM: 3500

Barco Type EC

*Extract from Barco Catalog 868 (1990)*

Barco EC unions are designed for water service up to 300 F (176 C). They are primarily applied to calendars with high shock loads, vibration and high internal flow velocity. The features include:

- Banded carbon seal for corrosion resistance, longer union life, reduced maintenance
- Heavy duty taper roller bearings to extend bearing life and allow higher shock loads
- A high density seal permits alignment and sealing capability
- Seal replacement without removing the union from the system
- Ports in housing permit heat dissipation and venting while also serving as weep holes
- Design is patented in the US (4,632,431)

Max temperature: Water 149 C (300 F)
Max Pressure: 10 bar (150 psi)
Max RPM: 750
Duff-Norton 2500 Series (2” – 6”)

*Extract from Bulletin RUPB-2500A 3/95*

The Duff-Norton Series 2500 Rotary union® is designed to perform in applications of high temperature, high speed, shock and vibration. The seal package is a John Crane balanced, welded edge metal bellows type seal. This seal design allows the Series 2500 to operate at temperatures up to 315 C (600 F). The dual heavy-duty roller bearings in the Series 2500 withstand hose load and provide protection for the seal against shock and radial run out. An air-cooled insulating sleeve minimizes heat transfer from the flow medium to the bearing cavity prolonging grease life.

**Features (as reported by Duff-Norton)**
- John Crane Welded Metal Edge Bellows Type Seal with tungsten carbide and silicon face materials
- Patented insulating sleeve
- Taper roller bearings
- Outboard grease passage
- Ventilation ports
- Fin design housing

<table>
<thead>
<tr>
<th>Max temperature:</th>
<th>Water 180 C (350 F)</th>
<th>Hot Oil 315 C (600 F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Pressure:</td>
<td>17 bar (300 psi)</td>
<td></td>
</tr>
<tr>
<td>Max RPM:</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Maier DP Series DN 10 – 50 (3/8” – 2”) Water Service

*Extract from Maier website*

The Maier DP union uses two ball bearings and is marketed to the textile, plastic, and paper industry for water service. The body is made of steel, the nipple is chrome-plated steel, and the seal surface made of metal ceramics.

The Maier DXS ranges in size from 1¼” to 6” and uses two taper roller bearings, which are maintenance-free up to 80 C. The DN 100 (4”) version is available with screwed flanges or BSP threads. For the DN 125 (5”) and DN 150 (6”) unions, the connections are welded flanges DIN 2633. The internal distribution pipe can be either stationary or rotating.

<table>
<thead>
<tr>
<th>Max temperature:</th>
<th>120 C (250 F) standard; 160 C special</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Pressure:</td>
<td>10 bar (145 psi)</td>
</tr>
<tr>
<td>Max Speed:</td>
<td>55000/DN (e.g. 550 rpm for 100 mm union size)</td>
</tr>
</tbody>
</table>
Maier DQ Series DN 50-150 (2” – 6”) Thermal Oil Service
Extract from Maier DQ Catalog D 13495e

Maier is the current market leader in large thermal oil rotary unions in Europe, and in 2001 opened offices in North America. The DQTX union can operate up to 400 C (750 F), but the price point is much higher than the RX line. The DQL thermal oil union can operate up to 200 C (392 F) without a separate cooling circuit.

The DQ uses ball bearings up to 6” where taper roller bearings are used.

<table>
<thead>
<tr>
<th>Design</th>
<th>Cooling Unit</th>
<th>Max Temp</th>
<th>Max Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>DQL</td>
<td>No</td>
<td>200 C (392 F)</td>
<td>10 bar (150 psi)</td>
</tr>
<tr>
<td>DQ</td>
<td>Yes</td>
<td>300 C (572 F)</td>
<td>10 bar (150 psi)</td>
</tr>
<tr>
<td>DQT</td>
<td>Yes</td>
<td>350 C (662 F)</td>
<td>10 bar (150 psi)</td>
</tr>
<tr>
<td>DQTX</td>
<td>Yes</td>
<td>400 C (750 F)</td>
<td>13 bar (190 psi)</td>
</tr>
</tbody>
</table>
RX™ Rotary Unions

Engineered reliability for demanding applications

RX Rotary Union Overview

• Size range from ¾” to 6” flow diameters
• Designed for water and thermal oil
• Extremely robust design
• Operating capabilities:
  – Up to 3,500 rpm
  – Up to 200 psig
  – Up to 500 F
RX Rotary Union Overview

- Reliable seal for rotating connections
- Direct upgrade of competitive rotary unions
  - Higher pressure capability
  - Higher speed capability
  - Higher flow capacity
- Reliable performance

Single and Dual Flow Configurations

Single flow rotary union

Dual flow rotary union
RX Rotary Union Features

• Springs located outside the flow area
• O-rings fully captured in glands
• Bearing isolation system
• Stainless steel rotor
• Two-piece housing
• Balanced seal assembly
• Precision lapped seals
• Matched seal faces
RX Rotary Union Features

- One-piece carbon graphite seal ring
- One-piece tungsten-carbide counterseat
- Widely-spaced ball bearing support
- Excellent corrosion resistance
- Tapped vent holes
- Full-bore flow area
- Compact envelope
- Sealed bearings
- Low torque

RX Rotary Union Benefits

- On-machine seal replacement
- Reliable service for demanding applications
- Fast delivery of standard configurations
- Reduced down-time and cost of maintenance
- Robust design, no risk of o-ring slipping
- Increased bearing protection
- High flow capacity
- Low pressure drop
- Long operating life
**RX Rotary Union – \( \frac{3}{8}'' \) to 1½”**

### Standard RX Ratings
- **Pressure:** 200 psig (13 bar)
- **Temperature:** 220°F (105°C)
- **Speed:** 3,500 RPM
- **Media:** Water, Air

Consult Kadant Johnson for RX-1, RX-2, and RX-3 unions for applications up to 450°F (232°C).

<table>
<thead>
<tr>
<th>Type</th>
<th>Media</th>
<th>Pressure (Max.)</th>
<th>Temperature (Max.)</th>
<th>Speed (RPM)</th>
</tr>
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<tr>
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**RX Rotary Union – 2” to 3”**

### Standard RX Ratings
- **Pressure:** 200 psig (13 bar)
- **Temperature:** 220°F (105°C)
- **Speed:** 1,000 RPM
- **Media:** Water, Thermal Oil

Consult Kadant Johnson for RX-1, RX-2, and RX-3 unions for applications up to 450°F (232°C).

<table>
<thead>
<tr>
<th>Type</th>
<th>Media</th>
<th>Pressure (Max.)</th>
<th>Temperature (Max.)</th>
<th>Speed (RPM)</th>
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<tr>
<td>RXK-3</td>
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</tr>
</tbody>
</table>
RX Rotary Union – 4” to 6”

Standard RX Ratings

Pressure: 150 psig (10 bar)
Temperature: 300°F (150°C)
Speed: 750 RPM
Media: Water, Thermal Oil

<table>
<thead>
<tr>
<th>Type</th>
<th>Media</th>
<th>Pressure (Max.)</th>
<th>Temperature (Max.)</th>
<th>Speed (RPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Thermal Oil</td>
<td>Steam</td>
<td>Air</td>
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<tr>
<td>4” to 6”</td>
<td>10</td>
<td>150</td>
<td>140</td>
<td>300</td>
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<td>RX-1</td>
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<td>RX-2</td>
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<td>RX-3</td>
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<td>●</td>
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<td>●</td>
</tr>
<tr>
<td></td>
<td>10</td>
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<td>160</td>
<td>320</td>
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<td></td>
<td>10</td>
<td>150</td>
<td>204</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>150</td>
<td>260</td>
<td>500</td>
</tr>
</tbody>
</table>
SNX™ Rotary Joint

General Customer Availability:

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediately</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>1” Immediately; all other sizes with the exception of the 4” ready to ship by 01 September 2012; 4” ready to ship by 01 November 2012</td>
</tr>
</tbody>
</table>

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Record of Changes

<table>
<thead>
<tr>
<th>Release</th>
<th>Date</th>
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<th>Change &amp; Reason</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>28 April 2009</td>
<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>30 July 2012</td>
<td>All</td>
<td>Added additional sizes</td>
</tr>
</tbody>
</table>
The SNX™ is a dual-flow rotary joint intended primarily for steam service and rotating syphon applications. The SNX features a double-guide, convex seal ring, o-ring sealed spring shoulder, and a positive internal differential seal for the rotating syphon inside the steam joint. This joint replaces the SN™ rotary joint.

The SNX rotary joint uses the same carbon seal ring and guides as the SX™ rotary joint. It uses the existing NA or N type head and assembly plate used with the SN rotary joint. The body, nipple, and spring shoulder are all new parts. The anti-torque hole on the body is centered between the two guides, for proper torque control.

The symbol number for each size along with connection sizes are:

<table>
<thead>
<tr>
<th>Size</th>
<th>M</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2300SNX</td>
<td>½&quot; – ¾”</td>
<td>½”</td>
<td>¾”</td>
</tr>
<tr>
<td>2550SNX</td>
<td>¾” – 1½”</td>
<td>¾” – 1¼”</td>
<td>½” – 1”</td>
</tr>
<tr>
<td>2600SNX</td>
<td>1” – 2½”</td>
<td>¾” – 1½”</td>
<td>¾” – 1½”</td>
</tr>
<tr>
<td>2700SNX</td>
<td>1½” – 3”</td>
<td>1” – 1½”</td>
<td>3½”</td>
</tr>
<tr>
<td>2750SNX</td>
<td>1½” – 3”</td>
<td>2”</td>
<td>1½”</td>
</tr>
<tr>
<td>2800SNX</td>
<td>2” – 2½”</td>
<td>2” – 2½”</td>
<td>3½”</td>
</tr>
</tbody>
</table>

The SNX rotary joint is intended to upgrade SN and LN™ steam joints with its improved sealing geometry and positive syphon seal. The self-supporting SNX rotary joint is similar in operation to the SN rotary joint. The SNX rotary joint includes a body, head, nipple, spring, carbon seal ring, retaining ring, and gaskets. The SNX rotary joint, however, has two carbon guides rather than one and a spring shoulder rather than a thrust collar. In addition, the syphon is sealed using two o-rings as the standard for steam applications; packing is optional.
**Unique Selling Proposition**

The improved support and sealing method provide for a longer-lasting, better performing self-supporting joint than the SN rotary joint. The maximized separation between the carbon guides increases the operating life and provides better support for the joint. The horizontal syphon pipe is supported by the nipple rather than by a thrust collar. This eliminates the key wear that results from misalignment. The dry guide is free to rotate. The ability for the dry guide to rotate distributes the overall wear of the guide and increases the operating life of the carbon.

**Customer Value**

Following is a summary of the benefits of the SNX rotary joint:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two internal support guides</td>
<td>Increased reliability and performance</td>
</tr>
<tr>
<td>Convex seal ring in compression</td>
<td>Improved seal and operating range</td>
</tr>
<tr>
<td>Smaller mean seal diameter</td>
<td>Extended seal life from slower wear rate</td>
</tr>
<tr>
<td>Less seal face movement (runout)</td>
<td>Reduced seal wear, less frequent maintenance</td>
</tr>
<tr>
<td>Maximum carbon guide separation</td>
<td>Improved syphon support, longer operating life</td>
</tr>
<tr>
<td>Flexibility in mounting</td>
<td>No special installation tools required</td>
</tr>
<tr>
<td>Anti-torque lug location optimized</td>
<td>Guide life increased</td>
</tr>
<tr>
<td>Nipple-mounted syphon</td>
<td>Eliminates key and key-way wear found with SN and LN joints</td>
</tr>
<tr>
<td>External seal wear indication</td>
<td>No need to remove pressure plugs to check seal wear</td>
</tr>
</tbody>
</table>

**Operating Conditions**

*Maximum Conditions*

- **Design Speed**: up to 450 RPM
- **Design Temperature (steam)**: up to 400°F (205°C) with o-ring* syphon pipe seal, up to 500°F (260°C) with pre-formed packing and packing gland
- **Design Temperature (oil)**: up to 650°F (343°C)
- **Design Pressure (steam)**: up to 300 psig (20 bar)
- **Design Pressure (oil)**: up to 150 psig (10 bar)
- **Service**: Steam and thermal oil**

*It is recommended that the end of the horizontal syphon pipe be machined and to add a chamfer for ease of installation when used with the o-ring seal.*

*Although the SNX rotary joint can be used with thermal oil service, RX™ and SX rotary joints are recommended for thermal oil applications that require rotary joints smaller than 4”. For thermal oil applications that require a 4” rotary joint, the ELSN™ rotary joint is recommended.*
Selling Strategies

The SNX rotary joint is targeted for machines that require a dual-flow steam joint with a rotating syphon. Users of Kadant Johnson SN or LN rotary joints as well as competitive installations (e.g., Barco, Deublin H, N, and 9000 series, and Maier H/HW joints) are also potential candidates for the SNX rotary joint.

The SNX rotary joint can provide improved performance due to the increased guide separation and nipple-mounted horizontal syphon pipe that allows for improved key/thrust collar wear resulting in smoother operation.

Qualifying questions:

- Are LN or SN joints currently being used?
- Is there a problem or concern with syphon stability or syphon pipe breakage?
- Are there concerns with rapid seal wear?
- Is the user looking for longer rotary joint operating life?
- Is there a concern with alignment and worn support rods?

Target Market and Applications

This rotary joint is well-suited for nonwoven, textile, and converting industries that require a steam joint with a rotating syphon. It can also be applied to thermal oil applications when the SXBN or ELSN rotary joint is not feasible.

The SNX rotary joint is positioned as a competitively-priced rotary joint for moderate application conditions. For demanding applications, the ELSN rotary joint is recommended. Note: The SNX rotary joint is NOT available with flanged connections.

Selling Strategy

In talking to production personnel about the SNX rotary joint, focus on:

- Reliability and long operating life
- Syphon support inside the nipple – eliminates key wear
- Seal life – explain how the design extends seal life, handles misalignment, and reduces downtime
- Economical upgrade when using SN or LN rotary joints

In talking to maintenance personnel, focus on:

- Fast, easy installation
- Ease of rebuild
- Familiarity with SN rotary joint design and operation
- Quick delivery
- Reduced maintenance cost due to extended seal and guide life
- Convex seal is contained if broken, controlled leakage toward roll and not the pipefitter
Selling Strategies

Sales Collateral / Reference Material

Bulletins / Brochures

SNX Rotary Joint Flyer
Installation Instructions
Disassembly and Repair Instructions

Sales Presentations

PowerPoint Presentation – SNX Rotary Joint
Deublin H Series

According to Deublin, its H series joint is designed for steam and thermal oil service.

- For steam and thermal oil applications in paper, plastic and textile industries and open gear paper machines
- Self-aligning spherical carbon graphite to ni-resist seal
- Compression load on the carbon seal
- Two threaded plugs provide access to monitor seal wear
- H series duo flow models have sight glasses in the end cap [head]
- Max pressure is 10 bar (150 psig); max temp 185 C (365 F); 400 rpm

(Source: http://deublin.thomasnet.com/item/steam-monoflow-unions/3-4-to-5-dual-bearing-monoflow-steam-unions/item-3377?&plpver=10&assetid=g1001)

Disadvantages of the Deublin H Series include:

- Limited connection configurations
- No assembly plate
- No external seal wear indication
- Limited pressure range
- Lower speed ratings
- Thermal oil joints are only pressure tested; not tested with thermal oil
- Seal inspection ports consistently cause oil leakage

Deublin 9000 Series for thermal oil

- 9100-020-221-xxx 1” rotating pipe version for thermal oil
- Seal wear indicator
- Nickel-plated cast iron housing
- Steel rotor
- Max pressure is 7 bar (100 psig); max temp 243 C (450 F); 400 rpm

Disadvantages of the Deublin 9000 Series include:

- End cap must be tightened with a spanner wrench
- End cap gasket is sheared during when the end cap is tightened
- Rotating syphon pipe rotates in the packing
- Single guide support
- Concave seal ring
- Seal wear indication appears only when seal is worn out
Maier Series H and HW

Steam: H and HW; Water at low RPM
Thermal oil: HW

Advantages according to Maier:
- Two carbon guides
- Wet guide is locked to prevent rotation
- Housing made of cast iron with [spherical] graphite [seal]
- Rotor made of chrome-plated steel
- The HW model has metal-impregnated artificial carbon for higher pressure, temperature and speed.
- Wear indicator for seal ring at rotor.
- Connection to roll by means of:
  - BSP thread. Adapter pieces for NPT and other threads are available
  - Q flange with split wedge
- Radial [M] and axial [P] housing connection with right-hand thread BSP. Adapter pieces for NPT and other threads as well as flange connections are available.

(Source: Maier catalog D 12805 e, p. 35)

Disadvantages of the Maier H Series include:
- Limited connection configurations
- Very thin outboard guide
- Threaded elbow used for dual flow configuration
- Adapters required for NPT threads
Professional Services

One of the most effective ways to sell rotary joints and associated components is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and syphon for the specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<table>
<thead>
<tr>
<th>Ready for Order:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Ship:</td>
<td>1&quot; Immediate; all other sizes with the exception of the 4&quot; ready to ship by 01 September 2012; 4&quot; ready to ship by 01 November, 2012</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until delivery of the product to the customer. The standard lead time for the SNX joint is two weeks after receipt of order. Most components are stocked in inventory and quick delivery can be made when needed.

Pricing

See SNX rotary joint price sheet.

Required Information to Place an Order

- Size of rotary joint
- Head type (NA, N)
- M, P, and S connection sizes
- Nipple connection (RH, LH and thread type, or Q-flange)
- Media (steam or thermal oil)
- Pressure, temperature, rotational speed
- O-ring (standard) or packing (special) design
**new PRODUCT introduction**

**SX Rotary Joint**

---

**General Customer Availability:**

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<thead>
<tr>
<th>Ready for Order Date:</th>
<th>22 February 2003</th>
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</tr>
<tr>
<td></td>
<td>03 June 2003 (Group 2, sizes 2” to 3”)</td>
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</tbody>
</table>

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<th>Release</th>
<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
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<tr>
<td>A</td>
<td>17 February 2003</td>
<td>All</td>
<td>Original Issue</td>
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<tr>
<td>B</td>
<td>02 March 2004</td>
<td>5, 6, 8, 13</td>
<td>Seal wear measurement update, General updates, SX with adjustable syphon added to appendix</td>
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<tr>
<td>C</td>
<td>21 May 2004</td>
<td>14-16</td>
<td>Appendix B; seal ring designs</td>
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<tr>
<td>D</td>
<td>08 July 2005</td>
<td>All</td>
<td>Kadant Johnson name update</td>
</tr>
</tbody>
</table>
Product Overview

The SX rotary joint is a pressure joint for steam, water, and hot oil applications. The SX joint can be configured to match all of the S joint configurations. Drawings and part numbers have been prepared in advance for the SX joint in many of the popular S joint configurations. The SX features two carbon guides, a convex seal in compression, reduced weight, and a distinctive appearance. It is available in sizes from ¾” to 3” in single- and dual-flow (stationary syphon) configurations. The joint can be sold as a new assembly or as a replacement cartridge.

The replacement cartridge is used to upgrade S joints (¾” to 3”). The existing joint head, syphon, assembly plate (if equipped), and flexible hoses can be re-used. The Cartridge allows for an economical upgrade of existing S joints to a new double-guide rotary joint with improved design features and performance. No piping modifications are required.

Symbol Numbers

Joint Assembly

Example: 3500SXBQ
The self-supporting SX joint is similar in operation to its predecessor, the S joint. The rotary joint assembly includes a body, head, nipple, spring, carbon seal ring, two carbon guides, a retaining ring, and gasket(s). The configurations available are the same as Type S joints (SXA, SXB, SXB2, SXC, SXD). Note that the dual flow SX joint is designed for stationary syphons, not for rotating syphons*.

Joint Cartridge

Example: 3500SX
In many S joint installations, the SX joint cartridge can be used. The cartridge includes all of the rotary joint components except for the assembly plate and head. If the assembly plate and head are in good condition, they can be re-used with the SX cartridge. The cartridge is pre-assembled and shipped with a plastic “shipping plate” and metric bolts to fasten the cartridge to the existing head. The SX cartridge provides a simple bolt-on upgrade of S joints at a competitive price.

Joint Repair Kit

Example: RK3500-SX
Use this repair kit when maintaining the new SX seal components for water and steam applications. The kit includes a seal ring, gasket, retaining ring, spring and two carbon guides.

Note: For hot oil applications, it is recommended that a new joint assembly be used. The seal ring, nipple, and body are lapped together for joint assemblies for hot oil applications.

* A rotating distribution pipe can be used with the type “BN” head on water or oil service, where some internal leakage is acceptable.
**Product Overview**

**Upgrade Path**

The following illustration highlights the upgrade path for users of S, ELS, and LJ joints. For additional product upgrade information, visit http://www.joco.com/members/marketingbeat/misc.html.

![Illustration of upgrade path]

In most installations, the user can upgrade directly from the current joint configuration to the SX joint. In those cases where other product enhancements are needed prior to moving to the SX joint, the above path illustrates the progression.

The SX double-guide joint provides improved performance at a similar price to the S joint. The SX joint effectively obsoletes the current S joint line. The convex seal design, carbon guide spacing, and dimensional equivalence to the S line makes this alternative a cost-effective upgrade to the single-guide S joint. For price-sensitive customers, the joint cartridge offers a better product than the S joint with minimal investment.

There are a number of different head configurations for the S joint line. All of these existing S joint heads are also available for the SX joint.

**Steam and Water Applications**

The majority of Type S joints are running in steam and water applications. The SX joint is a direct replacement for the Type S joint in these applications. The Green Streak (GS) seal ring can be used in steam applications, but not in water or oil applications. For water and for demanding steam applications, an Antimony Impregnated (AI) seal ring should be used. For hot oil applications, a special AI seal ring is used (see next section). The price of the AI seal ring is higher than the price of a GS seal ring.
Hot Oil Design Features & Applications
For hot oil applications, the SX rotary joint is provided with a special Al seal ring and higher seal loading force. Because of this distinction in seal geometry and load, it is important to identify the media (steam, water, or oil) so the correct SX seal ring is supplied.

The standard seal material for hot oil is antimony impregnated carbon. This self-lubricating material offers good performance up to 343 C (650 F) and was chosen for its ability to conform to the mating parts. The convex seal ring shape is inherently better for thermal cycling. For temperatures above 288 C (550 F), the spring, head bolts, and outboard guide are upgraded to handle the higher temperature. The dual-flow head designs that are used most often with hot oil applications are the type B and D configurations. These configurations are normally connected with the supply pipe connected to the P-connection to provide a high velocity through the distribution pipe. The outlet piping is connected to the M-connection (the larger port) for low-resistance draining. Flanged connections are recommended for all hot oil applications where this option is available.

When selling replacement parts for the SX joint for hot oil, the sealing components (e.g. body, seal ring, and nipple) must sold as a set. When possible, it is recommended to sell the cartridge as a replacement for hot oil applications. Field repair of the SX joint on hot oil must follow Kadant Johnson’s recommendation for lapping the seal ring against the SX body to ensure a proper seal during start-up.

Unique Selling Proposition
The improved seal design and rotary joint support (two carbon guides) in the SX joint provides for a longer-lasting self-supporting joint than competitive alternatives. Less guide load results in less guide wear, reduced seal wear, and lower torque.

Customer Value
Following is a summary of the benefits of the SX Joint.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller mean seal diameter</td>
<td>Extended seal life from slower wear rate.</td>
</tr>
<tr>
<td>Less seal face movement (runout)</td>
<td>Reduced seal wear, less frequent maintenance</td>
</tr>
<tr>
<td>Designed for steam, water and oil</td>
<td>Application flexibility, simplified inventory.</td>
</tr>
<tr>
<td>Two internal support guides</td>
<td>Increased reliability and performance.</td>
</tr>
<tr>
<td>Convex seal ring in compression</td>
<td>Improved seal and improved operating range.</td>
</tr>
<tr>
<td>Maximum carbon guide separation</td>
<td>Improved syphon support, longer operating life</td>
</tr>
<tr>
<td>Flexibility in mounting</td>
<td>No special installation tools are required.</td>
</tr>
<tr>
<td>Split wedge syphon support</td>
<td>Longer syphon pipe life with increased support in head of rotary joint.</td>
</tr>
<tr>
<td>Upgrade / Retrofit</td>
<td>Reduced cost of upgrade when applied to existing S joints.</td>
</tr>
<tr>
<td>Same connection locations as S joint</td>
<td>No piping modifications required, easy replacement.</td>
</tr>
<tr>
<td>Improved hot oil sealing</td>
<td>Increased reliability and service life.</td>
</tr>
<tr>
<td>Torque lug location optimized</td>
<td>Guide life increased an additional 6%.</td>
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</table>
**Product Overview**

**Operating Conditions**

**Maximum Conditions**

- **Design Speed**
  - up to 550 rpm (size dependent, see speed rating table below)

- **Design Temperature (steam, water)**
  - up to 288 C (550 F)

- **Design Temperature (oil)**
  - up to 343 C (650 F)**

- **Design Pressure (steam, water)**
  - up to 20 barg (300 psig)*

- **Design Pressure (oil)**
  - up to 10 barg (150 psig)

- **Service**
  - steam, water, oil

---

*Maximum limits vary in relation to changes in RPM, pressure, and temperature.*

*Consult Kadant Johnson for safe limitations under specific application conditions.*

<table>
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<th>Joint Size</th>
<th>RPM</th>
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<td>3”</td>
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* The SX cartridge can be supplied as SXH with a maximum pressure of 35 bar (510 psig). Refer to next page for drawing numbers and Part IDs for SX cartridges.

** Special spring, head bolts, and outboard guide are required for applications over 288 C (550 F).**

**SX Seal Wear Indicator**

All of the SX joint seal wear indication grooves are the same width as the allowable seal wear. The groove width is intended to be a quick reference for how much seal wear that particular joint size will allow.

Image 1 shows the position of the wear indication groove relative to the dry guide and the end of the body. When the joint is new the groove should start just outside of the dry guide. Image 2 shows the position of the wear indication groove relative to the dry guide and the end of the body when the joint needs to be rebuilt. The groove is as far from the dry guide as it is wide.

---

*Image 1* | *Image 2*
Part IDs are available as of this printing for the following SX replacement cartridge configurations:

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* 3200SXH is the same cartridge for both standard and heavy head configurations.

The SX cartridge can be used with all S type heads. Be sure to specify the rating of the existing head (standard or heavy) to ensure the body flange bolt circle drilling is correct.

GS = Green Streak resin seal ring for steam applications
AI = Antimony Impregnated seal ring for steam or water applications
Selling Strategies

The SX rotary joint is targeted at machines currently using Kadant Johnson Type S rotary joints or competitive installations of the Barco Type C, Deublin H series, and Maier H series.

If seal life, frequent joint maintenance, or syphon contact with the roll is a concern, the SX joint can provide improved performance as compared to the S and LJ rotary joints due to the increased guide spacing and total guide length.

Qualifying questions:

- Is there a problem or concerns with seal wear?
- Is there a problem or concern with syphon stability or syphon breakage?
- Is the user looking for extended joint life compared to currently used joints?
- Are S joints currently installed?
- Is the application using hot oil?

Selling Strategy

In talking to production supervisors about the SX joint, focus on:

- Reliability and long operating life
- Seal life on SX joints - explain how the design extends seal life, handles misalignment, and reduces down time
- Cartridge upgrades with bolt-on replacement
- Economical upgrade when using S joints

In talking to maintenance supervisors, focus on:

- Fast, easy installation / upgrade
- Familiarity with Type S design and operation
- Off-the-shelf delivery
- Reduced maintenance cost due to extended seal and guide life
- Bolt-on replacement or new assembly requires no piping modifications
- Convex seal is contained if broken, controlled leakage toward roll and not the pipefitter
Cross-selling Opportunities

Kadant Johnson Sales must make every effort to add value to the transaction, in order to retain its position in the market as a complete source for systems and integration. This includes installation services and steam system reviews.

When the Kadant Johnson Service and Technical Centers are involved in a project, Kadant Johnson can offer the following bundling opportunities:

1. Seal life estimations, installation improvement suggestions, and maintenance training programs.
2. Review existing steam and condensate systems and design.

Vacuum breakers - The SX joint does not provide leakage on shutdown to provide implicit vacuum protection. Check the customer’s steam system. If not already installed, offer to provide vacuum breakers that can be installed upstream of the joint in the steam system or in the head of the rotary joint (e.g. model SXB-V)

Spring-Lock Syphon Elbow – encourage the use of the spring-lock syphon elbow for improved syphon life and performance over conventional syphon elbows. The spring-lock syphon elbow is available in both ½” and ¾” sizes. Refer to the Spring-Lock Syphon Elbow NPI for additional information.

Sales Collateral / Reference Material

Bulletins / Brochures
- SX Rotary Joint Bulletin
- SX Cartridge flyer
- Installation Instructions
- Disassembly and Repair Instructions

Sales Presentations
- PowerPoint Presentation – SX Rotary Joints (download from the Kadant Johnson Intranet)
- PowerPoint Presentation – SX Rotary Joints w/ adjustable syphon clearance

Sales Models
- 3500SXBHQ-1 cut-away model
The major competitors for the SX rotary joint are Deublin, Barco, and Maier. Other competitors include Duff-Norton, and Rotary Foremost.

**Deublin Small H and H Series**

According to Deublin, its H series joint is designed for steam and hot oil service. **Deublin claims the following features:**

- Self-aligning spherical carbon graphite to ni-resist seal
- Compression load on the carbon seal
- Two threaded plugs provide access to monitor seal wear
- H series duo flow models have sight glasses in the end cap [head]
- Max pressure is 10 bar (150 psig); max temp 185 C (365 F)

The maximum speed rating is 180 RPM for steam service; 350 RPM for oil service. Sizes available from ¾” to 5”. Information taken from Deublin Catalog 952B, copyright 1999.

**Disadvantages of the Deublin H Series include:**

- Limited connection configurations
- No split wedge / pressure plate for additional syphon support
- No external seal wear indication
- Limited pressure range
- Lower speed ratings
- Hot oil joints are only pressure tested; not tested with hot oil

**Barco Type C, CS, CF, CSF, and Super G**

**Barco promotes its joints as follows:** Type C and CS rotary joints are available in sizes from ½” to 3”. The nipple is available in either bronze or ferrous material. Barco claims the following features:

- Applied to steam, water, and oil up to 316 C (600 F)
- Seal is under compression
- Seal wear indicator available on all sizes

Type C joints are dual flow, Type CS are single-flow. The letter “F” in the symbol indicates a flanged rotor (Q nipple). Barco recommends the “Super G” rotary joint for corrugating applications. It is a self-supported joint with two carbon guides. The joint is available in 1-1/4", 1-1/2" and 2" sizes and is rated up to 17 barg (250 psig) and 316 C (600 F). This joint is used with the Barco hinged syphon elbow made of bronze. Information taken from Barco Catalog 868, pp. 8-9, 14-5.

**Disadvantages of the Barco Type C joint include:**

- The Barco Type C joint is difficult to maintain. It requires heating the joint to remove the front guide. *(The SX joint uses a clip that is easily removed for access to the front guide and requires no heating or cooling of the joint.)*
- Hot oil joints are only pressure tested; not tested with hot oil
Maier Series H and HW

Steam: H and HW; Water at low RPM
Hot oil: HW

Advantages according to Maier are:

- Two carbon guides
- Housing guide is locked to prevent rotation
- Seal ring is resistant to fracture, even at high pressures
- Easy to repair (no lubrication necessary)

- Housing made of cast iron with spherical graphite [seal],
- Rotor (nipple) made of chrome steel
- For diameters DN 65 [2-1/2"] and above and HWA made of steel; sealing surface [is plated] chrome steel.
- Cover and compression springs made of chrome steel; HWA butting ring and adjustment ring made of chrome steel.
- Sealing elements made of wear resistant artificial carbon. Seal ring is pressure-loaded. The HW model has metal-impregnated artificial carbon for higher pressure, temperature and speed values. The seal and bearing require little maintenance. Wear indicator for sealing ring at rotor. Wear of second ring (HWA) is determined by means of measurement gauge.
- Connection to rotating pressure system by means of:
  - Standard connecting piece with right-hand or left-hand male thread BSP (ISO 228). Sealing and centering cone at end of thread. Adapter pieces for NPT and other threads are available.
  - Q flange with conical [split wedge] inner ring.
- Radial and axial housing connection with right-hand thread BSP (ISO 228). Adapter pieces for NPT and other threads as well as flange connections are available.

(source: http://www2.maier-heidenheim.de/english/abouth.asp)

Disadvantages of the Maier H Series include:

- Limited connection configurations
- No split wedge / pressure plate for additional syphon support
- Thin outboard guide
- Flow-through loading spring
Professional Services

One of the most effective ways to sell rotary joints and associated components is by *leading with services*. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and syphon for the specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

Ordering Information

General Customer Availability

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Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until delivery of the product to the customer. The standard lead time for the SX joint is 2 to 3 weeks after receipt of order. The SX cartridge can be shipped within 3 days. All components are stocked in inventory and quick delivery can be made when needed.

Pricing

See SX price sheet issued under separate cover.

Required Information to Place an Order

- Size of rotary joint
- Head type (A, B, B2, C, D)
- M-steam inlet, P-outlet sizes
- S-syphon size
- Nipple connection (RH, LH and thread type, or Q)
- Specify standard or ‘H’ rating for SX cartridges
- Media (steam, water, oil)
- Pressure, temperature, rotational speed
The SX rotary joint is also available with an adjustable syphon clearance. This design is applied primarily to the corrugating industry and well positioned against the Deublin HPS product. The adjustable syphon concept is similar to the CorrPro adjustable syphon concept.

The SX adjustable syphon has the following features:

- Vertical syphon adjustment
  - Uniform gap
  - Repeatable setting
- Two-point syphon support
  - Threaded connection
  - Split collar
- Compact connection locations
  - Minimum PV loading
- External piping attaches to head
- Flat-face o-ring seal for adjustment

The Deublin HPS design has the following features:

- Pivoting syphon adjustment
  - Non-uniform gap
  - Not repeatable
- One-point syphon support
  - Ball and socket fit
- Elbow further from guides
  - Higher PV loading on seal surface
- External piping attaches to syphon
- Spherical face o-ring seal

The syphon setup procedure is relatively simple:

- Mount rotary joint
- Center the horizontal pipe
- Adjust syphon to contact the shell ID
- Record vertical adjustment
- Re-center horizontal pipe
- Remove syphon pipe
- Cut vertical pipe to operating clearance, less vertical adjustment amount
- Install syphon pipe for operation
The SX joint is designed for steam, water, and hot oil applications. Steam, water, and oil each have a preferred method of sealing and corresponding seal design. Below is a summary of the various seal designs applied to each medium.

**Geometry (Shape) of SX Seals**

The shape of the carbon seal ring for all SX applications is convex. The convex shape has two benefits: (1) if the seal fractures, the seal ring is contained (e.g. the broken seal is kept in place and will operate for some time with leakage) and gives the customer time to notice the problem and shut down safely, and (2) the seal load resulting from thermal cycling provides a positive OD seal to keep contaminants away from the seal face. This second benefit is particularly important when the SX seal is applied to hot oil.

For steam and water applications, the seal contact surface is large with the spherical seal radius matched to the spherical body radius.

For oil applications, the seal contact surface is small with the spherical seal radius slightly larger than the spherical body radius. Figure 1 highlights this difference in the radii.

*Figure 1: Sealing surfaces of the SX joint*

With a new seal ring and body, the seal radius is larger than the body. The larger spherical radius on the seal ring will create loading on the outside edge of the seal ring and keeps contamination out of the seal face.

The first time the joint is heated with oil the body and seal ring will expand. The body will expand two times faster than the seal ring (i.e. if the body grows 0.002”, then the seal will grow 0.001”). The thermal growth will cause the spherical radius to grow and create a gap at the OD of the seal. The soft carbon and the high load will cause the seal ring to “wear-in” rapidly. The body and the seal ring will have the same “at temperature” spherical radius.

After the oil flow and temperature is shutdown, the joint cools and the body radius shrinks two times faster than the seal ring. At this point, the seal ring spherical radius is larger than the body spherical radius and the OD edge is again loaded.

At the next start-up, when the operating temperature is achieved, the body and the seal ring will have the same spherical radius. The initial hot oil testing at Kadant Johnson effectively creates seal surfaces that are “pre-set” for the customer’s conditions.
Appendix B – SX Seal Designs

Seal Loading

Loading on the seal ring surface is a combination of the internal joint pressure and the internal spring force. The spring force applies the initial loading to the seal ring. As the internal pressure in the joint increases, the body and the nipple squeeze the seal ring above this initial pre-load. This squeeze is a force/load on the seal ring contact areas. The force is distributed over the surface area and results in a contact pressure. Internal joint pressure and contact pressure are related, but they are not the same.

Seals applied to steam applications have a large contact area with correspondingly low contact pressure, to minimize wear. Seals applied to oil applications have a smaller contact area with correspondingly high contact pressure, to ensure proper sealing. Oil penetrates the seal much easier than steam and it takes a higher contact pressure to keep the oil out of the seal ring-to-metal interface. A smaller seal cross-section effectively reduces the area of the contact pressure resulting in an increased load. The ability for oil to penetrate the seal and the relationship between pressure and area are why seal rings applied to oil applications have a smaller cross-section than seals used with steam or water service.

In summary, steam applications are best served with seal rings that have low contact pressures, are hard, and contain self-lubricating properties for “dry” steam. Oil applications are best served with seal rings that have high contact pressures, a convex shape, are soft, and contain self-lubricating properties.

Seal Compression and Tension

Seal compression and tension refers to the radial load on the seal ring. Carbon is like concrete in that it "likes" compression. The spherical surface of the seal ring and the steam pressure around the seal are what create the radial loading. If we ignore the steam pressure around the seal and the seal is flat on both sides, it would be in compression with no radial loading.

Convex Seal Ring

Convex seal rings are used in conventional joints including ELS, IC, LJ, LN, and S configurations. In the absence of steam pressure, the concave seal ring is in tension – the metal parts are trying to push through the center of the ring. This puts forces on the seal ring that try to pull it apart. The reason that concave seals survive in pressure joints is due to the pressurization of the OD of the seal ring. The (steam) pressure in the joint acting on the OD surface is trying to compress the seal and counteracts the forces trying to pull it apart.

Convex Seal Ring

All SX joints use a convex shaped seal ring. A convex seal ring is always in compression. As shown in the figure below, the force from the metal parts is trying to “push” the seal ring out of the body. This introduces forces on the seal ring that squeeze the seal. This squeezing action creates compression with the seal.

The convex seal in pressure joints are OD pressurized. The steam pressure in the joint acting on the OD surface creates additional compression on the seal ring. Convex seals can also be used in ID pressurized joints because the force from the metal parts counteracts the internal steam pressure.
Appendix B – SX Seal Designs

Materials

All SX seals are made from one of three different carbon material classifications.

Steam Service
GS Seals – Carbon graphite containing resin filler
The base stock is carbon graphite impregnated with resin filler and rough machined. Parts are finish-machined to shape resulting in a seal that does not contain any heavy metals and is applied to low-end steam applications.

The carbon-resin materials do not operate well in cases of dry or superheated steam, submerged in water, or high PV loads. The dry applications do not provide sufficient lubrication and lead to high seal temperatures and rapid wear rates. Water-submerged applications cause a washing effect of the contact surfaces and effectively remove the lubricating film that would otherwise be present. This also can lead to rapid wear rates. High PV applications generate heat that can cause the binder to deteriorate. Oil applications are not good for resin seal rings because the resin breaks down at high temperatures.

Steam and Water Service
Hard Antimony Impregnated (AI) Seals – Hard carbon graphite containing an Antimony filler
The base stock is carbon graphite impregnated with Antimony filler and rough machined. Parts are machined to shape resulting in a very hard seal that has self-lubricating properties. Hard Antimony seal rings are best applied to high-pressure steam and all water applications. Antimony in the seal ring reduces the amount of water vapor needed to lubricate the seal.

The hard Antimony-carbon materials operate well in most applications. The hardness of these seal rings does not lend itself well to oil applications because of the extended operating time needed to conform the seal ring to the mating metal faces.

Hot Oil Service
Soft AI Seals – Soft carbon graphite containing an Antimony filler
The base stock is carbon graphite impregnated with Antimony filler and rough machined. Parts are machined to shape resulting in a “soft” seal that has self-lubricating properties. Soft Antimony seal rings are applied to all oil applications. The characteristics of the seal allow it to conform to the mating faces rapidly. This is particularly useful on applications with changing thermal cycles (e.g. thermal oil). Water applications that have a low PV can also use this material. The soft Antimony-carbon materials do not last long in applications with high PV conditions.
SX™ Rotary Joints

What is Being Replaced?

• Type S rotary joints
• Simple design introduced in the 1940s for steam
• Most popular joint previously offered by Kadant Johnson
• Applied to numerous industries
  – Paper
  – Corrugating
  – Textile
  – Rubber & Plastics
  – Food processing
  – Steel
Introducing the SX Rotary Joint

- Improved seal performance
- Two internal support guides
- Improved joint and syphon support
- Less seal face movement
- Convex seal ring in compression
- Sizes from \( \frac{3}{4} \)” to 3”

SX Rotary Joint

- One-piece Head
- One-piece Body
- Convex Carbon Seal Ring
- Stainless Steel Spring
- Two Carbon Guides
- Corrosion resistant nipple available threaded or with “O” flange
Shared Components with S Rotary Joint

- Head
- Syphon attachments
- Assembly plate
- Spring
- Gaskets
- Q flange

![Image of shared components]

New Components

- Body
- Nipple
- Seal ring
- Guides
- Head bolts
- Retaining ring
- A-plate screws

![Image of new components]
**SX Convex & S Concave Seal Ring Difference:**

- New convex design
- Always in compression
- Smaller OD & mean diameter
- Web not wear amount

- Old concave design
- Can be in tension
- Web is wear amount

---

**Compression & Tension**

- Compression – to squeeze, to make smaller
- Tension – to pull apart, to stretch
- Each arrow is a force in the direction shown

@90deg > ball = green 10 & blue 0 or red 0  
@60deg > ball = green 10 & blue 5.8 or red 11.5  
SX is ~ @47deg > ball = green 10 & blue 10.7 or red 14.7
SX Seal Ring Options

- Green streak (steam)
- Antimony (steam & water)
- Antimony – Hot Oil

SX Seal Rings
Which one is Which?

**Steam**
- Large X-section
- Resin or Ai
  - Ai rings are heavier
- Existing materials
- Radius matches body
- Mid-band contact
- OD & ID Chamfered

**Hot Oil**
- 44% thinner X-section
- Material – Always AI
  - Unique material grade
- New softer material
- Radius is bigger
- OD contact
- Heavy ID Chamfer
SX Syphon deflection

- Syphon deflection is related to body rotation
  - SX has 26% less body rotation
  - 1 m journal > S=6.81 mm, SX=5.06 mm
    » Or 0.07” difference

Rods and Bolts

- Anti-torque rods:
  - 1-1/2”, 2-1/2”, and 3” increased 1 pipe size
  - 2” increased 2 pipe sizes
  - All joints will run 13.8 bar (200 psi) with Schedule 80 pipe
- Torque lugs moved 12 to 17 mm closer to guides
  - 3% to 6% less guide load
- Bolt are metric:
  - 0 to 288 C (550 F) material = ISO 898-1, 8.8
  - 289 (551) to 343 C (650 F) material = A193, B7
  - 3400SXH (1-¼”) 12 mm bolts with washers
  - 3550SXH (2”) 14 mm bolts
### SX Features & Benefits

- Smaller mean seal diameter
- Less face movement (less runout)
- Two internal carbon support guides
- Convex seal ring in compression
- Maximum carbon guide separation
- Torque lug location optimized
- Extended seal life from slower wear rate
- Reduced seal wear, less frequent maintenance
- Increased reliability and performance
- Improved seal and improved operating range
- Improved joint and syphon support
- Guide life increased an additional 6%

### SX Features & Benefits

- Split wedge syphon support
- Upgrade / retrofit existing S joint installations
- Same connection locations as S joint
- Flexibility in mounting
- Antimony impregnated carbon seal ring
- Improved hot oil sealing
- Increased reliability and service life
- Longer syphon pipe life with increased support in head
- Reduced cost of upgrade when applied to S joints
- No piping modifications necessary
- No special installation tools
- Extended seal operating life and reduced maintenance
Model SXBPQ-1

with split-wedge syphon support

SX Rotary Joint Applications

- Steam or thermal oil service
- Single- and dual-flow
- 150 psig x 650 F (oil)
- 300 psig x 550 F (steam, water)
- Speed ratings (RPM)
  - ¾”  550
  - 1”  450
  - 1¼”  350
  - 1½”  300
  - 2”  250
  - 2½”  200
  - 3”  150
Why Upgrade to the SX Rotary Joint?

- Improved rotary joint reliability
- Improved seal and performance
- Improved syphon support
- Reduced maintenance
- Off-the-shelf delivery
- S rotary joint discontinued

Offer to email or fax a data sheet!

SX Rotary Joint Upgrade

- Low-cost upgrade
  - No piping changes
  - Re-use syphon and flex hoses
  - Re-use head and assembly plate
- Replacement cartridge
  - Body, two guides, reverse seal, nipple, spring
  - Standard or H-type body
  - Shipped with disposable cap to protect parts
- Off-the-shelf delivery
SX Rotary Joint Cartridge

SX Cartridge Features & Benefits

- Same connection locations as Type S rotary joint
- Fits existing Type S rotary joint heads
- Two internal carbon support guides
- Convex seal ring in compression
- Maximum carbon guide separation
- Optimized seal diameter
- No piping modifications, easy upgrade
- Low cost upgrade
- Increased reliability and performance
- Improved seal and improved operating range
- Improved rotary joint and syphon support
- Extended seal life, reduced maintenance
## Ordering Information

- Size of rotary joint
- Head type (A, B, B2, C, D)
- Inlet connection size
- Outlet connection size
- Syphon connection size
- Nipple connection (RH, LH and thread type, or Q)
- Media (steam, water, oil)
- Pressure, temperature, rotational speed
- Specify standard or “H” rating for SX Cartridge
Typical Questions

• Can you distinguish the AI steam and AI oil seal rings by looking at them?
• Why is the seal ring in compression/tension?
• When will the transfer from S to SX happen?
• Cartridges, metric threaded- buy bolts separately?
• Do wedge heads work without A-plates?
• What is lapping the surfaces?
  – Let me explain.........
    • To shape or fit by working surfaces with or without abrasives until a very close fit is achieved

SX Rotary Joint with Adjustable Syphon
SX Joint with Adjustable Syphon

- Vertical syphon adjustment
  - Uniform gap
  - Repeatable setting
- Two-point syphon support
  - Threaded connection
  - Split collar
- Compact connection locations
  - Minimum PV loading
- External piping attaches to head
- Flat-face o-ring seal for adjustment
Vertical Syphon Adjustment

Deublin HPS Joint

- Pivoting syphon adjustment
  - Non-uniform gap
  - Not repeatable
- One-point syphon support
  - Ball and socket fit
- Elbow further from guides
  - Higher PV loading on seal surface
- External piping attaches to syphon
- Spherical face o-ring seal
Syphon Set-Up Procedure

- Mount rotary joint
- Center the horizontal pipe
- Adjust syphon to contact the shell ID
- Record vertical adjustment
- Re-center horizontal pipe
- Remove syphon pipe
- Cut vertical pipe to operating clearance, less vertical adjustment amount
- Install syphon pipe for operation

SX Rotary Joint with Adjustable Syphon

- Horizontal pipe
  - Rigid support
  - Centered in nipple
  - Maximum clearance
- Vertical pipe
  - Optimum clearance
  - Repeatable position
General Customer Availability:

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediately</th>
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</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
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<tr>
<td>A</td>
<td>11/19/2010</td>
<td>All</td>
<td>Original Issue</td>
</tr>
</tbody>
</table>
The Kadant Johnson Pivot Body™ syphon elbow is a gravity-lock syphon elbow intended to replace existing gravity-lock syphon elbows (i.e., the JOCO elbow). This syphon elbow allows a syphon pipe to be inserted into a dryer through the dryer journal, without the need for a hand hole or manhole. Just like the 45° Locking Syphon Elbow, this elbow does not rely on a hinge pin to hold vertical and horizontal bodies together.

The term “Pivot Body” is a common law trademark owned by Kadant Johnson. The first use of the trademark must include the TM symbol followed by the noun “syphon elbow.” Trademark terms are always capitalized. The following examples show the correct and incorrect use of the product name:

Correct use: Pivot Body™ syphon elbow
Pivot Body™ Syphon Elbow

Incorrect use: Pivot body syphon elbow (“Body” must be capitalized)
Pivot elbow (missing “Body” and “syphon”)
Pivot syphon (missing “Body” and “elbow”)
Pivoting syphon elbow (missing “Body,” misspelled Pivot)

Symbol Numbers

SJXA537  ½” Pivot Body Syphon Elbow (A50103)  Part Id = 20A00320
SJXA637  ¾” Pivot Body Syphon Elbow (A50104)  Part Id = 20A00325
SJXA737  1” Pivot Body Syphon Elbow (A50105)  Part Id = 20A00335

The assembly drawings illustrate the horizontal body, pivot body, and o-ring seal between the two bodies. No special installation tools are required with this elbow.
Customer Value

Following is a brief summary of the benefits of the 45° Pivot Body syphon elbow.

Key Selling Points

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique, pivot body design</td>
<td>The pivot body elbow does not have a hinge pin, thereby eliminating hinge pin failure and extending operating life of the elbow.</td>
</tr>
<tr>
<td>Increased robustness of syphon system</td>
<td>Reduced maintenance, reduced chance for valved-out dryers due to syphon elbow failure, and increased life.</td>
</tr>
<tr>
<td>Off-the-shelf delivery</td>
<td>Less downtime due to unavailability of materials.</td>
</tr>
<tr>
<td>Stainless steel construction</td>
<td>Resists erosion and corrosion.</td>
</tr>
<tr>
<td>45° elbow</td>
<td>More of the syphon weight is used to hold the vertical pipe in the operating position improving condensate removal efficiency. Conventional syphon elbows leak if the vertical syphon pipe is not completely in the operating position. The pivot body syphon elbow does not leak regardless of the position of the vertical syphon pipe.</td>
</tr>
<tr>
<td>Bushing support</td>
<td>Can be used with a journal-mounted support tube with an internal support bushing, for greatly improved syphon pipe stability.</td>
</tr>
<tr>
<td>No seat required to seal</td>
<td>Eliminates potential leak path in conventional elbows.</td>
</tr>
<tr>
<td>Shorter vertical syphon pipe than conventional bent pipe sypons</td>
<td>The shorter vertical syphon pipe places less weight and less bending moment on the rotary joint and is less likely to contact the roll and fail.</td>
</tr>
</tbody>
</table>

Unique Selling Proposition

The Pivot Body syphon elbow features a unique pinless design that increases reliability and allows easier installation when working on a roll with limited or no access (e.g., blind rolls).

Operating Conditions

Maximum Conditions

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>600°F (317°C)</td>
</tr>
<tr>
<td>Speed</td>
<td>Up to 600 fpm</td>
</tr>
</tbody>
</table>

Example: 66 rpm for a 36” (1 m) diameter roll
Pivot Body Elbow Design

The Kadant Johnson Pivot Body syphon elbow design consists of three major parts: horizontal body, pivot body, and standard EPR o-ring. Both body components are made of stainless steel. There are three sizes available:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Drawing</th>
<th>Size</th>
<th>Horizontal Pipe</th>
<th>Vertical Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJXA 537</td>
<td>A50103</td>
<td>½&quot;</td>
<td>½&quot; NPT</td>
<td>¾&quot; NPT</td>
</tr>
<tr>
<td>SJXA 637</td>
<td>A50104</td>
<td>¾&quot;</td>
<td>¾&quot; NPT</td>
<td>½&quot; NPT</td>
</tr>
<tr>
<td>SJXA 737</td>
<td>A50105</td>
<td>1&quot;</td>
<td>1&quot; NPT</td>
<td>¾&quot; NPT</td>
</tr>
</tbody>
</table>

Note that the horizontal pipe and vertical pipe are not the same size. The vertical pipe is one pipe size smaller. The smaller vertical leg limits blow-through steam and reduces the cantilevered weight of the syphon assembly. In turn, this reduces the stress on the pipe threads securing the horizontal pipe into the head of the rotary joint. Consequently, the operating life of the syphon assembly is extended relative to conventional designs.
Targeted Customers and Applications

Targeted applications for the Pivot Body syphon elbow are characterized by:

- Dryers operating with conventional gravity-lock elbows (JOCO elbows).
- Other steam-heated rolls using conventional gravity-lock and spring-lock elbows such as Deublin, Fulton “Autoflex” syphon elbows, and other pinned elbows.
- Slow speed machines, generally less than 150 fpm (50 mpm).
- The customer is not interested in replacing, or does not have budget for replacing, the complete joint and syphon system.
- Stacked dryers.
- Smaller diameter rolls with limited (handhole) access or no access to the roll interior except through the roll journal.
- Dryer diameters are 36” (0.9 m), 48” (1.2 m), and occasionally 60” (1.5 m).
- The customer is unhappy with the performance of the current syphon elbow or bent pipe.
- The customer needs increased syphon elbow life.
Sales Strategy

Selling Strategy
When talking to production supervisors, focus on:

- Reduced downtime for syphon elbow replacement due to new pinless design
- Reduced number of valved-off dryers due to syphon breakage

When talking to maintenance supervisors, focus on:

- Increased syphon elbow life
- Reduced frequency of inside the dryer maintenance
- Fast, easy installation

Installation

Note: The Pivot Body syphon elbow can be used in most applications where Fulton Autoflex syphons, spring-lock syphons, 90-degree Johnson locking elbows, conventional gravity-lock elbows, and other competitive gravity-lock elbows are being used.

If the Pivot Body syphon elbow fits through the rotary joint nipple (1 ½” and larger), then the rotary joint (less head) can be attached to the roll prior to the syphon assembly. The horizontal pipe is threaded into the head and secured into place with the pressure plate and split collars. The syphon assembly is inserted into the roll and the head is attached to the body of the rotary joint. This is the same procedure used when installing gravity-lock elbows.

The Pivot Body syphon elbow can also be used on rolls with smaller joints, but the installation is slightly different. There are two ways to install the syphon elbow assembly in these smaller joints:

1. The syphon pipe assembly is first inserted into the roll. The rotary joint assembly (less head) is then slid over the syphon pipe, and the nipple is attached to the journal. The syphon pipe is then threaded into the head, and the head is attached to the body of the rotary joint. This procedure will generally require two people.

2. The syphon pipe assembly is threaded into the head of the rotary joint and inserted through the journal into the roll. The nipple is secured to the journal and the installation is complete. This method may be easier than attaching the nipple to the journal before attaching the head, if the syphon assembly is relatively short.

Refer to the installation instruction sheet available online or from Kadant Johnson Marketing for specific installation details.

Sales Collateral / Reference Material

Bulletins / Brochures

- Pivot Body Syphon Elbow Flyer

Installation Instructions

- IS Pivot Body SE
**Competitive Elbows**

There are many competitive syphon elbows on the market. Unlike the Pivot Body syphon elbow, they all use small pins to hold the two syphon elbow halves together. Competitors include conventional suppliers such as Deublin, Barco, and Fulton, as well as companies such as Ace Carbon Products (Mumbai India), Sun Krishna Engineering (Gujarat India), and Star Engineering (India), among others.

**Deublin:**

Elbow Stationary Siphons – designed for dryers without manholes for maximum operating speeds of 50 mpm. These siphons are used with Deublin H or HS Series steam joints with S type inner bushing.

Spring Loaded Elbow Stationary Siphons – an extension of the elbow stationary siphon designed for similar applications, but for machines with higher operating speeds. Reinforcing braces and a spring loaded vertical pipe help reduce the load on the pin. This elbow is designed for speeds up to 475 fpm (150 mpm).

**Barco:**

Reinforced Syphon Elbow -
Syphon Type: Stationary
Sizes: 1/2" & 3/4"
Speeds: 0-500 fpm
Construction: Bronze

Syphon Elbow -
Syphon Type: Stationary
Sizes: 1/2" and 3/4"
Speeds: 0-500 fpm
Construction: Bronze
**Fulton:**

Autoflex Syphon -
Syphon Type: Stationary
Dryer Diameters up to 60"
Sizes 1/2" and 3/4"
Speeds: 0-900 fpm
Construction: Stainless Steel

**Sun Krishna Engineering:**

Syphon Elbows
Size: 1/4" to 1"

Made from G.M. and stainless steel solid bar with stainless steel seat, hinge, and cap
Professional Services

One of the most effective ways to sell Kadant Johnson products is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the locking syphon elbow for the specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<table>
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</thead>
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</tr>
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</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until shipment of the product to the customer.

Typical lead time for the Pivot Body syphon elbow is 1 week. Larger quantities will need to be manufactured to order. Delivery information for rush orders should be confirmed with the Kadant Johnson factory.

Pricing

Pricing can be found in the Kadant Johnson price sheet.

*Prices are subject to change without notice.

Required Information to Place an Order

- Rotary joint size (minimum is 2" for the ¾" Pivot Body syphon elbow, for ease of installation)
- Minimum journal I.D. (1.75" for the ¾" Pivot Body syphon elbow)
- Operating temperature
- Media

Ordering Services

Kadant Johnson services are available for installation, training, and maintenance services. For a quote, contact Kadant Johnson Inc.
General Customer Availability:

<p>| | |</p>
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</table>
**Product Description**

The Kadant Johnson 45° Locking Syphon Elbow is the first of its kind to feature a pinless design. This locking elbow allows easy installation on blind rolls and was created to replace the 90° Locking Syphon Elbow. Similar to the 90° Locking Syphon Elbow, this new elbow is locked into place using a stainless steel locking insert.

The locking elbow requires an installation tool with a long extension to tighten the locking insert. A removable plug must be available on the rotary joint for the installation tool to reach the insert for tightening. For rotary joints 1.5” and smaller, the installation will require more care, since the joint and syphon must be installed as an assembly. This is outlined in detail below.

**Symbol Numbers**

SJA937-5  ¾” 45° Locking Elbow (drawing B5773)

This assembly drawing includes the horizontal body, swing body, locking insert, pre-load spring, and an installation tool. The installation tool can be used for multiple installations.

**Customer Value**

Following is a brief summary of the benefits of the 45° Locking Syphon Elbow.

**Key Selling Points**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent-pending pinless design</td>
<td>Eliminates pin breakage</td>
</tr>
<tr>
<td>45° locking design</td>
<td>Ease of installation compared to the 90° locking elbow</td>
</tr>
<tr>
<td>Increased robustness of syphon</td>
<td>Reduced maintenance, reduced chance for valved-out dryers due to syphon elbow</td>
</tr>
<tr>
<td>system</td>
<td>failure, increased life</td>
</tr>
<tr>
<td>Off-the-shelf delivery</td>
<td>Less downtime due to unavailability of materials</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Resists erosion, corrosion, and galling</td>
</tr>
<tr>
<td>Installation tool</td>
<td>Allows blind installation of locking syphon elbow</td>
</tr>
<tr>
<td>45° elbow</td>
<td>Less cantilever weight compared to a long bent syphon pipe</td>
</tr>
<tr>
<td>Bushing support</td>
<td>Can be used with a journal-mounted support tube with an internal support bushing, for greatly improved syphon pipe stability</td>
</tr>
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</table>
**Product Description**

**Unique Selling Proposition**

The 45° Locking Syphon Elbow features a patent-pending, pinless design that increases reliability and allows easier installation when working on a roll with limited hand holes or no access at all (i.e., blind rolls).

**Operating Conditions**

*Maximum Conditions*

<table>
<thead>
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<th>Parameter</th>
<th>Condition</th>
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<td>Pressure</td>
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<tr>
<td>Temperature</td>
<td>600°F (317°C)</td>
</tr>
<tr>
<td>Speed</td>
<td>¾” – up to 600 fpm (66 rpm for a 36” (1 m) diameter roll)</td>
</tr>
</tbody>
</table>

**45° Locking Elbow Design**

The Kadant Johnson locking elbow design consists of four major parts, including: body, swing body, locking screw (anti-galling stainless steel), and spring. All components are made of stainless steel. The horizontal body is designed to accept a 1” NPT horizontal syphon pipe. The swing body is machined to accept a ¾” NPT vertical syphon pipe.
Targeted Customers and Applications

Targeted applications for the 45° Locking Syphon Elbow are characterized by:

- Dryers operating with conventional 60° Gravity-Lock Elbows (JOCO elbow).
- Other steam heated rolls using conventional gravity-lock and spring-lock elbows (such as Deublin, Fulton “Autoflex” syphon elbows, and other pinned elbows).
- Slow speed machines (generally less than 150 fpm, 50 mpm).
- The customer is not interested in replacing, or does not have budget for replacing the complete joint and syphon system.
- The dryers are stacked or in a slow-speed two-tier configuration.
- Smaller diameter rolls with limited hand holes or no access to the roll.
- Dryer diameters are 36” (0.9 m), 48” (1.2 m), and occasionally 60” (1.5 m).
- The customer is unhappy with the performance of the current syphon elbow or bent pipe.
- The customer needs increased syphon elbow life.

Available Options

The 45° Locking Syphon Elbow can be supported in the head of the rotary joint using a pressure plate and split ring (-1 head), or with an optional journal-mounted support tube and a carbon bushing as shown below. The journal-mounted support tube and carbon bushing design has been created specifically for use with the LJ-PT and SXB rotary joints for use in the corrugating industry. Specifically, the LJ-PT rod-supported joint and journal-mounted locking elbow system and the SXB self-supporting joint and journal-mounted locking elbow system offers improved reliability and runnability for all single facer positions including upper and lower corrugating rolls, pressure rolls, preheat rolls, and preconditioner rolls.
Sales Strategy

Selling Strategy

When talking to production supervisors, focus on:
- Reduced downtime for syphon elbow replacement due to new design
- Reduced valved-off dryers due to syphon breakage

When talking to maintenance supervisors, focus on:
- Increased syphon elbow life
- Reduced frequency of inside the dryer maintenance
- Fast, easy installation. No changes to joint or syphon pipes

Installation

If the locking elbow fits through the rotary joint nipple (2” and larger), then the rotary joint (less head) can be attached to the roll prior to the syphon assembly. The horizontal pipe is threaded into the head and secured into place with the pressure plate and split ring. The syphon assembly is inserted into the roll and the head is attached to the body of the rotary joint. This is the same procedure used when installing gravity-lock elbows.

The locking elbow can also be used on rolls with smaller joints, but the installation requires more care. There are two ways to install the syphon elbow assembly in these smaller joints:

1. The syphon pipe assembly is first inserted into the roll. The rotary joint assembly (less head) is then slid over the syphon pipe, and the nipple is attached to the journal. The syphon pipe is then threaded into the head, and the head is attached to the body of the rotary joint. This procedure will generally require two people.

2. The syphon pipe assembly is threaded into the head of the rotary joint and inserted through the journal into the roll. The nipple is secured to the journal and the installation is complete. This method may be easier than attaching the nipple to the journal before attaching the head, if the syphon assembly is relatively short.

The installation tool instructions can be found on drawing B5773. (Drawing Attached)

Sales Collateral / Reference Material

Bulletins / Brochures
- 45° Locking Syphon Elbow Flyer
- SX Steam Joint with Advanced Syphon System Flyer
- LJ-PT Steam Joint with Advanced Syphon System Flyer

Sales Presentations
- 45° Locking Syphon Elbow PowerPoint Presentation
- Syphon Elbows PowerPoint Presentation
Competitive Elbows

There are many competitive syphon elbows on the market. Unlike the 45° Locking Syphon Elbow, they all use small pins to hold the two syphon elbow halves together. Competitors include conventional suppliers such as Deublin, Barco, and Fulton, as well as companies such as Ace Carbon Products (Mumbai India), Sun Krishna Engineering (Gujarat India), and Star Engineering (India), among others.

Deublin:

Elbow Stationary Siphons – designed for dryers without manholes for maximum operating speeds of 50 mpm. These siphons are used with Deublin H or HS Series steam joints with S type inner bushing.

Spring Loaded Elbow Stationary Siphons – an extension of the elbow stationary siphon designed for similar applications, but for machines with higher operating speeds. Reinforcing braces and a spring loaded vertical pipe help reduce the load on the pin. This elbow is designed for speeds up to 150 mpm.

Barco:

Reinforced Syphon Elbow -
Syphon Type: Stationary
Sizes: 1/2" & 3/4"
Speeds: 0-500 fpm
Construction: Bronze

Syphon Elbow -
Syphon Type: Stationary
Sizes: 1/2" and 3/4"
Speeds: 0-500 fpm
Construction: Bronze
Competition

Fulton:

Autoflex Syphon -
Syphon Type: Stationary
Dryer Diameters up to 60"
Sizes 1/2" and 3/4"
Speeds: 0-900 fpm
Construction: Stainless Steel

Sun Krishna Engineering:

Syphon Elbows
Size: 1/4" to 1"

Made from G.M. and stainless steel solid bar with stainless steel seat, hinge, and cap
Professional Services

One of the most effective ways to sell Kadant Johnson products is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the locking syphon elbow for the specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Ready for Order:</td>
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</tr>
<tr>
<td>Ready for Ship:</td>
<td>Immediately</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until shipment of the product to the customer.

Typical lead time for the 45° Locking Syphon Elbow is 1 week. Larger quantities will need to be manufactured to order. Delivery information for rush orders should be confirmed with the Kadant Johnson factory.

Pricing

Pricing can be found on Kadant Johnson price sheet.

*Prices are subject to change without notice.*

Required Information to Place an Order

- Rotary Joint size (minimum is 2” for the ¾” 45° locking elbow, for ease of installation)
- Minimum journal I.D. (1.9” for the ¾” 45° locking elbow)

Ordering Services

Kadant Johnson services are available for installation, training, and maintenance services. For a quote, contact Kadant Johnson Inc.
45° Locking Syphon Elbow

Topics

• Condensate Behavior
• Syphon Evolution
• Product Features and Benefits
• Applications
Condensate Behavior

- Condensate behavior is dependent on rotational speed and load
- Three stages of condensate
  - Ponding
  - Cascading
  - Rimming
Syphon Evolution

- A bent pipe was the first stationary syphon applied to rotating cylinders

Syphon Evolution

- To facilitate installation, a syphon elbow was developed
Syphon Evolution

• The syphon elbow simplified installation
• Provided a closer clearance to the cylinder
• In cascading conditions, elbow failure increased

Syphon Evolution

• To increase syphon elbow life, the weak points needed to be eliminated
• Three alternatives were developed:
  – Spring-Lock Syphon Elbow
  – 90° Locking Elbow
  – 45° Locking Elbow
45° Locking Syphon Elbow

- Pin-less design
- No need to use tool to start threads
- Uses existing locking insert
- Same envelope as existing extended elbow
- 45 degree angle
- Patented design
45° Locking Syphon Elbow

Stainless Steel Swing Body

Stainless Body

Locking Screw

Product Features

- Retains existing Kadant Johnson rotary joint and syphon pipes
- Increased robustness of syphon system
- Off-the-shelf delivery
- Stainless steel construction
Product Benefits

- Simple design
- Reduced maintenance and valved-off cylinders due to syphon elbow failure
- Corrosion resistant materials provide maximum life inside the cylinder
- Quick delivery
- Easy assembly and installation

Applications

- ¾” syphon elbows
- Speeds up to 600 fpm
- Stacked or two-tier dryers
- Rolls using gravity-lock elbows with a high failure rate
Spring-Lock 60° Syphon Elbow

General Customer Availability:

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Now</th>
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</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>1/2&quot; 01 February 2002; 3/4&quot; 01 March 2002</td>
</tr>
</tbody>
</table>

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
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<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
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<td>A</td>
<td>23 Jan 2002</td>
<td>All</td>
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<tr>
<td>B</td>
<td>26 Feb 2002</td>
<td>8</td>
<td>Added Fulton 3/4&quot; Autoflex price and dimension</td>
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<td>C</td>
<td>30 Dec 2005</td>
<td>All</td>
<td>Update name to Kadant Johnson</td>
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Product Overview

The spring-lock system is a relatively low-cost upgrade of the gravity-lock elbow, reducing its susceptibility to failure, and allowing higher speed operation. Kadant Johnson currently sells more than 3,000 units of the ½” and ¾” gravity-lock elbows each year. Each of these sales is a potential for the spring-lock assembly, if the spring-lock assembly will fit through the dryer journal (minimum I.D. is 1.88” for ½” size and 2.28” for ¾” size) and (ideally) also through the nipple of the rotary joint.

The spring-lock system is a good after-market product. There is significant potential for high sales volumes and the units can be sold from stock.

The ½” spring-lock elbows should be offered as upgrades for replacement of ½” gravity-lock elbows, where the journal and joint size are large enough. Minimum journal and joint sizes are listed below. The spring-lock elbows can be used in smaller joints than the ones listed, but the installation will be more difficult. The spring-lock elbow must be attached to the joint before the joint is attached to the roll journal.

The CorrPro™ locking elbow should be offered as an upgrade for replacement of ¾” gravity-lock elbows. The CorrPro elbow has a larger diameter horizontal pipe and it has a smaller diameter for installation. It does, however, require an installation tool and may require a new head on the joint for using this tool. For joints less than 2”, the installation will be more difficult, because the elbow must be attached to the joint before the joint is attached to the roll journal.

As an alternative to the CorrPro elbow, a spring-lock ¾” elbow can be offered as an upgrade for replacing ¾” gravity-lock elbows, if the CorrPro joint and syphon system can not be sold at the higher price. By offering both the spring-lock ¾” elbow and the CorrPro elbow, we are able to expand our product mix and increase the number of price/performance points. The ¾” spring-lock elbow only fits through nipples larger than 2-1/2”. The unit can be used in 1-1/2” and 2” joints, however the installation is a bit more difficult (the syphon assembly must be attached to the joint and the entire joint and syphon assembly installed onto the roll). See the dimensions and clearance required below.

Symbol Numbers

SJ537-16  ½” Spring-Lock Syphon Elbow (drawing AB8111)
SJ637-13  ¾” Spring-Lock Syphon Elbow (drawing AB8382)

Application Information

<table>
<thead>
<tr>
<th>Elbow Size and Type</th>
<th>Symbol Number</th>
<th>Elbow Diameter*</th>
<th>Speed fpm (5’ O.D.)</th>
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</thead>
<tbody>
<tr>
<td>½” gravity lock</td>
<td>SJ-537</td>
<td>1.188”</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>½” spring lock</td>
<td>SJ537-16</td>
<td>1.880”</td>
<td>&lt; 500</td>
</tr>
<tr>
<td>¾” gravity lock</td>
<td>SJ637</td>
<td>1.640”</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>¾” spring lock</td>
<td>SJ637-13</td>
<td>2.28”</td>
<td>&lt; 500</td>
</tr>
<tr>
<td>1” gravity lock</td>
<td>SJ737</td>
<td>2.063</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>1” CorrPro 90° Locking Elbow</td>
<td>SJA937</td>
<td>1.750”</td>
<td>&lt; 600</td>
</tr>
</tbody>
</table>

*It is important to verify the nipple I.D. to ensure proper fit and installation requirements prior to order.
Product Overview

Unique Selling Proposition

Compared to the gravity-lock syphon elbow, the Kadant Johnson Spring-Lock Elbow offers significantly longer life, requires virtually no maintenance, and is competitively priced.

Customer Value

Following is a brief summary of the benefits of the Spring-Lock Syphon Elbow.

Key Selling Points

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retains existing Kadant Johnson Joint and syphon pipes.</td>
<td>Simple, inexpensive upgrade installs quickly and easily using existing dryer drainage equipment.</td>
</tr>
<tr>
<td>Standard syphon elbow design enhanced.</td>
<td>Additional inventory of multiple elbow configurations is not necessary as the same elbow is used for both the conventional gravity-lock and the spring-lock configuration.</td>
</tr>
<tr>
<td>Increased robustness of syphon system results in increased life.</td>
<td>Reduced maintenance, reduced chance for valved-out dryers due to syphon elbow failure.</td>
</tr>
<tr>
<td>Off-the-shelf delivery.</td>
<td>Less downtime due to unavailability of materials.</td>
</tr>
<tr>
<td>Collars and spring are stainless steel.</td>
<td>Corrosion-resistant materials provide for maximum life inside the cylinder.</td>
</tr>
<tr>
<td>Spring-Lock elbow assembly and installation does not require tools.</td>
<td>Easy assembly and installation.</td>
</tr>
<tr>
<td>Straps of the spring-lock assembly are contoured.</td>
<td>Allows for easy removal of syphon elbow by guiding the elbow into the open position.</td>
</tr>
<tr>
<td>Spring-lock elbow pins are integral parts of the spring collars</td>
<td>Pins cannot loosen and fall out during operation.</td>
</tr>
</tbody>
</table>
**Product Description**

**Operating Conditions**

*Maximum Conditions*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Temperature</td>
<td>650°F (343°C)</td>
</tr>
<tr>
<td>Speed</td>
<td>½” - up to 150 fpm (15 rpm); ¾” – up to 500 fpm (55 rpm)</td>
</tr>
<tr>
<td>Service</td>
<td>steam/condensate</td>
</tr>
</tbody>
</table>

*Maximum limits vary in relation to changes in RPM, pressure, and temperature.*

*Consult Kadant Johnson for safe limitations under specific application conditions.*

**Spring-Lock Design**

The Kadant Johnson spring-locking elbows consist of the standard gravity-lock elbow and a spring-lock assembly. The spring-lock assembly consists of five parts:

- (2) Pipe collars (identical parts)
- (2) Collar straps (identical parts)
- (1) Locking spring

Features of the Kadant Johnson spring-lock system:

- The collars and spring are stainless steel, to avoid corrosion. The straps are mild steel.
- The spring-lock assembly can be assembled without any tools.
- The pivot pins in the collars cannot loosen and fall out.
- The collars have flats on them for clearance in nipples with welded keys.
- The straps are contoured to guide the elbow into the open position for easier removal.
- The spring is located on the radial syphon pipe, to minimize the extension into the dryer.
Targeted Customers and Applications

Target customers for the Spring-Lock 60° Syphon Elbow are characterized by:

- Operating dryers with conventional 60° gravity-lock elbows (JOCO elbow).
- Slow speed machines (generally less than 150 fpm, 50 mpm).
- The customer is not interested in replacing, or does not have budget for replacing the complete joint and syphon system.
- The dryers are stacked or in two-tier configuration.
- Dryer diameters are 36" (0.9 m), 48" (1.2 m), and occasionally 60" (1.5 m).
- The customer is unhappy with the performance of the current syphon elbow or bent pipe.
- The customer needs increased syphon elbow life.
Selling Strategy

When talking to production supervisors, focus on:

- Reduced down time for syphon elbow replacement due to new design
- Reduced valved-off dryers due to syphon breakage

When talking to maintenance supervisors, focus on:

- Increased syphon elbow life
- Reduced frequency of inside the dryer maintenance
- Immediate availability of spring-lock syphon elbows
- Fast, easy installation. No changes to joint or syphon pipes

Installation

If the spring-lock elbow fits through the joint nipple, then the joint can be attached to the roll first. The elbow and spring-lock assembly can then be installed on the syphon pipes, the horizontal syphon pipe threaded onto the head of the joint, and the assembly pushed through the joint nipple and dryer journal. Once the syphon is in the dryer, the head is attached to the joint body.

The ½” and ¾” spring-lock elbows can also be installed in dryers with smaller nipples, but the installation can be more difficult. There are two ways to install the elbows in these smaller joints:

- The syphon pipe assembly is first inserted into the roll. The joint assembly is then slid over the syphon pipe and the nipple is attached to the journal. The syphon pipe is then attached to the head and the head is attached to the joint body. This procedure will generally require two people, working in tight quarters.

- The head of the joint is first attached to the joint body, then the syphon pipe assembly is attached to the head of the joint, then the syphon pipe is passed through the roll journal and the nipple attached to the journal. This may be easier than attaching the nipple to the journal before attaching the head, if the syphon assembly is not too long.

- Note: The same difficulty is encountered when installing a CorrPro elbow in a dryer with a 1½” joint.

Complete installation instructions can be found on drawing AB8111 (½”) and AB8382 (¾”).

Cross-Selling Opportunities

Kadant Johnson Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration. This includes dryer surveys, estimation of drying rate improvements, installation services, and steam system reviews.

When the Kadant Johnson Service and Technical Centers are involved in the projects, Kadant Johnson can offer the following bundling opportunities for Beloit CS upgrades:

1. Complete seal life and maintenance improvement estimations
2. Review existing steam and condensate systems (valves, thermocompressors, separator tanks)
3. Review / develop justification for the purchase of Turbulator bars (if applicable)
4. Installation services
5. Prepare assembly drawings for future mill / Kadant Johnson reference
6. Provide on-going service and sales support (through network of reps and direct sales force)
7. Conduct R&D testing of Kadant Johnson and competitive configurations
8. Conduct audit for future machine production limitations
9. Establish blow-through correlations for system design

Sales Collateral / Reference Material

Bulletins / Brochures

Installation Instructions and Assembly Drawing – AB8111 and AB8382

Sales Presentations

PowerPoint Presentation – Spring-Lock 60° Syphon Elbow (download from the members section at www.kadant.com)
The major competitor for gravity-lock syphon elbows is Deublin. Barco, Duff-Norton, Maier, Ompi, Rocky, and Pearl are also offering gravity lock syphon elbows. Only Deublin, Ompi, and Fulton offer a spring-lock assembly, as shown in the tables below. The Kadant Johnson spring-lock elbow dimensions are very close to the dimensions of the Deublin units and pricing is very competitive.

### Price Comparisons

<table>
<thead>
<tr>
<th>Elbow Size</th>
<th>Kadant Johnson Elbow Symbol Number</th>
<th>Kadant Johnson Elbow List Price</th>
<th>Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>½” gravity lock</td>
<td>SJ-537</td>
<td>$92.10</td>
<td>Deublin (S1005-001) $118 user net</td>
</tr>
<tr>
<td>½” spring lock</td>
<td>SJ537-16</td>
<td>$199.25</td>
<td>Deublin (S3005-001) $190 user net</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Fulton Autoflex $200 user net</td>
</tr>
<tr>
<td>¾” gravity lock</td>
<td>SJ637</td>
<td>$111.80</td>
<td>Deublin (S1006-001) $125 user net</td>
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<tr>
<td>¾” spring lock</td>
<td>SJ637-13</td>
<td>$221.95</td>
<td>Deublin (S3006-001) $201 user net</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fulton Autoflex $383 user net</td>
</tr>
<tr>
<td>1” gravity lock</td>
<td>SJ737</td>
<td>$158.90</td>
<td></td>
</tr>
<tr>
<td>CorrPro 90° Locking Elbow (1” NPT)</td>
<td>SJA937</td>
<td>$292.90</td>
<td>Installation tool required at $177</td>
</tr>
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</table>

**Gravity Lock Units (units in inches)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Kadant Johnson</th>
<th>Deublin</th>
<th>Barco</th>
<th>Duff-Norton</th>
<th>Maier</th>
<th>Ompi</th>
<th>Rocky</th>
<th>Pearl</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼”</td>
<td>0.91</td>
<td>---</td>
<td>---</td>
<td>0.94</td>
<td>0.87</td>
<td>0.98</td>
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<td>---</td>
</tr>
<tr>
<td>⅜”</td>
<td>1.19</td>
<td>1.10</td>
<td>---</td>
<td>1.25</td>
<td>0.98</td>
<td>1.10</td>
<td>1.30</td>
<td>1.50</td>
</tr>
<tr>
<td>½”</td>
<td>1.19</td>
<td>1.20</td>
<td>1.25</td>
<td>1.25</td>
<td>1.18</td>
<td>1.38</td>
<td>1.30</td>
<td>1.50</td>
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<tr>
<td>¾”</td>
<td>1.66</td>
<td>1.60</td>
<td>1.62</td>
<td>1.66</td>
<td>1.42</td>
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<td>1”</td>
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<td>2.03</td>
<td>1.77</td>
<td>1.97</td>
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<tr>
<td>1-1/4”</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>2.36</td>
<td>2.95</td>
<td>2.44</td>
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<tr>
<td>1-1/2”</td>
<td>2.44</td>
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<td>---</td>
<td>2.36</td>
<td>2.56</td>
<td>2.95</td>
<td>2.76</td>
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**Spring-Lock Units (units in inches)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Kadant Johnson</th>
<th>Deublin</th>
<th>Ompi</th>
<th>Fulton</th>
</tr>
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<tbody>
<tr>
<td>½”</td>
<td>1.88</td>
<td>1.90</td>
<td>1.38</td>
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<td>¾”</td>
<td>2.28</td>
<td>2.05</td>
<td>1.57</td>
<td>2.19</td>
</tr>
<tr>
<td>1”</td>
<td>---</td>
<td>---</td>
<td>1.97</td>
<td>---</td>
</tr>
<tr>
<td>1-1/4”</td>
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<td>---</td>
<td>2.36</td>
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</tr>
<tr>
<td>1-1/2”</td>
<td>---</td>
<td>---</td>
<td>2.56</td>
<td>---</td>
</tr>
</tbody>
</table>

*Note: Barco, Duff-Norton, Maier, Rocky, and Pearl do not offer a spring-lock syphon elbow assembly. Fulton offers a spring-lock syphon elbow named Autoflex in ½” and ¾” sizes – no dimensional data available for ½” unit.*
Professional Services

One of the most effective ways to sell Kadant Johnson products is by *leading with services*. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the Kadant Johnson equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<table>
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<tr>
<th>Ready for Order:</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Ship:</td>
<td>01 Feb 2002 (1/2’’), 01 March 2002 (3/4’’)</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until delivery of the product to the customer.

Typical delivery, from date of receipt of Purchase Order, would be 1 to 2 weeks. Delivery information for rush orders should be confirmed with the Kadant Johnson factory.

Pricing

<table>
<thead>
<tr>
<th>Size</th>
<th>Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>½” SJ537-16</td>
<td>$199.25 List Ea.</td>
</tr>
<tr>
<td>¾” SJ637-13</td>
<td>$221.95 List Ea.</td>
</tr>
</tbody>
</table>

Prices are subject to change without notice.

Required Information to Place an Order

- Size of spring-lock syphon elbow (½” or ¾”)
- Rotary Joint size (minimum is 2” for the ½” spring-lock elbow, for ease of installation)
- Rotary Joint size (minimum is 3” for the ¾” spring-lock elbow, for ease of installation)
- Minimum journal I.D. (1.88” for the ½” spring-lock elbow)
- Minimum journal I.D. (2.28” for the ¾” spring-lock elbow)

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.
Spring-Lock Syphon Elbow

Topics

• Condensate Behavior
• Syphon Evolution
• Product Features and Benefits
• Applications
Condensate Behavior

- Condensate behavior is dependent on rotational speed and load
- Three stages of condensate
  - Ponding
  - Cascading
  - Rimming
Syphon Evolution

- A bent pipe was the first stationary syphon applied to rotating cylinders

Syphon Evolution

- To facilitate installation, a syphon elbow was developed
Syphon Evolution

• The syphon elbow simplified installation
• Provided a closer clearance to the cylinder
• In cascading conditions, elbow failure increased

Syphon Evolution

• To increase syphon elbow life, the weak points needed to be eliminated
• Two alternatives were developed:
  – Spring-Lock Syphon Elbow
  – 90° Locking Elbow
Spring-Lock Syphon Elbow

- Utilizing the same syphon elbow, a spring-lock assembly was designed
- The spring-lock assembly reduces the stress on the pivot pin
- The spring-lock system extends the elbow life and reduces syphon maintenance
Spring-Lock Syphon Elbow

Product Features

- Retains existing Kadant Johnson rotary joint and syphon pipes
- Increased robustness of syphon system
- Off-the-shelf delivery
- Collars and spring are stainless steel
- Straps of the spring-lock assembly are contoured for easy elbow removal
- No installation tools required
Product Benefits

- Simple, inexpensive upgrade using existing dryer drainage equipment
- Reduced maintenance and valved-off cylinders due to syphon elbow failure
- Corrosion resistant materials provide maximum life inside the cylinder
- Quick delivery
- Easy assembly and installation

Applications

- ½” and ¾” syphon elbows
- Speeds up to 500 fpm (¾” elbow)
- Stacked or two-tier dryers
- Rolls using gravity-lock elbows with a high failure rate
General Customer Availability

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

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Record of Changes

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<tr>
<td>A</td>
<td>---</td>
<td>31 January 2007</td>
<td>All</td>
<td>Original Issue</td>
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The Internally Supported Stationary Syphon (ISSS) is a cantilevered stationary syphon supported by an internal bushing. The syphon is a simple design, using existing Kadant Johnson joints and carbon bushings. This unit is particularly applicable to dryers with small-bore journals or open-gear drives. It can be used for medium- to high-speed operation. The units can also be used where the price of a PTX cantilever syphon is too high. The internal syphon support bushings are mounted in an internal spider. If the dryer does not have a machined surface for an internal spider, a unique tri-pod mounting can be used instead.

**General Overview of the ISSS**

- Use in dryers with enclosed gears (preferred); can be applied to open gear machines
- Maximum speed is 1200 mpm (4,000 fpm)
- Use with (2-3) carbon graphite guides as a bushing on a QPQ-plated steel sleeve
- Teflon tip pick-up syphon shoe
- Used with IC, PT, PTX, and ELS joints (2.5” to 3.5”)
- Particularly applicable for dryers with small journal bores or an open gear drive
- Used with 1.2m (48”) and 1.5 m (60”) OD dryers

**Mechanical Design**

The ISSS syphon size is 1”x 1.25”. The 1” vertical pipe is Schedule 80, turned down and inserted into the sweep bent pipe. The 1.25” horizontal pipe also has a Schedule 80 pipe wall to provide adequate rigidity. A 1” schedule 80 horizontal pipe is available, but only recommended when flow velocities prevent the use of a 1.25” pipe. The syphon shoe has a stainless steel clamp pad with a Teflon tip. Teflon is a sacrificial material to prevent damage to the dryer shell. A vertical brace is clamped to the vertical and horizontal syphon pipes.

Antimony impregnated carbon guide bushings inserted into the QPQ-plated internal spider flange are used to support the horizontal pipe up to speeds of 1200 mpm (4000 fpm). Three carbon guides are used. Two carbon guides can be used when the maximum operating speed is less than 600 mpm (2000 fpm). A QPQ-plated sleeve is welded to the horizontal pipe and then turned to provide a precision fit to the carbon bushing.
For dryers that do not have the internal dryer head machined to accept a spider flange, a tri-pod support mechanism is available (see image below). This shell-mounted support uses the same carbon guide bushings as the spider flange supported mounting. However, the maximum speed rating for the tri-pod support (shell mounted) is 750 mpm (2460 fpm), due to the difficulty of achieving accurate centerline positioning of the mounting. Two carbon guides can be used when the maximum operating speed is less than 350 mpm (1,150 fpm). **Alignment is critical with the shell-mounted design. Use of a laser alignment device is recommended for installation.**

It is important to have a rigid anti-rotation bracket for the rotary joint. On enclosed gear machines, the rods of the LN-IC joints should be checked to ensure proper size. On open gear machines where self-supported (ELS) joints are used, a strong bracket is required to prevent joint rotation and still allow axial movement to accommodate seal wear. These brackets can be bolted to the floor for bottom dryers. It can be more difficult to find proper mounting for the brackets for top dryers, where a support stand to the floor can be up to three meters (10 ft) long. Contact Kadant Johnson Applications or Engineering for help.

The recommended rotary joints for use with the ISSS include ELS, IC, PT, and PTX. All joints must use a type NA (threaded) or NAF (flanged) head to ensure internal clearance for the syphon pipe assembly.

**Syphon Position**

The syphon should be positioned in the 6 o’clock position for dryer rotational speeds less than 120 mpm (400 fpm). At these low speeds, the condensate will remain in a puddle in the bottom of the dryer. The puddle size will be small and the drive load will be low.

Offset syphon 17° in the direction of rotation if the dryer speeds are operating above 120 mpm and up to 300 mpm (1000 fpm). In this speed range, the condensate will not be rimming, but the puddle will be shifted over to the 5 o’clock position. If the syphon is not offset, the amount of condensate will be quite large and the drive loads will go up accordingly.

If the dryer speed is more than 300 mpm (1,000 fpm), set the syphon in the 6 o’clock position and install Turbulator® bars. At these speeds, the condensate will be rimming. The ISSS is not recommended for speeds greater than 1200 mpm (4,000 fpm).
**Product Description**

**Product performance**

- The ISSS syphon has been tested on the JOCO 4000 over a wide range of operating conditions in the Kadant R&D Center in Three Rivers, Michigan, USA. A video clip showing this operation is available from Global Marketing or on the Intranet. Kadant can duplicate the mill's exact operating conditions (pressure, condensing load, speed, and differential pressure) and demonstrate the performance of the recommended joint and syphon solution for the customer.
- Syphon clearance has been optimized through R&D testing to produce the highest possible heat transfer performance with Turbulator® bars. No other supplier has either the testing facilities or the data for such optimization work.
- The stationary syphon does not require high differential pressure to evacuate condensate. This eliminates the risk of dryer flooding when the syphon is properly sized.

**Bushing Life**

- The carbon graphite bushing can be guaranteed for a period of 12 months. We can expect to achieve a life of two to four years, but do not guarantee this life. There are several ISSS installations which are providing operating experience over a wide range of operating conditions to eventually support longer bushing life guarantees, if that becomes a requirement of the sale.
- The carbon bushings should be inspected annually, at least in selected dryers, to determine the wear rate and replacement frequency. After the wear rate is determined, the inspection period may be increased to an inspection every two years, or as part of the annual dryer internal inspections.
- For speeds greater than 350 mpm, the use of three carbon bushings is recommended.

**Teflon Tip Syphon Shoe Features / Benefits**

- Investment cast stainless steel clamp pad eliminates erosion and corrosion
- One-piece Teflon tip securely mounted to clamp pad
- Converging entrance to syphon shoe improves flood recovery time and steady-state operation
- Large syphon tip opening improves condensate flow rate into syphon pipe
- Double-cut, double-bolt clamp secures syphon shoe in place

**Operating Conditions for the ISSS**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>All normal dryer operating pressure up to 11 bar (160 psig)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Up to 191°C (375°F)</td>
</tr>
<tr>
<td>Speed</td>
<td>Up to 1200 mpm (4,000 fpm)</td>
</tr>
<tr>
<td>Service</td>
<td>Steam/condensate, water</td>
</tr>
</tbody>
</table>

*Note: Superheat in the supply steam should be limited to 28°C (50°F)*
Applications

The ISSS can be used in the following applications:

- Slow, medium, and high operating speeds (up to 1200 mpm)
- Open or enclosed drive gear machines
- Dryers with small journal bores or cored holes (60 – 85 mm)
- Low-pressure wet end dryers (requiring stationary syphons)
- Machines with low capacity vacuum systems (ones that can not handle the higher blow through flow rates that are required by a rotary syphon at high speeds)
- Replacing rotary syphons in dryers with flooding problems
- This syphon should be used with Turbulator bars for rimming speeds (over 300 mpm)

Note:

- The 5750SBAF taper-roller bearing stationary syphon is also an option for high-speed open gear machines, but it has a higher cost and requires a larger journal bore.
- At speeds less than 100 mpm, a simple stationary, without an internal bushing support may be sufficient.
- For speeds greater than 550 mpm, the PTX joint and stationary syphon is recommended, if the dryer bore is sufficiently large and the ring bracket can be mounted to the dryer bearing housing or gear case.

Customer Value

- Stationary syphons reduce steam usage by reducing the amount of blow-through compared to a rotating syphon design. The reduced blow-through is achieved during normal operation, as well as during machine upsets.
- Reduced blow-through and pressure differential can provide savings by:
  - Reducing the amount of motive steam required
  - Reducing the amount of steam that is vented
  - Reducing the amount of steam that goes to the condenser
  - Reducing the back pressure from power-generating turbine

Note: Kadant Johnson Systems has a simple spreadsheet program for evaluating these various savings.

- Long life components reduce the downtime for inspections or repair. The robust design of the Kadant Johnson ISSS and rigid mounting of the syphon system reduce routine maintenance as well as the occurrences of catastrophic syphon failure that result from less robust competing designs.

The target market for this stationary syphon system is the Paper Industry, for dryers that are running at speeds below 1200 mpm. Stationary syphons are also helpful in improving the stability of marginal steam and condensate systems. A combined sale of the ISSS and steam system upgrades provides a unique market opportunity for Kadant.

Unique Selling Proposition

The Kadant Johnson Internally Supported Stationary Syphon system has a long life, high reliability, and excellent operating performance for low speed machines. Kadant backs this up with the most knowledgeable and most experienced engineering and service support in the world, and these services are available worldwide.
Selling Strategy

Production Supervisors - focus on:
- Syphon pick-up shoe material sacrificed in unlikely event shoe contacts dryer shell
- Eliminates dryer flooding during operation; easy recovery of a flooded dryer
- Reduced blow-through reduces load on steam system
- Improved runnability
- Integration with complete Systems offerings. Only Kadant can offer a complete system, including joints, syphons, system design, and control. Specific operational results can be guaranteed if required by the customer.
- Thermocompressor sizing can be reviewed by Kadant
- Pipe sizes and separator station sizing can be reviewed by Kadant
- Control system can be evaluated by Kadant

Maintenance Supervisors - focus on:
- Minimal maintenance is required
- The syphon pipe and shoe clamp pad is stainless steel, to avoid erosion
- Vertical support brace minimizes vibration and fatigue

Cross-selling Opportunities
Kadant Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration. This includes dryer surveys, estimation of drying rate improvements, steam system reviews, installation services, Turbulator bar sales, thermocompressor sizing and sales, and Vortec vacuum generators.

Turbulator® Tube™ bars are strongly suggested for any dryer that operates above rimming speed.

The following bundling opportunities are available to our customers:
1. Complete seal life and maintenance improvement estimations and guarantees
2. Review existing steam and condensate systems (valves, thermocompressors, separator tanks)
3. Review / develop justification for the purchase of Turbulator bars (if applicable)
4. Installation services
5. Prepare assembly drawings for future mill / Kadant reference
6. Provide on-going service and sales support (through network of reps and direct sales force)
7. Conduct R&D testing of Kadant and competitive configurations
8. Conduct audit for future machine production limitations
9. Establish blow-through correlations for system design
10. Establish the optimum syphon clearances (consistent with the installed bar configuration)
Precluding Sales Objections

Kadant Sales should attempt to sell the positive features and benefits of Kadant products, not the negative features of competitive products.

One of the Kadant competitors (Deublin) has been negative-selling its products in North America. Rather than counter these sales tactics with similar negative selling, Kadant Sales should attempt to identify the negative selling strategies used by its competitors and address these items before the customers ask questions on them. That is, Kadant Sales should present its products, focusing on the positive aspects of the features that the competitors are using for negative selling. This precludes the objections to sales and keeps the presentation properly focused.

Listed below are some of the negative comments that our competitors have made. Also listed are statements that can be made during the course of a product presentation to avoid questions on these aspects.

**Competitive comment:** Kadant Johnson syphons have experienced a number of failures when the syphon shoe slips or rotates at the end of the vertical syphon pipe.

The heart of the dryer performance rests with this shoe and the way it behaves with the Turbulator bars. It is important that the syphon clearance is set correctly and accurately and that this clearance not change after the dryer is closed up. Many shoes on the market today are difficult to set up and have been known to slip during operation.

The current design has a number of unique features that have overcome these problems, making it the most successful design in the industry: This shoe has a two-bolt clamping system with a special split collar. The syphon clearance can be easily set by lowering it onto the set-up shim, tightening the two bolts, and removing the set-up shim. This is the same shoe used on the high-performance PTX syphon.

**Note:** The positive clamping can be demonstrated by giving the customer a Kadant Johnson shoe, stub end of a vertical pipe, and a ratchet. It is only necessary to barely tighten the two hex head bolts and the shoe is positively clamped to the pipe.

**Competitive comment:** Kadant has had a number of problems with their stationary syphons vibrating and failing.

Kadant has learned through R&D testing, engineering analysis, and field experience that there are a number of important considerations in determining the required natural frequency of the cantilevered syphon assembly. Most suppliers only look at the rotational frequency of the dryers. Kadant, however, also looks at the rotational frequencies of the adjacent felt rolls. On many machines, particularly those that have been increased in speed, it is the “half-critical” of the felt rolls that causes the most serious vibrations. Kadant has also found that the shedding of vortices in condensate that hit the syphon shoe can induce vibrations. All of these factors are considered in selecting the stiffness of a Kadant Johnson stationary syphon to achieve the required natural frequency.

**Sales Collateral / Reference Material**

**Drawings**

Available from the local manufacturing site.

**Presentation Materials**

PowerPoint Presentation – “Internal Supported Stationary Syphon”

Inside the Dryer Video – Condensate Behavior (stationary and rotating camera)
Selling Strategy

Customer Reference Materials

A technical paper titled “Vibration Characteristics in Cantilever Stationary Syphons” is available to present R&D studies on vibration and stationary syphons. This paper is available online in the Intranet or from Global Marketing. This paper can be used to highlight that a support tube that is reduced in size to fit through the dryer journal may not have adequate stiffness for the intended operating speed.

Mill application / case study article reprints from major trade publications available from Global Marketing.

Internal Supported Stationary Syphon offset 17° positioned in puddling condensate. Dryer speed is 150 mpm.
### Kadant Johnson Stationary Syphon Designs

<table>
<thead>
<tr>
<th>Syphon Type</th>
<th>Joints</th>
<th>Entry Required</th>
<th>Max Speed*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent pipe</td>
<td>LJ SJX SB ELS</td>
<td>None</td>
<td>150 (45)</td>
<td>Generally supplied by mill, for small dryer diameters with low condensing loads, has high failure rate.</td>
</tr>
<tr>
<td>Gravity Lock 60° elbow</td>
<td>LJ SJX SB ELS</td>
<td>None</td>
<td>250 (75)</td>
<td>For small dryer diameters with low condensing loads, less cantilever weight than bent pipe, still has high failure rate.</td>
</tr>
<tr>
<td>Spring Lock 60° elbow</td>
<td>LJ SJX SB ELS</td>
<td>None</td>
<td>400 (120)</td>
<td>For small dryers with low condensing loads, improvement over the gravity lock elbow, slightly higher cost, lower failure rate, needs larger journal.</td>
</tr>
<tr>
<td>Journal-mounted bushing-supported 60° elbow</td>
<td>LJ SJX SB ELS</td>
<td>None</td>
<td>600 (185)</td>
<td>Used for longer pipes and for low condensing load dryers. Improvement over unsupported units. Dryers must be at least 32° for SXB or ELS joints. Requires periodic maintenance of support bearing bushing.</td>
</tr>
<tr>
<td>90° Locking Elbow</td>
<td>LJ SJX SB ELS</td>
<td>Hand</td>
<td>600 (185)</td>
<td>For small dryers with low condensing loads, good reliability but should have hand-hole access, in case of failure. Improvement over the non-lock elbow, slightly higher cost. Dryers must be at least 32° for SXB or ELS joints.</td>
</tr>
<tr>
<td>90° Locking Elbow</td>
<td>CorPro™ Joint</td>
<td>Hand</td>
<td>1000 (300)</td>
<td>Improved cantilever support for small dryers with low condensing loads and higher speeds. Improvement over the non-lock elbow. Good reliability, but should have hand hole access in case of failure. Higher cost but has no bushing maintenance.</td>
</tr>
<tr>
<td>Journal-mounted bushing-support 90° locking elbow</td>
<td>CorPro™ Joint</td>
<td>None</td>
<td>1200 (365)</td>
<td>Used for low condensing load dryers with long syphon pipes. Improvement over unsupported unit. Requires bearing bushing maintenance.</td>
</tr>
<tr>
<td>Internal spider, carbon bushing, no syphon brace, syphon pipe</td>
<td>LJ SJX SB ELS</td>
<td>Man</td>
<td>1150 (350)</td>
<td>Alternative to scoop. Can be used with steam trap with steam-lock release. Standard carbon guide bearing, requires maintenance, uses syphon pipe without tip. Better performance with a blow through steam system. Dryers must be at least 32° for SXB or ELS joints, use with split wedge-pressure plate syphon support head. ISSS is preferred.</td>
</tr>
<tr>
<td>Medium Speed Stationary Syphon (MSSS)</td>
<td>LJ SJX SB ELS</td>
<td>Man</td>
<td>1800 (550)</td>
<td>Alternative to scoop. Uses Sch 80 pipe and Teflon pickup shoe. Carbon bearing requires maintenance. Use with a blow through steam system. Dryers must be at least 32° for SXB or ELS. The ISSS is preferred over this offering.</td>
</tr>
<tr>
<td>Internal Supported Stationary Syphon (ISSS)</td>
<td>IC PT, PTX ELS</td>
<td>Man</td>
<td>4000 (1200)</td>
<td>Improved syphon system with heavy-wall syphon pipe, supported with internal spider or shell-mounted tri-pod, used for small journal dryers. Dryer OD must be at least 48°.</td>
</tr>
<tr>
<td>Self-supported stationary</td>
<td>5750 SBAF</td>
<td>Man</td>
<td>4000 (1200)</td>
<td>For dryer sections with open gears. The rotary joint is supported by the dryer journal and uses anti-friction roller bearings to support the load.</td>
</tr>
<tr>
<td>PTX cantilever stationary</td>
<td>PTX</td>
<td>Man</td>
<td>All</td>
<td>All speed and condensing load applications. Requires large journal bore. Used with Turbulator bars at high speeds, state-of-the-art, low differential pressures, low blow through, stable evacuation, highest cost. Replaced PT system.</td>
</tr>
</tbody>
</table>

* Speeds are shown in fpm (mpm)
Professional Services

One of the most effective ways to sell rotary joints and associated components is by solving a customer problem. This requires careful attention to the customers' needs; to find out what problems they are facing and the associated cost of those problems. The solution can be expanded to include a number of professional services that help to further distinguish the Kadant offering. Kadant can combine its steam system expertise, R&D testing capabilities, hardware integration, and project management to conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and stationary syphon for the specific application.

Kadant services are available for installation, training and maintenance services at a competitive price.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

When using the shell-mounted tri-pod support version of the ISSS, Kadant Johnson installation services or technical supervision are strongly recommended.

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

General Customer Availability

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Ready for Order:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

Lead Time

For standard quotations, the Regional Sales Manager must enter the proposed delivery. There are no default times. Quotations should include the following statements:

- Delivery is typically 6 to 8 weeks from receipt of Purchase Order
- Delivery is subject to acceptance of PO by Kadant, based on prior order commitments
- Delivery is subject to timely confirmation of dimensional information
- Expedited delivery is available upon request

Pricing

Prices for the ISSS are dependent on dryer dimensional information, but are priced similar to rotary syphons. Contact your local Kadant Johnson manufacturing site or regional sales office for pricing for your application-specific needs.

Required Information to Place an Order

To begin engineering for a ISSS, the following informational sheets must be completed and provided to the factory with the order:

- A41650  Field Measurements for Design of Stationary Cantilever Syphon, Sheet 1 of 3
- A41651  Field Measurements for Design of Stationary Cantilever Syphon, Sheet 2 of 3
- AB7385  Field Measurements for Design of Stationary Cantilever Syphon, Sheet 3 of 3
1. **What types of syphons does Kadant offer?**

Kadant offers a full range of stationary and rotary syphons. A cantilevered support tube connected to a rigid rotary joint supports stationary syphons. Stationary syphons do not rotate with the dryer. Rotary syphons are fixed to the dryer shell and rotate with the shell.

2. **When are stationary syphons applied?**

Stationary syphons have a wide range of application. They are normally proposed on new paper machines and rebuilds, particularly rebuilds of high-speed machines.

3. **When are rotary syphons applied?**

If the customer requests rotating syphons, Kadant can provide them. The rotary syphons built by Kadant Johnson have the best performance in the industry and can be used with good efficiency up to 1200 mpm (4000 fpm). Above this speed, the operating differential pressure and associated blow through flow rates for rotary syphons become quite high.

4. **Who manufactures the stationary syphons for Kadant?**

Kadant Johnson manufactures its own joints and syphons. Kadant sells these to customers in the pulp and paper industry through its direct sales force, in some situations through representatives, or through OEM suppliers.

5. **What are insulating sleeves?**

Insulating sleeves are cylindrical tubes that isolate the dryer journal from the steam and condensate following through the journal bore. A properly sealed insulating sleeve greatly reduces the heat transfer from the steam to the journal.

6. **Are insulating sleeves required?**

Kadant recommends that all dryers have insulation sleeves in the journals. Without sleeves, more heat is transferred to the lube oil and there is a higher risk of cracking the inner race of the dryer bearings. SKF, Beloit, and Voith have reported this. Beloit conducted tests at their Rockton Research Center in the early 1980’s, showing that even at low pressures, there was a significant increase in inner race temperature without sleeves. Kadant extended this testing in 2005, conducting analytical and experimental evaluations of the effectiveness of insulating sleeves. A white paper is available on the Kadant Johnson intranet.

It is possible to install syphons without sleeves without serious problems, at least on lower pressure dryers, but the mill must warm up the dryers at a slower rate. Rapid warm-ups can cause the journal to heat up before the inner race, expand at a faster rate than the bearing race, put stress on the race, and cause premature failure.

Note that the recommendation for insulating sleeves is not a competitive disadvantage -- regardless of whose syphons (rotating, stationary, Beloit, Voith, Valmet, Deublin, etc.) are used, the same issue exists.

7. **What should be the difference in temperature between the steam and the dryer outside surface?**

The difference between the steam and outside dryer surface temperatures is normally considered to be “acceptable” if it lies in the range of 22-33 °C (40-60 °F). This is not a bad benchmark, for most dryers, but is not an independent parameter. See TAPPI TIP 0404-39 (“Methods for measuring dryer surface temperature”) for further information.
8. **How is the ISSS cantilever syphon attached to the steam joint?**

The horizontal syphon pipe passes through and is supported by internal carbon bushings. These bushings are retained in an internal spider flange bolted to the inside surface of the dryer. A vertical support brace that extends from the end of the horizontal pipe to the lower end of the vertical pipe supports the vertical syphon pipe.

9. **What size dryer journal bore is required?**

The dryer journal should be at least 6 mm (0.25") larger than the horizontal pipe outer diameter. If an insulating sleeve is needed, the bore should be at least 25 mm (1") larger than the horizontal pipe outer diameter. If the journal bore is cored and not machined, more space should be allowed to account for possible core shift.

10. **Is the ISSS syphon shoe “handed”?**

The standard vertical syphon pipe has two bends so that the same syphon shoe can be used in dryers that are rotating either clock-wise or counter-clock-wise. That is, the standard syphon shoes are not “handed”.

11. **Does the ISSS require the use of “mini-bars” or “baby-bars”?**

The narrow set of Turbulator bars is called **Edge Control™** bars. They are not required, but are recommended in certain rimming applications. They are provided with the standard syphon shoe, to fill in the gap between the syphon and the flange of the dryer shell.

12. **Have there been any problems with these syphon shoes coming loose?**

There have been a number of installations where competitive syphon shoes have rotated or dropped. Even some of the earlier Kadant installations had this problem. Kadant no longer uses set screws to hold the syphon in place until it is clamped. Setscrews cannot be used reliably to hold the syphon in place, so the temporary set screw has been removed to insure that it cannot be left in place.

13. **How does Kadant attach the syphon shoe to the vertical pipe?**

The Kadant Johnson stationary syphon shoe is a two-piece cast assembly. The two-piece clamp uses two large cap screws to lock the syphon shoe in place. The force of the two cap screws goes directly into clamping the syphon, not into bending a split collar. There have been no failures of this design.

14. **What is the material of the stationary syphon shoe (tip)?**

The Kadant Johnson syphon shoe is Teflon. If the shoe contacts the dryer (when, for example, the front dryer bearing housing falls off of its rockers), the shoe will be worn down, rather than damage the dryer shell. A stainless steel shoe, on the other hand, would quickly cut a groove in the dryer shell.

15. **How is the vertical support brace mounted to the horizontal pipe?**

The vertical support brace is clamped with two bolts and a split collar to the horizontal and vertical syphon pipes. In order to make this design reliable, the clamp must be machined to match the syphon pipes. It is designed to withstand the force of the condensate in a flooded dryer.

16. **What size vertical / horizontal syphon pipe is supplied with the ISSS?**

The standard vertical leg (syphon) size is 1" and the horizontal pipe is 1.25". Both are schedule 80 pipe.
ISSS Syphon Overview

Internally Supported Stationary Syphon

ISSS Application Overview

• Designed for open gear machines
• Small journal bores
• Internal spider mounted
  • 1200 mpm (1.5 m dia. dryer)
  • 1.25” horizontal pipe, schedule 80
  • 1” vertical leg, 60 or 90 degree
  • 3 carbon bushings to support cantilevered pipe
Steam Joint and Syphon

Internal Spider-Mounted Installation
Convert Existing Steam Joint

 Requires additional assembly/wedge plate

![Image of a steam joint]

Tri-pod / Shell Mounted Option

• Designed for open gear machines
• Small journals with no internal machining
• 3-leg, shell mounted design
  • 750 mpm (1.2 m dia. dryer)
  • 1” horizontal pipe
  • 1” vertical leg, 60 or 90 degree
  • 3 carbon bushing supports
Tri-pod / Shell Mounted Design

Installation Tool for Alignment
Medium Speed Stationary Syphon

General Customer Availability

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
<th>Release</th>
<th>Mark</th>
<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>---</td>
<td>1 December 2003</td>
<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>---</td>
<td>30 December 2005</td>
<td>All</td>
<td>Update name to Kadant Johnson</td>
</tr>
</tbody>
</table>
Product Description

The Medium-Speed Stationary Syphon (MSSS) is a cantilevered stationary syphon supported by an internal bushing. The syphon is a simple design, using existing Kadant Johnson joints and carbon bushings. This unit is particularly applicable to low-speed, price-sensitive paper dryer markets.

General Overview of the MSSS

- Use in dryers with open gears or closed gears
- Maximum speed is 550 mpm (1800 fpm)
- Use with carbon graphite guide as a bushing on a stainless steel sleeve
- The Teflon tip pick-up syphon shoe is recommended
- Used with ELS, SX, or LJ rotary joints
- Particularly applicable for dryers with small journal bores

Mechanical Design

The MSSS syphon size is 1” x 1.25”. The horizontal pipe is Schedule 80 pipe wall to provide adequate rigidity. The vertical pipe is also Schedule 80, turned down and inserted into the sweep bend pipe. The recommended shoe has a stainless steel clamp pad with a Teflon tip. Teflon is a sacrificial material to prevent damage to the dryer shell. A vertical brace is clamped to the vertical and horizontal syphon pipes.

Standard carbon guide bushings inserted into the internal spider flange are used to support the horizontal pipe up to speeds of 550 mpm (1800 fpm). The bushing support and the syphon connection to the rotary joint head are the two main areas for concern. A split wedge and pressure plate syphon support in the head and the carbon graphite guide bushing (S2410) placed in the internal spider flange provide the best solution. The carbon bushing supports the horizontal pipe with a stainless steel sleeve. This sleeve is welded to the pipe, and then turned to provide a precision fit to the carbon bushing.

It is important to have a rigid anti-rotation bracket for the rotary joint. On enclosed gear machines, the rods of the LJ joints are sufficient for this purpose. On open gear machines where self-supported (ELS or SX) joints are used, a strong bracket is required to prevent joint rotation and still allow axial movement to accommodate seal wear. These brackets can be bolted to the floor for bottom dryers. It can be more difficult to find proper mounting for the brackets for top dryers, where a support stand to the floor can be up to three meters (10 ft) long.

The recommended rotary joints for use with the MSSS include ELSJ, EL-IC, SX and LJ. All should be fitted with the split wedge / pressure plate syphon support in the head.

Note: Two other Medium-Speed Stationary Syphon configurations, each with self-supporting joints and internal support bushings, are shown in J3R drawings LE1408 and LE1504 (these units do not have vertical support braces).

Syphon Position

The syphon should be positioned in the 6 o’clock position for dryer rotational speeds less than 120 mpm (400 fpm). At these low speeds, the condensate will remain in a puddle in the bottom of the dryer. The puddle size will be small and the drive load will be low.
**Product Description**

Offset syphon 17° in the direction of rotation if the dryer speeds are operating above 120 mpm and up to 300 mpm (1000 fpm). In this speed range, the condensate will not be rimming, but the puddle will be shifted over to the 5 o’clock position. If the syphon is not offset, the amount of condensate will be quite large and the drive loads will go up accordingly.

If the dryer speed is more than 300 mpm (1,000 fpm), set the syphon in the 6 o’clock position and install Turbulator® bars. At these speeds, the condensate will be rimming. The MSSS is not recommended for speeds greater than 550 mpm (1800 fpm). However, a special version is available from Nippon Joint for speeds up to 1000 mpm.

**Product performance**

- The MSSS syphon has been tested on the JOCO 4000 over a wide range of operating conditions in Kadant Johnson’s R&D Center. A video clip showing this operation is available from Global Marketing or on the Intranet. Kadant Johnson can duplicate the mill's exact operating conditions (pressure, condensing load, speed, and differential pressure) and demonstrate the performance of the recommended joint and syphon solution for the customer.
- Syphon clearance has been optimized through R&D testing to produce the highest possible heat transfer performance with Turbulator bars. No other supplier has either the testing facilities or the data for such optimization work.
- The stationary syphon does not require high differential pressure to evacuate condensate. This eliminates the risk of dryer flooding when the syphon is properly sized.

**Bushing Life**

- The carbon graphite bushing can be guaranteed for a period of 12 months. We can expect to achieve a life of two to four years, but do not have sufficient operating experience over a wide enough range of operating conditions to support aggressive bushing guarantees at this time.
- The carbon bushings should be inspected annually, at least in selected dryers, to determine the wear and replacement frequency. After the wear rate is determined, the inspection period may be increased to an inspection every two years.
- For speeds greater than 550 and less than 1000 mpm, an alternative bushing material is available.

**Teflon Tip Syphon Shoe Features / Benefits**

- Investment cast stainless steel clamp pad resists erosion and corrosion
- One-piece Teflon tip securely mounted to clamp pad
- Converging entrance to syphon shoe improves flood recovery time and steady-state operation
- Large syphon tip opening improves condensate flow rate into syphon pipe
- Double-cut, double-bolt clamp secures syphon shoe in place

**Operating Conditions for MSSS**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>N/A</td>
</tr>
<tr>
<td>Temperature</td>
<td>Up to 275°C (550°F)</td>
</tr>
<tr>
<td>Speed</td>
<td>Up to 550 mpm (1800 fpm)</td>
</tr>
<tr>
<td>Service</td>
<td>Steam/condensate, water</td>
</tr>
</tbody>
</table>

*Note: Superheat in the supply steam should be limited to 28°C (50°F)*
Kadant Johnson Research ran tests on the MSSS syphon to evaluate the speed limit and operating characteristics. Reference Research Report RD200200990 (October 21, 2002) for test data. A summary of the test results is presented below.

Testing was conducted on the Joco 4000. The syphon was built per Kadant Johnson System International drawing number M1186 with a 1” x 1.25” syphon, located 76 mm past the edge of the tending end dryer groove with a clearance of 4.7 mm. Operating conditions for these tests are shown in Table I. The tests covered the speed range of 200 to 600 mpm. The initial tests were run with the syphon oriented vertically (6 o’clock position). The testing series was then repeated with the syphon offset in the direction of rotation approximately 20º from vertical.

<table>
<thead>
<tr>
<th>Pressure bar absolute</th>
<th>Speed mpm</th>
<th>Condensing Rate kg/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>201</td>
<td>450</td>
</tr>
<tr>
<td>2.8</td>
<td>299</td>
<td>450</td>
</tr>
<tr>
<td>2.8</td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td>2.8</td>
<td>500</td>
<td>450</td>
</tr>
<tr>
<td>2.8</td>
<td>600</td>
<td>450</td>
</tr>
</tbody>
</table>

Syphon vibrations were recorded under a separate set of conditions, shown in Table II. These conditions were selected for comparison to existing cantilever stationary tests. The accelerometer was mounted horizontally on the syphon shoe.

<table>
<thead>
<tr>
<th>Rimming Thickness mm</th>
<th>Speed MPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td>610</td>
</tr>
<tr>
<td></td>
<td>762</td>
</tr>
<tr>
<td>6.4</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td>610</td>
</tr>
<tr>
<td></td>
<td>762</td>
</tr>
<tr>
<td>9.5</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td>610</td>
</tr>
<tr>
<td></td>
<td>762</td>
</tr>
</tbody>
</table>
The results are summarized in Table III. Note that the condensate and blow through steam were not collected for test numbers 21391 through 21394.

Table III - Summary of Results

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Syphon Orientation</th>
<th>Steam Pressure bar abs</th>
<th>Speed mpm</th>
<th>Cond kg/m²-hr</th>
<th>Average Temp C</th>
<th>Temp Range C</th>
<th>Torque N·M</th>
</tr>
</thead>
<tbody>
<tr>
<td>21385</td>
<td>vertical</td>
<td>2.8</td>
<td>201</td>
<td>15.9</td>
<td>120.8</td>
<td>0.7</td>
<td>188</td>
</tr>
<tr>
<td>21386</td>
<td></td>
<td>2.8</td>
<td>299</td>
<td>16.2</td>
<td>121.2</td>
<td>0.6</td>
<td>320</td>
</tr>
<tr>
<td>21387</td>
<td></td>
<td>2.8</td>
<td>400</td>
<td>16.0</td>
<td>121.3</td>
<td>0.6</td>
<td>537</td>
</tr>
<tr>
<td>21388</td>
<td></td>
<td>2.8</td>
<td>500</td>
<td>16.2</td>
<td>121.1</td>
<td>0.7</td>
<td>753</td>
</tr>
<tr>
<td>21389</td>
<td></td>
<td>2.8</td>
<td>600</td>
<td>15.9</td>
<td>105.9</td>
<td>10.5</td>
<td>91</td>
</tr>
<tr>
<td>21390</td>
<td>offset 20°</td>
<td>2.8</td>
<td>201</td>
<td>16.0</td>
<td>120.4</td>
<td>1.2</td>
<td>191</td>
</tr>
<tr>
<td>21391</td>
<td></td>
<td>2.8</td>
<td>299</td>
<td>NA</td>
<td>120.9</td>
<td>1.1</td>
<td>278</td>
</tr>
<tr>
<td>21392</td>
<td></td>
<td>2.8</td>
<td>400</td>
<td>NA</td>
<td>118.2</td>
<td>1.1</td>
<td>83</td>
</tr>
<tr>
<td>21393</td>
<td></td>
<td>2.8</td>
<td>500</td>
<td>NA</td>
<td>114.5</td>
<td>2.3</td>
<td>83</td>
</tr>
<tr>
<td>21394</td>
<td></td>
<td>2.8</td>
<td>600</td>
<td>NA</td>
<td>107.2</td>
<td>10.1</td>
<td>85</td>
</tr>
</tbody>
</table>

With the syphon in the 6 o’clock position, the condensate rimmed at a dryer speed between 500 and 600 mpm, as shown in Graph I (dryer drive torque verses dryer speed). The drive torque values were quite high prior to rimming. With the syphon in the offset position, the condensate rimmed at a between 300 and 400 mpm and the drive torque values were always low.
All of the testing was conducted without dryer bars. The dryer surface temperatures and temperature profiles reflected the state of the condensate: With cascading condensate, the dryer surface temperatures remained high, with a low deviation. After the condensate rimmed, the average temperature decreased and the range increased, as shown in Graphs II and III.
The vibration levels for the bushing supported syphon were found to be low, over the entire range tested. These vibration levels were even lower than a cantilever stationary syphon, as shown in Graph IV. This highlights the mechanical stability provided by an internal support bushing. Vibration does not limit the application of this syphon. The limiting factors for machine speed are the service life of the support bushing and fatigue loading of the syphon under long-term operation in a flooded dryer.

Supporting Field Trial

Two commercial MSSS units were installed in the warm-up after-size dryers of a fine paper machine in Klipans (formerly Inveresk), Inverkeithing / Caldwell, Scotland.

- The syphons were installed on February 4, 2002. The machine operates five days per week, 50 weeks per year.
- Bob Walker (Kadant Johnson Systems International) coordinated this trial.
- Graham Bodger, JSI Service Engineer, inspected the units on June 29, 2003. The bushings were found to be in very good condition.
- The carbon bushings on the internal support had worn about 0.010" (0.25 mm). The syphon tip clearance had not changed (7-10 mm). Based on this performance, the bushing life could be as much as four years.
- The dryers had been opened four times during this period and no problem with flooding was found.
- The rotary joint is a 2700ELSJRQ-1 with a split wedge / pressure plate syphon support in the head. The nipples of the joints were bored out for the horizontal pipe.
- Operating steam pressures in these dryers range from 0.3 to 1.0 bar (gauge).
- Operating speeds range from 250 to 450 mpm (occasionally to 550 mpm).
- The machine was observed running 490 mpm with 4 psig steam pressure and 4 psi differential pressure.
- The dryers are draining without problems and the mill reported that the drive load for the section was significantly reduced. The previous "frame shake" had disappeared and the operating speed had been increased by 20 mpm.
Applications

The MSSS can be used in the following applications:

- Low operating speeds (less than 550 mpm, 1800 fpm)
- Open or enclosed gear machines
- Dryers with small journal bores or cored holes (60 – 85 mm)
- Low-pressure wet end dryers (requiring stationary syphons)
- Machines with low capacity vacuum systems (ones that can not handle the higher blow through flow rates that are generated with a rotary syphon)
- Replacing rotary syphons in dryers with flooding problems
- This syphon should be used with Turbulator bars for rimming speeds (over 300 mpm)

Note:

- The 5750SBAF taper-roller bearing stationary syphon is also an option for higher speeds, but it has a higher cost and requires a larger journal bore.
- At speeds less than 300 mpm, a simple stationary, without an internal bushing support may be sufficient.
- For speeds greater than 550 mpm and less than 1000 mpm, an alternative bushing material is available when the PTX offering is not applicable. Contact Global Marketing for additional details.

Customer Value

Financial savings

- Stationary syphons reduce steam usage by reducing the amount of blow-through compared to a rotating syphon design. The reduced blow-through is achieved during normal operation, as well as during machine upsets.
- Reduced blow-through and pressure differential can provide savings by:
  - Reducing the amount of motive steam required
  - Reducing the amount of steam that is vented
  - Reducing the amount of steam that goes to the condenser
  - Reducing the back pressure from power-generating turbine
  - Kadant Johnson Systems has a simple spreadsheet program for evaluating these various savings.
- Long life components reduce the downtime for inspections or repair. The robust design of the Kadant Johnson MSSS rigid mounting of the syphon system reduce routine maintenance as well as the occurrences of catastrophic syphon failure that result from less robust competing designs.

The target market for the medium-speed stationary syphon system is the Paper Industry, for dryers that are running at non-rimming condensate speeds, particularly those running at speeds below 550 mpm. The stationary syphons are also helpful in improving the stability of marginal steam and condensate systems. A combined sale of the MSSS and steam system upgrades provides a unique market opportunity for Kadant Johnson.

Unique Selling Proposition

The Kadant Johnson Medium-Speed Stationary Syphon system has a long life, high reliability, and excellent operating performance for low speed machines. Kadant Johnson backs this up with the most knowledgeable and most experienced engineering and service support in the world, and these services are available worldwide.
Production Supervisors - focus on:

- Syphon pick-up shoe material sacrificed in unlikely event shoe contacts dryer shell
- Eliminates dryer flooding during operation; easy recovery of a flooded dryer
- Reduced blow-through reduces load on steam system
- Improved runnability
- Integration with complete Systems offerings. Only Kadant Johnson can offer a complete system, including joints, syphons, system design, and control. Specific operational results can be guaranteed if required by the customer.
- Thermocompressor sizing should be reviewed
- Pipe sizes and separator station sizing should be reviewed
- Control system should be evaluated

Maintenance Supervisors - focus on:

- Minimal maintenance is required
- The syphon pipe and shoe clamp pad is stainless steel, to avoid erosion
- Vertical support brace minimizes vibration and fatigue

Cross-selling Opportunities

Kadant Johnson Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration. This includes dryer surveys, estimation of drying rate improvements, steam system reviews, installation services, Turbulator bar sales, thermocompressor sizing and sales, and Vortec vacuum generators.

Turbulator® bars are strongly suggested for any dryer that operates above rimming speed.

When the Kadant Johnson Service is involved in the projects, Kadant Johnson can offer the following bundling opportunities:

1. Complete seal life and maintenance improvement estimations and guarantees
2. Review existing steam and condensate systems (valves, thermocompressors, separator tanks)
3. Review / develop justification for the purchase of Turbulator bars (if applicable)
4. Installation services
5. Prepare assembly drawings for future mill / Kadant Johnson reference
6. Provide on-going service and sales support (through network of reps and direct sales force)
7. Conduct R&D testing of Kadant Johnson and competitive configurations
8. Conduct audit for future machine production limitations
9. Establish blow-through correlations for system design
10. Establish the optimum syphon clearances (consistent with the installed bar configuration)
**Selling Strategy**

**Precluding Sales Objections**

Kadant Johnson Sales should attempt to sell the positive features and benefits of the Kadant Johnson products, not the negative features of competitive products.

One of the Kadant Johnson competitors (Deublin) has been negative-selling its products in North America. Rather than counter these sales tactics with similar negative selling, Kadant Johnson Sales should attempt to identify the negative selling strategies used by its competitors and address these items before the customers ask questions on them. That is, Kadant Johnson Sales should present its products, focusing on the positive aspects of the features that the competitors are using for negative selling. This precludes the objections to sales and keeps the presentation properly focused.

Listed below are some of the negative comments that our competitors have made. Also listed are statements that can be made during the course of a product presentation to avoid questions on these aspects.

1. **Competitive comment:** Kadant Johnson syphons have experienced a number of failures when the syphon shoe slips or rotates at the end of the vertical syphon pipe.

   The heart of the dryer performance rests with this shoe and the way it behaves with the Turbulator bars. It is important that the syphon clearance is set correctly and accurately and that this clearance not change after the dryer is closed up. Many shoes on the market today are difficult to set up and have been known to slip during operation. Even some of the early Kadant Johnson shoes had this problem.

   The current design, however, has a number of unique features that have overcome these problems, making it the most successful design in the industry: This shoe has a two-bolt clamping system with a special split collar. The syphon clearance can be easily set by lowering it onto the set-up shim, tightening the two bolts, and removing the set-up shim. This is the same shoe used on the high-performance PTX syphon.

   Note: The positive clamping can be demonstrated by giving the customer a Kadant Johnson shoe, stub end of a vertical pipe, and a ratchet. It is only necessary to barely tighten the two hex head bolts and the shoe is positively clamped to the pipe.

2. **Competitive comment:** Kadant Johnson has long and unreliable deliveries. Any order to Kadant Johnson should have a delivery penalty.

   The standard delivery from Kadant Johnson is 8-10 weeks. Expedited deliveries are also possible, if needed for the project. Expedited delivery is possible, because Kadant Johnson has a dedicated ductile iron foundry in North America (Specialty Castings), located close to its manufacturing center in southern Michigan.

3. **Competitive comment:** Kadant Johnson has had a number of problems with their stationary syphons vibrating and failing.

   Kadant Johnson has learned through R&D testing, engineering analysis, and field experience that there are a number of important considerations in determining the required natural frequency of the cantilevered syphon assembly. Most suppliers only look at the rotational frequency of the dryers. Kadant Johnson, however, also looks at the rotational frequencies of the adjacent felt rolls. On many machines, particularly those that have been increased in speed, it is the “half-critical” of the felt rolls that causes the most serious vibrations. Kadant Johnson has also found that the shedding of vortices in condensate that hit the syphon shoe can induce vibrations. All of these factors are considered in selecting the stiffness of a Kadant Johnson stationary syphon to achieve the required natural frequency.

   *** The MSSS is not subject to vibration-induced failures (see page 7 for more information).
Selling Strategy
Sales Collateral / Reference Material

Drawings

Available from the local manufacturing site.

Presentation Materials

PowerPoint Presentation – “Medium Speed Stationary Syphons”

Inside the Dryer Video – Condensate Behavior (stationary and rotating camera)

Customer Reference Materials

A technical paper titled “Vibration Characteristics in Cantilever Stationary Syphons” is available to present R&D studies on vibration and stationary syphons. This paper is available online in the Intranet or from Global Marketing.

Mill application / case study article reprints from major trade publications available from Global Marketing.

Medium-Speed Stationary Syphon offset 17° positioned in puddling condensate. Dryer speed is 150 mpm.
## Selling Strategy

### Kadant Johnson Stationary Syphon Designs

<table>
<thead>
<tr>
<th>Syphon Type</th>
<th>Joints</th>
<th>Entry Required</th>
<th>Max Speed*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent pipe</td>
<td>LJ SXB ELS</td>
<td>None</td>
<td>150 (45)</td>
<td>Generally supplied by mill, for small dryer diameters with low condensing loads, has high failure rate.</td>
</tr>
<tr>
<td>Gravity Lock 60° elbow</td>
<td>LJ SXB ELS</td>
<td>None</td>
<td>250 (75)</td>
<td>For small dryer diameters with low condensing loads, less cantilever weight than bent pipe, still has high failure rate.</td>
</tr>
<tr>
<td>Spring Lock 60° elbow</td>
<td>LJ SXB ELS</td>
<td>None</td>
<td>400 (120)</td>
<td>For small dryers with low condensing loads, improvement over the gravity lock elbow, slightly higher cost, lower failure rate, needs larger journal.</td>
</tr>
<tr>
<td>Journal-mounted bushing-supported 60° elbow</td>
<td>LJ SXB ELS</td>
<td>None</td>
<td>600 (185)</td>
<td>Used for longer pipes and for low condensing load dryers. Improvement over unsupported units. Dryers must be at least 32” for SXB or ELS joints. Requires periodic maintenance of support bearing bushing.</td>
</tr>
<tr>
<td>90° Locking Elbow</td>
<td>LJ SXB ELS</td>
<td>Hand</td>
<td>600 (185)</td>
<td>For small dryers with low condensing loads, good reliability but should have hand-hole access, in case of failure. Improvement over the non-lock elbow, slightly higher cost. Dryers must be at least 32” for SXB or ELS joints.</td>
</tr>
<tr>
<td>90° Locking Elbow CorrPro™ Joint</td>
<td>CorrPro™ Joint</td>
<td>Hand</td>
<td>1000 (300)</td>
<td>Improved cantilever support for small dryers with low condensing loads and higher speeds. Improvement over the non-lock elbow. Good reliability, but should have hand hole access in case of failure. Higher cost but has no bushing maintenance.</td>
</tr>
<tr>
<td>Journal-mounted bushing-support 90° locking elbow</td>
<td>CorrPro™ Joint</td>
<td>None</td>
<td>1200 (365)</td>
<td>Used for low condensing load dryers with long syphon pipes. Improvement over unsupported unit. Requires bearing bushing maintenance.</td>
</tr>
<tr>
<td>Internal spider, carbon bushing, no syphon brace, syphon pipe</td>
<td>LJ SXB ELS</td>
<td>Man</td>
<td>1150 (350)</td>
<td>Alternative to scoop. Can be used with steam trap with steam-lock release. Standard carbon guide bearing, requires maintenance, uses syphon pipe without tip. Better performance with a blow through steam system. Dryers must be at least 32” for SXB or ELS joints, use with split wedge-pressure plate syphon support head.</td>
</tr>
<tr>
<td>Medium Speed Stationary Syphon (MSSS)</td>
<td>LJ SXB ELS</td>
<td>Man</td>
<td>1800 (550)</td>
<td>Alternative to scoop. Uses Sch 80 pipe and Teflon pickup shoe. Carbon bearing requires maintenance. Use with a blow through steam system. Dryers must be at least 32” for SXB or ELS.</td>
</tr>
<tr>
<td>Internal spider, Al bushing and ceramic SS sleeve (Nippon Joint)</td>
<td>LJ SXB ELS</td>
<td>Man</td>
<td>3250 (1000)</td>
<td>Improved syphon system with heavy-wall syphon pipe, support bearing maintenance required, used for small journal dryers. Dryers must be at least 48” for SXB or ELS joints.</td>
</tr>
<tr>
<td>Self-supported stationary</td>
<td>5750 SBAF</td>
<td>Man</td>
<td>4000 (1200)</td>
<td>For dryer sections with open gears. The rotary joint is supported by the dryer journal and uses anti-friction roller bearings to support the load.</td>
</tr>
<tr>
<td>PTX cantilever stationary</td>
<td>PTX</td>
<td>Man</td>
<td>All</td>
<td>All speed and condensing load applications. Requires large journal bore. Used with Turbulator bars at high speeds, state-of-the-art, low differential pressures, low blow through, stable evacuation, highest cost. Replaced PT system.</td>
</tr>
</tbody>
</table>

*Speeds are shown in fpm (mpm)*
**Services**

**Professional Services**

One of the most effective ways to sell rotary joints and associated components is by *leading with services*. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and stationary syphon for the specific application.

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact your local Kadant Johnson Service Center or Kadant Johnson.

**Installation & Rebuild Services**

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

**Training & Education Services**

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

General Customer Availability

<table>
<thead>
<tr>
<th></th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Order:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

Lead Time

For standard quotations, the Regional Sales Manager must enter the proposed delivery. There are no default times. Quotations should include the following statements:

- Delivery is typically 6 to 8 weeks from receipt of Purchase Order
- Delivery is subject to acceptance of PO by Kadant Johnson, based on prior order commitments
- Delivery is subject to timely confirmation of dimensional information
- Expedited delivery is available upon request

Pricing

Prices for the MSSS are dependent on dryer dimensional information, but are priced similar to rotary syphons. Contact your local Kadant Johnson manufacturing site or regional sales office for pricing for your application-specific needs.

Required Information to Place an Order

To begin engineering for a MSSS, the following informational sheets must be completed and provided to the factory with the order:

- A41650 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 1 of 3
- A41651 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 2 of 3
- AB7385 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 3 of 3
1. **What types of syphons does Kadant Johnson offer?**

   Stationary and rotary. A cantilevered support tube connected to a rigid rotary joint supports stationary syphons. Stationary syphons do not rotate with the dryer. Rotary syphons are fixed to the dryer shell and rotate with the shell.

2. **When are stationary syphons applied?**

   Stationary syphons have a wide range of application. They are normally proposed on new paper machines and rebuilds, particularly rebuilds of high-speed machines.

3. **When are rotary syphons applied?**

   If the customer requests rotating syphons, Kadant Johnson can provide them. The rotary syphons built by Kadant Johnson have the best performance in the industry and can be used with good efficiency up to 1220 mpm (4000 fpm). Above this speed, the operating differential pressure for rotary syphons become quite high.

4. **Who manufactures the stationary syphons for Kadant Johnson?**

   Kadant Johnson manufactures its own joints and syphons. Kadant Johnson sells these to customers in the pulp and paper industry through its direct sales force, in some situations through representatives, or through OEM suppliers.

5. **What are insulating sleeves?**

   Insulating sleeves are cylindrical tubes that isolate the dryer journal from the steam and condensate following through the journal bore. A properly sealed insulating sleeve greatly reduces the heat transfer from the steam to the journal.

6. **Are insulating sleeves required?**

   Kadant Johnson recommends that all dryers have insulation sleeves in the journals. Without sleeves, more heat is transferred to the lube oil and there is a higher risk of cracking the inner race of the dryer bearings. SKF, Beloit, and Voith have reported this. Beloit conducted tests at the Rockton Research Center in the early 1980’s, showing that even at low pressures, there was a significant increase in inner race temperature without sleeves.

   It is possible to install syphons without sleeves without serious problems, at least on lower pressure dryers, but the mill must warm up the dryers at a slower rate. Rapid warm-ups can cause the journal to heat up before the inner race, expand at a faster rate than the bearing race, put stress on the race, and cause premature failure.

   Note that the recommendation for insulating sleeves is not a competitive disadvantage -- regardless of whose syphons (rotating, stationary, Beloit, Voith, Valmet, Deublin, etc.), the same issue exists.

7. **What should be the difference in temperature between the steam and the dryer outside surface?**

   The difference between the steam and outside dryer surface temperatures is normally considered to be “acceptable” if it lies in the range of 22-33 °C (40-60 °F). This is not a bad benchmark, for most dryers, but is not an independent parameter. See TAPPI TIP 0404-39 (“Methods for measuring dryer surface temperature”) for further information.
8. **How is the MSSS cantilever syphon attached to the steam joint?**

The horizontal syphon pipe passes through and is supported by an internal carbon bushing. This bushing is attached to an internal spider flange bolted to the inside surface of the dryer. A vertical support brace that extends from the end of the horizontal pipe to the lower end of the vertical pipe supports the vertical syphon pipe.

9. **What size dryer journal bore is required?**

The dryer journal should be at least 6 mm (0.25") larger than the horizontal pipe outer diameter. If an insulating sleeve is needed, the bore should be at least 25 mm (1") larger than the horizontal pipe outer diameter. If the journal bore is cored and not machined, more space should be allowed to account for possible core shift.

10. **Is the MSSS syphon shoe “handed”?**

The standard vertical syphon pipe has one bend so that the same syphon shoe can be used in dryers that are rotating either clock-wise or counter-clock-wise. That is, the standard syphon shoes are not “handed”.

11. **Does the MSSS require the use of “mini-bars” or “baby-bars”?**

The narrow set of Turbulator bars is called **Edge Control** bars. They are not required, but are recommended in certain rimming applications. They are provided with the standard syphon shoe, to fill in the gap between the syphon and the flange of the dryer shell.

12. **Have there been any problems with these syphon shoes coming loose?**

There have been a number of installations where competitive syphon shoes have rotated or dropped. Even some of the earlier Kadant Johnson installations had this problem. Kadant Johnson no longer uses set screws to hold the syphon in place until it is clamped. Setscrews cannot be used reliably to hold the syphon in place, so the temporary set screw has been removed to insure that it cannot be left in place.

13. **How does Kadant Johnson attach the syphon shoe to the vertical pipe?**

The Kadant Johnson stationary syphon shoe is a two-piece cast assembly. The two-piece clamp uses two large cap screws to lock the syphon shoe in place. The force of the two cap screws goes directly into clamping the syphon, not into bending a split collar. There have been no failures of this design.

14. **What is the material of the stationary syphon shoe (tip)?**

The Kadant Johnson syphon shoe is Teflon. If the shoe contacts the dryer (when, for example, the front dryer bearing housing falls off of its rockers), the shoe will be worn down, rather than damage the dryer shell. A stainless steel shoe, on the other hand, would quickly cut a groove in the dryer shell.

15. **How is the vertical support brace mounted to the horizontal pipe?**

The vertical support brace is clamped with two bolts and a split collar to the horizontal and vertical syphon pipes. In order to make this design reliable, the clamp must be machined to match the syphon pipes. It is designed to withstand the force of the condensate in a flooded dryer running at 550 mpm (1800 fpm), without failure.

16. **What size vertical / horizontal syphon pipe is supplied with the MSSS?**

The standard vertical leg (syphon) size is 1" and the horizontal pipe is 1.25". Both are schedule 80 pipe.
PTX Rotary Joint and Stationary Syphon

General Customer Availability:

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
<th>Revision</th>
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<td>A</td>
<td>---</td>
<td>15 November 2000</td>
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<td>01 March 2002</td>
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<tr>
<td>C</td>
<td>---</td>
<td>21 February 2003</td>
<td>14, 15, 25</td>
<td>Teflon syphon shoe updates</td>
</tr>
<tr>
<td>D</td>
<td>---</td>
<td>10 November 2003</td>
<td></td>
<td>General updates</td>
</tr>
<tr>
<td>E</td>
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<td>12 February 2004</td>
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<td>30 December 2005</td>
<td>All</td>
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</table>
The Kadant Johnson PTX rotary joint and stationary syphon system is the most modern system on the market. It is a significant upgrade of the original PT. It improves Kadant Johnson’s competitive position in the market by providing enhanced customer benefits. In addition to the traditional benefits of Kadant Johnson’s PT joint design, key enhancements include:

- The total weight of joint and syphon assembly is significantly reduced for easier handling during installation and maintenance, while stiffness has been improved.
- The joint accommodates thermal expansion of dryers with bearings that allow for “float,” such as SKF CARB® bearings.
- It has increased flow area to expand the range of each size, without increasing the pressure drop.
- It is designed with high natural frequency to reduce the potential for damage due to vibration.
- Axial adjustment of vertical syphon pipe allows fine-tuning the axial location of syphon shoe.
- The joint has a cleaner appearance, partially due to weight reduction of the castings.
- O-ring experiences have been positive resulting in the use of o-rings as standard and cup seals by special order only.
- Vertical syphon pipe support is now cast and available for 1.5 m (60") and 1.8 m (72") dryer diameters.

### Joint Sizes

The PTX is available in two sizes, each with either ASA (American) or DIN (European) flange patterns:

<table>
<thead>
<tr>
<th>PTX</th>
<th>M - ASA connection</th>
<th>M - DIN connection</th>
<th>P - ASA connection</th>
<th>P - DIN connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>9750</td>
<td>3&quot; (2.5&quot;)</td>
<td>DN 80 (DN65) PN16</td>
<td>1.5&quot; or 2&quot;</td>
<td>DN40 (DN50) PN16</td>
</tr>
<tr>
<td>9800</td>
<td>4&quot; (3.5&quot;)*</td>
<td>DN100 (DN80) PN16</td>
<td>2&quot; or 2.5&quot;</td>
<td>DN50 (DN65) PN16</td>
</tr>
</tbody>
</table>

### Symbol Numbers

- 9750AFYSCPTX-1 PTX Rotary Joint – 3" M connection, 2" P connection
- 9750AFYSCPTX-10 PTX Rotary Joint – 2.5" M connection, 1.5" P connection
- 9750AFYSCPTX-11 PTX Rotary Joint – single flow, 1.5" P connection
- 9750AFYSCPTX-12 PTX Rotary Joint – single flow, 2" P connection
- SS2446 3" Cantilever Stationary Syphon, 60" dryer, Teflon shoe
- SS2422 3" Cantilever Stationary Syphon, 60" dryer, ductile iron shoe
- SS2455 3" Cantilever Stationary Syphon, 72" dryer, Teflon shoe
- SS2409 3" Cantilever Stationary Syphon, 72" dryer, ductile iron shoe
- 9800AFYSCPTX PTX Rotary Joint – 4" M connection, 2-1/2" P connection
- 9800AFYSCPTX-10 PTX Rotary Joint – 4" M connection, 2" P connection
- 9800AFYSCPTX-1 PTX Rotary Joint – single flow, 2-1/2" P connection
- 9800AFYSCPTX-5 PTX Rotary Joint – single flow, 2" P connection
- 9800AFYSCPTX-8 PTX Rotary Joint – 3" M connection, 2" P connection, SPECIAL short body/head version
- SS2463 4.25" Cantilever Stationary Syphon, 72" dryer, Teflon shoe
- SS2408 4.25" Cantilever Stationary Syphon, 72" dryer, ductile iron shoe
- SS2468 4.25" Cantilever Stationary Syphon, 60" dryer, Teflon shoe
- SS2432 4.25" Cantilever Stationary Syphon, 60" dryer, ductile iron shoe
SS2462 3.75” Cantilever Stationary Syphon, 72” dryer, Teflon shoe, SPECIAL for small bore journals that will not allow for the 4.25” standard support tube size

J9752NAXF-2-1-1 9750 PTX Sight flow head (option)
J9802NAXF-2-1-1 9800 PTX Sight flow head (option)
(Offered primarily to European customers)

Cast Vertical Syphon Supports

<table>
<thead>
<tr>
<th>PTX</th>
<th>Support Tube Diameter</th>
<th>Dryer O.D.</th>
<th>Cast Vertical Support Bracket</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5 m (60&quot;)</td>
<td>SC2421-6A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 m (72&quot;)</td>
<td>SC2421-11A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 m (60&quot;)*</td>
<td>SC2421-14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 m (72&quot;)*</td>
<td>SC2421-15</td>
</tr>
<tr>
<td>9750</td>
<td>3.00&quot;</td>
<td>1.5 m (60&quot;)</td>
<td>SC2421-13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 m (72&quot;)</td>
<td>SC2421-9A</td>
</tr>
<tr>
<td>9800</td>
<td>4.25&quot;</td>
<td>1.5 m (60&quot;)</td>
<td>SC2421-13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 m (72&quot;)</td>
<td>SC2421-9A</td>
</tr>
<tr>
<td></td>
<td>3.75&quot;</td>
<td>1.5 m (60&quot;)</td>
<td>SC2421-13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 m (72&quot;)</td>
<td>SC2421-9A</td>
</tr>
</tbody>
</table>

*These brackets provide special clearance chamfers to allow the syphon shoe to be offset from the 6 o’clock position in the dryer. This feature is used for machines that operate over a wide speed range that may include speeds below rimming conditions.
**Sales Strategy**

**Trade Marks**

The Kadant Johnson product name for this steam joint is the “PTX series” joint. This is not a registered or common law trademark, but rather a product name. The PTX stationary syphons are normally supplied with Kadant Johnson Turbulator® dryer bars. “Turbulator” is a registered trademark of Kadant Johnson. It should be indicated by a ® mark in the first occurrence of the name in any publication.

**Standards**

Standard components and configurations of the PTX joint and syphon should be offered whenever possible. Our objective is to use standard components to reduce cost, improve delivery times, and insure the best product performance. Standard configurations include selected support tube lengths, standard vertical support brackets, standard syphon pipes, and Edge Control™ bars.

**Customer Value**

The customer value of the PTX joint and syphon system includes the traditional value of the Kadant Johnson PT joint and syphon system, as well as additional value created with the new PTX design.

**Financial savings**

- Stationary syphons reduce steam usage by reducing the amount of blow-through compared to a rotating syphon design. The reduced blow-through is achieved during normal operation, as well as during machine upsets.
- Reduced blow-through and pressure differential can provide savings by:
  - Reducing the amount of motive steam required
  - Reducing the amount of steam that is vented
  - Reducing the amount of steam that goes to the condenser
  - Reducing the back pressure from power-generating turbine
  - Note: Kadant Johnson Systems has a simple spreadsheet program for evaluating these various savings.
- Long life components reduce the downtime for inspections or repair. The robust design of the Kadant Johnson PTX joint and rigid mounting of the syphon system reduce routine maintenance as well as the occurrences of catastrophic syphon failure that result from less robust competing designs.
- Flow areas through the joint are the highest of any competitive joint. Lower flow resistance and lower blow-through requirements reduces the size, cost and complexity of steam and condensate piping system.

**Product performance**

- The PTX joint has been tested on 1.5m (5’) and 1.8m (6’) diameter dryers over a wide range of operating conditions in Kadant Johnson’s R&D Center. Kadant Johnson can duplicate the mill's exact operating conditions (pressure, condensing load, speed, and differential pressure) and demonstrate the performance of the recommended joint and syphon solution for the customer.
- Syphon clearance has been optimized through R&D testing to produce the highest possible heat transfer performance with Turbulator bars. No other supplier has either the testing facilities or the data for such optimization work.
- For similar sized joints, the Kadant Johnson support tube has the highest natural frequency of any support tube on the market. The Kadant Johnson support tubes are sized to avoid the natural (rotational) frequencies of the dryers, felt rolls, and framework.
Sales Strategy

- The stationary syphon does not require high differential pressure to evacuate condensate. This eliminates the risk of dryer flooding when the syphon is properly sized.

- The Kadant Johnson PTX joint and stationary syphon assembly is used in paper machine dryers to insure reliable removal of condensate. For high-speed dryers (any machine that runs over rimming speed), the syphon should be used with Kadant Johnson Turbulator bars. These bars produce the highest rate of heat transfer of any device on the market. The uniformity of heat transfer is also much better than any other dryer configuration. Dryer performance can be evaluated by measuring the dryer outside surface temperature. When the PTX system is part of a steam and condensate system designed by Kadant Johnson, the dryer surface temperature will be no more than 33°C (60°F) less than the internal steam temperature. This indicates proper condensate removal. Kadant Johnson can also demonstrate and guarantee uniform cross-machine temperature profiles.

Ease of Installation

- The weight of the Kadant Johnson PTX joint and cantilever stationary syphon assembly has been significantly reduced. One person can easily handle each of the components / assemblies during installation. (see table below)

- The horizontal support tube in the PTX joint can be easily slid into the journal bore and locked into position. There are no o-rings to be damaged. Most importantly, the joint does not rely on four small cap screws to hold the tube. A single massive hollow bolt holds the tube in position.

- The PTX body can be positioned with the M-connection in any one of eight positions, as a standard offering. (Vertical, horizontal, and at 45-degree increments between these positions).

- The PTX (and all PT style) joints use a unique reverse seal ring design that allows for run-out and angular misalignment of the joint, as well as thermal expansion.

- The PTX joint and syphon system can be installed in place of the existing 2750LN-IC joint, with few piping changes. The details are shown in the following table:

<table>
<thead>
<tr>
<th>Item</th>
<th>Kadant Johnson 2750LN-IC</th>
<th>Kadant Johnson 9750PT Cantilever</th>
<th>Kadant Johnson 9750PTX Cantilever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight, lb</td>
<td>~ 41 (varies)</td>
<td>79</td>
<td>52</td>
</tr>
<tr>
<td>Body weight, kg</td>
<td>~ 19</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Bracket weight, lb</td>
<td>Varies</td>
<td>~ 85 (varies)</td>
<td>~ 42 (varies)</td>
</tr>
<tr>
<td>Bracket weight, kg</td>
<td></td>
<td>~ 39</td>
<td>~ 19</td>
</tr>
<tr>
<td>Support tube, lb</td>
<td>Not applicable</td>
<td>103</td>
<td>59</td>
</tr>
<tr>
<td>Support tube weight, kg</td>
<td></td>
<td>45</td>
<td>27</td>
</tr>
<tr>
<td>Journal - M, inches</td>
<td>8.94</td>
<td>11.75</td>
<td>11.74 *</td>
</tr>
<tr>
<td>Journal – M, mm</td>
<td>227</td>
<td>298</td>
<td>298</td>
</tr>
<tr>
<td>Journal - P, inches</td>
<td>17.0</td>
<td>19.56</td>
<td>19.25 *</td>
</tr>
<tr>
<td>Journal – P, mm</td>
<td>432</td>
<td>497</td>
<td>489</td>
</tr>
</tbody>
</table>

* Can be reduced by ~ 1.0" (25 mm) if the wear plate and journal adapter flange are made as one piece. This would be a special offering.

Reduced Maintenance

- The potential for damage and wear due to vibration is significantly reduced by using the high natural frequency and stiffness of the PTX system.

- The syphon shoe is attached with a double-cut, double-bolted joint. This has been proven in numerous commercial installations to prevent slipping. Competitive setscrew systems are known to fail.

- The PTX joint has the same very long seal life as the traditional Kadant Johnson PT joint. Kadant Johnson knows of original PT seal rings installed in 1992 that are still in operation today!

- The standard terms and conditions for sales of Kadant Johnson products covers materials and workmanship for one year. It excludes seal wear life. For PT/PTX sales, a guarantee of two years has been offered for the past several years. If a seal wear guarantee is required, this can be increased to three years. In competitive situations, if necessary this can be increased to five years. For these long periods of time, it should be clear...
that the guarantee is for the life of the seal ring, not for “leak-free operation” of the entire joint. Flex hose and insulating sleeve leaks are not part of this guarantee, nor are secondary seals (gaskets and o-rings).

Quality improvement

- The axial location of syphon shoe can be adjusted in the field by moving the vertical support for the bent syphon pipe assembly. The vertical support can be adjusted relative to the horizontal support tube over a range of 100 mm (+/- 50 mm from the design position). Precise location of the pick-up shoe ensures optimized condensate removal, clearance from balance weights on the dryer heads, minimum cantilever distances, correct position with respect to syphon grooves and dryer bars, and therefore optimized heat transfer.
- The cross-direction temperature profile is optimized within 1.7° to 2.8°C (3° to 5°F) variation when used with Kadant Johnson Turbulator bars. This results in improved cross-direction moisture profiles.
- The PTX joint and stationary syphon system maintains proper surface temperature of the dryer can with reduced steam usage. This reduces picking, edge consistency, cross-machine profile and many other runnability issues.

Teflon Tip Syphon Shoe Features / Benefits

- Investment cast stainless steel clamp pad resists erosion and corrosion
- One-piece Teflon tip securely mounted to clamp pad
- Converging entrance to syphon shoe improves flood recovery time and steady-state operation
- Large syphon tip opening improves condensate flow rate into syphon pipe
- Double-cut, double-bolt clamp secures syphon shoe in place
Operating Conditions

Maximum Conditions:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Up to 11 bar (160 psig)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Up to 232°C (450°F)</td>
</tr>
<tr>
<td>Speed</td>
<td>Up to 2500 mpm (8000 fpm), or up to 500 rpm</td>
</tr>
<tr>
<td>Service</td>
<td>Steam/condensate, water</td>
</tr>
</tbody>
</table>

Note: Superheat in the supply steam should be limited to 28°C (50°F).

Maximum limits vary in relation to changes in RPM, pressure, and temperature. Consult Kadant Johnson for safe limitations under specific application conditions.

Note: Kadant Johnson can drill the M and P flanges to match 300 lb (PN16 or PN40) flanged connections, however the Kadant Johnson PTX flange is rated for 160 psig (11 bar). No paper machinery dryers are coded for over 160 psig, but if a customer requires a joint rated for a higher pressure, the PT joint can be considered. Consult the factory if a PT-style joint is required to support design pressures above 160 psig.

Operating Principles

A PTX rotary joint connects stationary piping to a rotating cylinder. A cantilever stationary syphon pipe extends through the joint to drain the condensate from inside the cylinder and out through the rotary joint. The differential pressure between the steam pressure inside the cylinder and the backpressure at the outlet forces condensate out of the dryer along with some uncondensed steam (blow-through).

With stationary syphons, high differential pressures and blow-through rates are not needed to propel condensate up the syphon and out of the cylinder. Once the condensate enters a stationary syphon, it is no longer subjected to centrifugal forces. This is why stationary syphons can operate with low, or in some cases, no pressure differentials. This also means the amount of differential pressure required to evacuate condensate does not increase as rotational speed increases, as it does with rotary syphons.

Joint and Support Tube Sizing

The rotary joint size (9750 or 9800 PTX) is selected first on the basis of flow requirements, using the Kadant Johnson joint sizing program. The steam velocity is normally limited to around 10,000 fpm (40 mps). The syphon support tube diameter is then selected from a few standard diameters, with the selection based on the stiffness requirement for the particular application. The support tube may require that a larger PTX joint be used, even though the smaller joint size has adequate flow capacity.

The support tube must have a high enough stiffness so that adjacent felt rolls and dryers do not cause it to vibrate during operation. The stiffness that is required for the support tube depends on the intended machine operating speed, felt roll diameters, length of the support tube, and weight of the cantilevered components.
Selection charts have been prepared for initial sizing. A copy is included in this package. This initial sizing chart is for "high-tuned" applications (that is, the natural frequency of the support tube is greater than the rotational frequency of the dryer, felt roll, and 2x felt roll rpm).

A smaller diameter support tube can also be used ("low-tuned"), following review of the application by Kadant Johnson Engineering. Details of support tube sizing are included later in this NPI. The smaller diameter support tube (low-tuning) would be considered only when the dryer journal bore is too small for the larger tube.

The dryer journal should be at least 6 mm (0.25") larger than the support tube diameter. If an insulating sleeve is needed, the bore should be at least 25 mm (1") larger than the support tube diameter. If the journal bore is cored and not machined, more space should be allowed to account for possible core shift. The steam inlet flow area for the 9750 is the area between the support tube O.D. and the journal I.D.

The syphon support tube selection chart is also available in the Lotus Notes Product Development database and the Your Account (members section) – Global Marketing Beat web page on JOCO.com. If you do not have access to this database, contact Gayle Van Heukelum (gmvanheukelum@joco.com) for additional copies.

### Syphon Pipe Size

- The standard syphon pipe for the 9750 PTX joints is a 1-1/4" stainless steel pipe. This is the largest size that will be needed for a 9750 PTX.
- The 9750 PTX can accommodate a 1" pipe (not recommended by Joco, but it may be required by Voith).
- A 1-1/2" syphon pipe will not fit in the 9750 PTX. There are, however, no applications that would require such a large syphon in this size joint anyway.
- The standard syphon pipe for the 9800 PTX is also a 1-1/4" stainless steel pipe. This is the best size for virtually all applications.
- The 9800 PTX can also accommodate a 1-1/2" pipe, which might be needed for a few wet end dryers with very low pressures. This would be a special configuration, sold at a higher price with longer delivery.
- The 9800 PTX could also use a 2" pipe. This is not recommended by Joco, but it may be requested by Bruno Cavallini to handle the large blow-through flows that are used in his system designs.
- The 1-1/4" syphon is actually not a pipe, but rather a 1.75" OD tube. The tube has an OD between the 1-1/4" and a 1-1/2" pipe. The ID of the tube, however, is the same as a 1-1/4" schedule 40 pipe. That is why it is called a 1-1/4" pipe.
- The Cv of the PTX is actually higher with the 1-1/4" syphon pipe than it was with the old PT design with the 1-1/2" syphon pipe.
- Kadant Johnson sizes orifice plates for the condensate pipes to provide the required amount of blow-through. This allows the flow resistance to be tailored for each dryer rather than selecting just one pipe size as a compromise between high blow-through and low blow-through dryers.
- The Teflon tip syphon shoe is available in sizes 1", 1-1/4" and 1-1/2". “Handed” shoes are available in both 1-1/4" and 1-1/2" sizes.

### Installation

Basic installation instructions are provided on customer-specific LE drawings. For an example, refer to drawing LE1644 (9750PTX) or LE1646 (9800PTX). Generic detailed installation instructions are also available. Kadant Johnson field personnel should supervise initial installations. This service offering can be included as part of the joint and syphon proposals.
Variations in dryer dimensions can make it difficult to install conventional Cantilever Stationary Syphons. These potential problems were considered and addressed in the development of the new PTX syphon. Following is a list of the features that have been incorporated into the design of the PTX to assist with installation:

- Rather than simply use extra-long support tubes, there are a few standard lengths to choose from, with the ability to adjust the position of the syphon during installation. The axial adjustment is +/- 50 mm.

- There are four "standard" support tube lengths. These can be manufactured and inventoried in advance. One of these standard lengths would be selected for each order. Based on the Kadant Johnson order history (several thousand units), these standard lengths should cover most of our orders.

- Where none of these standard lengths can be used, the support tubes could be machined specifically for that order, or the end of pre-manufactured support tubes could be cut to the required lengths. This is being done in Europe, to reduce the amount of machining required for a given order.

- The shortest possible support tube length should be selected for each application, based on the best knowledge of the dryer dimensions. The support tube diameter (9750 or 9800) is then selected, to provide a high enough natural frequency to run at the machine design / operating conditions.

- Support tubes may be longer than what is required to clear the dryer head balance weights, for example, for low tuning. In most cases however, it is preferred to achieve the highest possible natural frequency. This will safely avoid resonant vibrations caused by the dryer and felt roll rotational frequencies and the condensate vortex-shedding frequencies. The natural frequency is highly dependent on the length of the support tube (to the fourth power). A short support tube greatly contributes to achieving a high natural frequency.

- When the syphon is installed, the syphon shoe is positioned inside the dryer, using the axial adjustment range of 100 mm (+/- 50 mm from the nominal position). This large adjustment range is intended to accommodate variations in the positions of the syphon groove or extra-large balance weights. This range of adjustment should greatly improve the ease of syphon installation.

- The large range of axial adjustment can be used during installation to maximize the natural frequency by adjusting the position of the syphon to be as close as possible to the dryer head, to give us an extra margin of safety (higher natural frequency). This is better than designing the syphon so that it is always a large enough distance from the dryer head, trying to accommodate every possible groove position, balance weight size, or journal length variation. The clearance to balance weights should be around 25 mm (1").

The target market for the PTX joint and stationary syphon system is the Paper Industry, for dryers that are running at rimming condensate speeds, particularly those running at high-speeds. The stationary syphons are also helpful in improving the stability of marginal steam and condensate systems. A combined sale of the PTX and steam system upgrades provides a unique market opportunity for Kadant Johnson. Competitive designs are now 10-15 years old, without the features of the PTX. Example applications include:
- Increasing paper machine speed past capability of rotating syphons
- Installing a new high-speed paper machine
- Improving cross-direction moisture profile
- Improving heat transfer to reduce steam pressure and improve paper quality
- Redesigning steam system for reduced steam usage and energy efficiency
- Customer is unhappy with lack of support or high parts prices for their existing joints and syphons (for example, Metso / Beloit CS series rotary joints and Voith joints), and does not wish to maintain existing CS joints with either a Kadant Johnson Beloit CS Upgrade Kits or with expensive OEM parts.
- Customer wants to perform less maintenance than required by their existing joints and syphons.
Unique Selling Proposition

The Kadant Johnson PTX rotary joint and stationary syphon system has a long life, high reliability, and the best operating performance of any joint and syphon system available in the market. Kadant Johnson backs this up with the most knowledgeable and most experienced engineering and service support in the world, and these services are available worldwide.

Selling Strategy

Production Supervisors - focus on:

• PTX vs. PT
  ➢ Increased flow area through joint
  ➢ Ease of installation; less downtime required
  ➢ Adjustability of syphon shoe location both axially and vertically

• PTX vs. Competition
  ➢ Increased stiffness, designed to avoid machine-induced vibrations
  ➢ Accommodates thermal expansion of dryers mounted on floating bearings, such as CARB bearings
  ➢ Accommodates run-out and angular misalignment
  ➢ Adjustable positioning of syphon shoe facilitates proper installations
  ➢ Syphon pick-up shoe material sacrificed in unlikely event shoe contacts dryer shell

• PTX vs. Rotary Syphon
  ➢ Eliminates dryer flooding during operation; easy recovery of a flooded dryer
  ➢ Reduced blow-through reduces load on steam system
  ➢ Higher heat transfer rate
  ➢ Improved runnability
  ➢ Joint may be run dry
  ➢ Very long seal life

• Integration with complete Systems offerings. Only Kadant Johnson can offer a complete system, including joints, syphons, system design, and control. Specific operational results can be guaranteed if required by the customer.
  ➢ Thermocompressor sizing should be reviewed
  ➢ Pipe sizes and separator station sizing should be reviewed
  ➢ Control system should be evaluated
Sales Strategy

Maintenance Supervisors - focus on:

- Lighter weight - installation and maintenance work is much easier, and therefore faster and safer
- Accommodates run-out and up to 18° of angular misalignment of the seal
- Accommodates up to 20 mm thermal expansion (for CARB bearings)
- Syphon adjustment for precise placement of pick-up shoe in the dryer
- Minimal maintenance is required – when necessary, seal replacement is easily done while the joint is mounted on the machine
- The syphon pipe and shoe clamp pad is stainless steel, to avoid erosion
- Straight or angled pickup shoes are available. The straight shoe is recommended. It is not "handed" and can be used in either clockwise or counter-clockwise dryer rotation.

Cross-selling Opportunities

Kadant Johnson Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration. PTX sales should always include appropriate elements of the Kadant Johnson Systems steam systems offerings. This includes dryer surveys, estimation of drying rate improvements, steam system reviews, installation services, Turbulator bar sales, thermocompressor sizing and sales, and Vortec vacuum generators.

Turbulator bars are strongly suggested for high-speed drying applications (any dryer that operates above rimming speed).

When the Kadant Johnson Service and Technical Centers are involved in the projects, Kadant Johnson can offer the following bundling opportunities for the PTX joint and stationary syphon system:

1. Complete seal life and maintenance improvement estimations and guarantees
2. Review existing steam and condensate systems (valves, thermocompressors, separator tanks)
3. Review / develop justification for the purchase of Turbulator bars (if applicable)
4. Installation services
5. Replacement bearing covers (engineering and manufacture)
6. Prepare assembly drawings for future mill / Kadant Johnson reference
7. Provide on-going service and sales support (through network of reps and direct sales force)
8. Conduct R&D testing of Kadant Johnson and competitive configurations
9. Conduct audit for future machine production limitations
10. Establish blow-through correlations for system design
11. Establish the optimum syphon clearances (consistent with the installed bar configuration)
Precluding Sales Objections

Kadant Johnson Sales should attempt to sell the positive features and benefits of the Kadant Johnson products, not the negative features of competitive products.

One of the Kadant Johnson competitors (Deublin) has been negative-selling its products in North America. Rather than counter these sales tactics with similar negative selling, Kadant Johnson Sales should attempt to identify the negative selling strategies used by its competitors and address these items before the customers ask questions on them. That is, Kadant Johnson Sales should present its products, focusing on the positive aspects of the features that the competitors are using for negative selling. This precludes the objections to sales and keeps the presentation properly focused.

Listed below are some of the negative comments that our competitors have made. Also listed are statements that can be made during the course of a product presentation to avoid questions on these aspects.

1. Competitive comment: The Kadant Johnson rotary joint and stationary syphon are very heavy and hard to install, compared to the Deublin unions.
   The Kadant Johnson PTX rotary joint and syphon have been designed from the beginning to make the best use of all the material and strength, to reduce the weight and at the same time increase the stiffness of the assembly. The result is a joint and syphon that are low in weight, are easy to install, and have the highest natural frequency in the industry.

2. Competitive comment: The Kadant Johnson rotary joint does not look as nice as the Deublin FS joint.
   This argument is subjective, so presenting the Kadant Johnson PTX joint and syphon with colorful 3-D drawings easily diffuses it. Include in the presentation a comment that the shape and lines of the rotary joint not only enhance the stiffness but also the appearance of the product. Focus on the conical shape of the joint body, the streamlined head, the tapered syphon support tube and the innovative vertical support bracket design. They are all distinguishing features that the competitors do not provide.

3. Competitive comment: Kadant Johnson syphons have experienced a number of failures when the syphon shoe slips or rotates at the end of the vertical syphon pipe.
   The heart of the dryer performance rests with this shoe and the way it behaves with the Turbulator bars. It is important that the syphon clearance is set correctly and accurately and that this clearance not change after the dryer is closed up. Many shoes on the market today are difficult to set up and have been known to slip during operation. Even some of the early Kadant Johnson shoes had this problem.

   The current design, however, has a number of unique features that have overcome these problems, making it the most successful design in the industry: This shoe has a two-bolt clamping system with a special split collar. The syphon clearance can be easily set by lowering it onto the set-up shim, tightening the two bolts, and removing the set-up shim.

   Note: The positive clamping can be demonstrated by giving the customer a Kadant Johnson shoe, stub end of a vertical pipe, and a ratchet. It is only necessary to barely tighten the two hex head bolts and the shoe is positively clamped to the pipe.
4. Competitive comment: Kadant Johnson has long and unreliable deliveries. Any order to Kadant Johnson should have a delivery penalty.

The standard delivery from Kadant Johnson is 8-10 weeks. Expedited deliveries are also possible, if needed for the project. Expedited delivery is possible, because Kadant Johnson has a dedicated ductile iron foundry in NA (Specialty Castings), located close to its manufacturing center in southern Michigan. This foundry is able to provide new bearing housing covers, ring brackets, and PTX bodies faster than any other supplier. Kadant Johnson Europe has all standard PTX components in stock, for expedited delivery, with only custom parts required to be machined-to-order.

5. Competitive comment: Kadant Johnson has copied the Deublin design.

Kadant Johnson designed the PTX syphon using the proprietary Kadant Johnson PT technology and incorporated all of the latest advancements in product design. Every drawing at Kadant Johnson is made as a solid model. All components are assembled as 3-D computer models, to ensure that there are no interferences. These models are also coupled to a state-of-the-art Finite Element Analysis (FEA) program, to insure that the product meets all of the Kadant Johnson design criteria and makes effective use of the available materials. No other supplier of joint and syphons goes through this much detail in developing their products. The visibly obvious differences include the cast vertical support for the syphon, the PTX seal package, the conical joint body shape, compact and streamlined head, the tapered support tube and the Teflon pick up shoe.

6. Competitive comment: Kadant Johnson has had a number of problems with their stationary syphons vibrating and failing.

Kadant Johnson has learned through R&D testing, engineering analysis, and field experience that there are a number of important considerations in determining the required natural frequency of the cantilevered syphon assembly. Most suppliers only look at the rotational frequency of the dryers. Kadant Johnson, however, also looks at the rotational frequencies of the adjacent felt rolls. On many machines, particularly those that have been increased in speed, it is the “half-critical” of the felt rolls that causes the most serious vibrations. Kadant Johnson has also found that the shedding of vortices in condensate that hit the syphon shoe can induce vibrations. All of these factors are considered in selecting the stiffness of a Kadant Johnson stationary syphon to achieve the required natural frequency. Kadant Johnson has more than 10,000 stationary syphons in operation around the world. None of these have experienced problems with vibrations when they meet the Kadant Johnson criteria. The more stringent design criteria used by Kadant Johnson may, in some cases, require a larger diameter support tube than offered by its competitors.

8. Competitive comment: Deublin has presented references of Kadant Johnson installations where there have been problems.

Kadant Johnson Sales should be aware that Deublin has also experienced a large number of failures. The number of failures is lower, due to their lower market share. Kadant Johnson Sales should be aware of these installations, but not resort to similar negative selling tactics.

If you become aware of other negative selling strategies used by our competitors, please send the information to Kadant Johnson Global Marketing, to be shared with the rest of the Kadant Johnson organization.
Sales Strategy

Sales Collateral / Reference Material

Bulletins / Brochures

PTX Joint flyer
PTX Stationary Syphon flyer – CSSFlyer
PTX Joint brochure

Presentation Materials

PowerPoint Presentation – “PTX Joint & Stationary Syphon System”
PowerPoint Presentation – “New Developments in Steam Joint and Syphon Technologies”
Inside the Dryer Video – Cantilever Stationary Syphon with Turbulator Bars plus five other segments.
Vibration Simulation video clip showing vibration at various natural frequencies
Deublin FS syphon vibration video clip

Product Models

Twelve models have been distributed to Kadant Johnson locations worldwide for demonstrating the PTX Joint & Stationary Syphon System to customers. These are available from the Kadant Johnson sites for sales demonstrations, customer training, and trade shows. They are a very effective selling tool.

Customer Reference Materials

Reference List – A copy of the current reference list for North America and Europe, for both the PT and the PTX installations can be downloaded from the Intranet. For more information about any specific customer, contact the Kadant Johnson Regional Sales Manager responsible for the account.

Instructions – Installation instructions and Disassembly and Repair instructions are available for order or for download from the Intranet.

A technical paper titled “Vibration Characteristics in Cantilever Stationary Syphons” is available to present R&D studies on vibration and stationary syphons. This paper is available online in the Members section or from Global Marketing.

Mill application / case study article reprints from major trade publications available from Global Marketing.

Customer Proposals

A standard customizable customer proposal notebook with collateral materials and introduction letter is available from Global Marketing. A template document is available for download from the Intranet.
Primary competition for the PTX rotary joint and syphon system is the Deublin FS series rotary joint and syphon system. Metso and Voith provide their own joint and syphons, typically as part of a new machine or major machine rebuild. Customers with Beloit CS series joints are facing enormous price increases for spare parts from Metso, and are likely to be ready to switch to another joint and syphon system or to purchase the Kadant Johnson Beloit CS Upgrade Kit. Further information on competitive products is presented later in this NPI.

**Feature / Function / Benefit Comparison**

<table>
<thead>
<tr>
<th>Feature / Function</th>
<th>Deublin FS</th>
<th>Kadant Johnson PTX</th>
<th>Valmet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sizes</strong></td>
<td>4&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Some components require two persons</td>
<td>All components easily handled by one person</td>
<td>Some components require two persons</td>
</tr>
<tr>
<td><strong>Maximum speed</strong></td>
<td>400 rpm</td>
<td>500 rpm</td>
<td>400 rpm</td>
</tr>
<tr>
<td><strong>Maximum Operating Pressure</strong></td>
<td>150 psig (10 bar)</td>
<td>160 psig (11 bar)</td>
<td>150 psig (10 bar)</td>
</tr>
<tr>
<td><strong>Maximum Operating Temperature</strong></td>
<td>366°F (186°C)</td>
<td>450°F (232°C)</td>
<td>366°F (186°C)</td>
</tr>
<tr>
<td><strong>Minimum differential pressure</strong></td>
<td>2 to 4 psig (0.14 to 0.3 bar)</td>
<td>2 to 4 psig (0.14 to 0.3 bar)</td>
<td>2 to 4 psig (0.14 to 0.3 bar)</td>
</tr>
<tr>
<td><strong>Steam flow and condensing rate calculations to determine proper flow rates and equipment size</strong></td>
<td>Sometimes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pre-design analysis of syphon and cylinder frequencies</strong></td>
<td>No</td>
<td>Yes</td>
<td>Generally Not</td>
</tr>
<tr>
<td><strong>Accommodates misalignment</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Seal Ring</strong></td>
<td>Flat face, balanced, in tension</td>
<td>Convex, balanced, in compression</td>
<td>Flat face, balanced, in tension</td>
</tr>
<tr>
<td><strong>External Seal Ring Wear Indicator</strong></td>
<td>No</td>
<td>Yes</td>
<td>Bracket has observation holes</td>
</tr>
<tr>
<td><strong>Syphon pick-up shoe material</strong></td>
<td>Stainless Steel (Ductile iron option)</td>
<td>Teflon (optional Ductile Iron)</td>
<td>Cast steel or cast iron</td>
</tr>
<tr>
<td><strong>Pick-up shoe placed under support for positioning close to dryer head</strong></td>
<td>60° configuration</td>
<td>Straight shoe (standard) 60° shoe (optional)</td>
<td>Straight shoe</td>
</tr>
<tr>
<td><strong>Hydroplaning pick-up shoe</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Research testing and product demonstration</strong></td>
<td>None</td>
<td>Yes - Accurate assessment of dryer improvements</td>
<td>Very limited</td>
</tr>
<tr>
<td><strong>Installation and maintenance training available onsite</strong></td>
<td>Very limited</td>
<td>Yes</td>
<td>Limited to major orders</td>
</tr>
</tbody>
</table>
Kadant Johnson PTX vs. Deublin FS Series

- Kadant Johnson can determine all blow-through and operating differential pressures directly from controlled R&D tests and field studies. Kadant Johnson does not rely on field measurements to know the performance of its equipment in customer applications. Deublin does not have an R&D center for testing and evaluating its joints. It relies on field trials and often under-sizes its joints and syphons.

- Flow areas through the Kadant Johnson PTX joint are the highest of any competitive joint. The flow areas for equivalent sizes are inherently larger with the Kadant Johnson PTX. Note: Deublin has recently copied Kadant Johnson’s design that utilizes the flow area around the outside of the support tube as well as the annular area between the support tube and the horizontal pipe.

- The design of the Kadant Johnson PTX syphon shoe connection has been proven in numerous commercial installations to prevent slipping. Deublin continues to use two setscrews to hold the shoe in place. These do not prevent slipping and rotation. Deublin’s design is more likely to fail due to excessive vibration, resulting in shoe contact with the dryer shell.

- The Kadant Johnson stationary syphon shoe is made from Teflon with a stainless steel clamping pad. In the (unlikely) event that the shoe contacts the rotating dryer shell, the Kadant Johnson shoe will become a sacrificial material to minimize damage to the dryer shell. The Deublin shoe is stainless steel. It will cut a groove in the dryer shell when the shoe contacts the shell.

- The Kadant Johnson PTX seal ring design can accommodate both run-out and angular misalignment. The Deublin joint must be very carefully aligned, because it can accommodate only a limited amount of run-out and no angular misalignment. Since backside as well as front-side bearing housings tend to tip in the cross-machine direction in operation, there must be some allowance for angular misalignment. When this happens, the seal plate in the Deublin FS joint must "cock". This puts severe demands on its cup seal (the most critical elastomeric seal), often beyond its limits of flexibility. This deficiency was a severe problem with Beloit CS joints, and is a limitation on the life of the Deublin joint as well.

- The Kadant Johnson seal ring has been designed to operate under compression. The steam pressure and nipple face compresses the seal ring against the concave surface of the wear plate. By comparison, the Deublin seal ring is under tension, relying on the tensile strength of the carbon to withstand the steam pressure forces.

- The Deublin FS joint is not able to run dry at high speed. Deublin has been forced to develop a seal unloading mechanism in order to avoid excessive seal wear if the dryer must run without steam. There are several questions relating to the use of the Deublin seal unloading system:

  - Will the papermakers actually use it?
  - Will they remember to turn off the unloading mechanism before they pressurize the dryer again?
  - If the mechanism is not turned off, steam will blow out, with the risk of injury to any mill personnel.
  - Does the operator have to be close to the joint to activate the unloading mechanism?
  - If the dryer is under pressure, will injury result if the seal is unloaded?
  - What is the cost of a pneumatic seal unloading option, how much extra does it cost and how long will the cylinders last?

> Conclusion: It would be better to use a rotary joint that can handle dry running operation. The patented PT/PTX seal package doesn't require this "band-aid" approach because the seal design is much more robust than Deublin's. The Kadant Johnson PTX seals will provide excellent life without having an unloading mechanism.
• The weight of the Kadant Johnson cantilever PTX syphon has been reduced. One person can easily handle each of the components / assemblies during installation. The stiffness, however, has not been compromised. The excess weight from non-load bearing components has been removed and the remaining material optimized. Each of the major components (elbows, brackets, and body) has been streamlined, not only for weight reduction but also for appearance. By comparison, the Deublin FS joint of the same size is much heavier.

• The appearance of a product (good or bad) is subjective. Because customers have expressed that competitive systems “look” like they work better and look like nicer on initial installation, the PTX should be presented as a smooth, well-designed product. This plants the perception of a nice appearance, to set the standard for the competition. Some of the appearance aspects are:
  ➢ The PTX head / elbow has a smooth contour. Compare this to the Deublin joint with its rather “clunky” looking design with its sight flow indicators. The Deublin sight flow ports add weight and maintenance. They do not show the condensate flow because they are located at the bend in the elbow. In the PTX elbow, the tapped port for checking outlet pressure is outside the flow. Deublin has placed their port directly in line with the impinging condensate. This will surely give a false indication of pressure differential.
  ➢ The PTX body has a tapered contour, from its face to the outlet elbow. The Deublin FS body still has the shape of a round pipe, which is also an inefficient use of material.

• The PTX joint has been designed to meet all of the demands of the paper industry. It can not only handle high pressures, high speeds, and misalignment, but also accommodate the thermal expansion of the dryer journal, even when used on the front side of large paper machines that have CARB or other similar floating bearings. The Deublin FS joint does not have this capability.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Kadant Johnson PTX Joints</th>
<th>Deublin FS Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal design</td>
<td>Spherical face</td>
<td>Flat face</td>
</tr>
<tr>
<td>Misalignment capability</td>
<td>x-y-z and angular</td>
<td>x-y and z</td>
</tr>
<tr>
<td>Angular misalignment</td>
<td>18°</td>
<td>None</td>
</tr>
<tr>
<td>Seal wear range</td>
<td>0.438”</td>
<td>0.384”</td>
</tr>
<tr>
<td>Thermal expansion</td>
<td>20 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td>Seal material</td>
<td>Antimony</td>
<td>Carbon graphite</td>
</tr>
<tr>
<td>Sight flow indicator options</td>
<td>4” glass in head or separate sight flow</td>
<td>2” glass in head</td>
</tr>
<tr>
<td>Shims adjusting seal clearance</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td>Body and head materials</td>
<td>Ductile iron</td>
<td>?</td>
</tr>
<tr>
<td>Body configuration</td>
<td>Conical shape</td>
<td>Cylindrical shape</td>
</tr>
<tr>
<td>Internal steam ports</td>
<td>Tapered oval holes</td>
<td>Drilled holes</td>
</tr>
<tr>
<td>Ring bracket</td>
<td>One-piece, 360°</td>
<td>Fabricated, 360°</td>
</tr>
<tr>
<td>Support tube</td>
<td>Tapered tube</td>
<td>Pipe</td>
</tr>
<tr>
<td>Support tube mounting</td>
<td>Hollow bolt</td>
<td>4 fasteners</td>
</tr>
<tr>
<td>Vertical support material</td>
<td>Single-piece cast</td>
<td>Welded mild steel</td>
</tr>
<tr>
<td>Vertical support adjustment</td>
<td>4” range</td>
<td>None</td>
</tr>
<tr>
<td>Installation time / joint</td>
<td>2 hours</td>
<td>?</td>
</tr>
<tr>
<td>Installation cost</td>
<td>$25,000</td>
<td>$35,000</td>
</tr>
<tr>
<td>Syphon shoe construction</td>
<td>Teflon tipped</td>
<td>Cast iron</td>
</tr>
<tr>
<td>Syphon shoe mounting</td>
<td>Double-cut, 2 bolts</td>
<td>2 set screws</td>
</tr>
<tr>
<td>Flow sizing orifice plates</td>
<td>Included</td>
<td>None</td>
</tr>
<tr>
<td>Drying rate improvement</td>
<td>18% with Tube bars</td>
<td>No guarantee</td>
</tr>
<tr>
<td>Research demonstration</td>
<td>Available</td>
<td>None</td>
</tr>
<tr>
<td>Delivery</td>
<td>3 weeks</td>
<td>6-8 weeks</td>
</tr>
<tr>
<td>ISO 9001:2000 Certified</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Local service centers</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Kadant Johnson PTX vs. Metso

- The Metso joint has the same type of flat face seal that Deublin uses, and therefore has the same problems noted in the previous section.

- Older Metso designs used a 180° bracket instead of a full ring bracket. These brackets do not provide sufficient stability for the joint and syphon system. The latest design from Metso has corrected this problem.

- After a rebuild of the Metso joint, the dryer must be entered to reset syphon clearance. A Kadant Johnson PTX joint can be rebuilt and reassembled entirely from the outside of the dryer.

Seal Wear Stop

The PT joint had two (sometimes three) c-clips that acted as stops to prevent the nipple from contacting the metal surface of the wear plate if the seal ring wears out. These clips prevented metal-to-metal contact. The Deublin FS joint and the Beloit CS joint also had similar stop mechanisms. None of these stops, however, would prevent contact if the joint was used on a machine with CARB bearings.

There is no provision on the PTX joint for a stop to keep the nipple from hitting the wear plate. The reason is the PTX was designed to accommodate a large amount of variability for the set up dimension as well as the thermal expansion of dryer journals with CARB bearings.

The new PTX allows +/- 6 mm (+/- 0.25") for bracket or journal length variations, PLUS an additional 15 mm (0.6") of thermal expansion allowance, PLUS 11 mm seal wear allowance (12.5 mm with the 9800PTX). With this much flexibility, the initial position of the piston can vary by more than the seal wear thickness. A positive "stop" could be placed on the piston and set to the to the correct position after the joint is installed, but this method would not work for any application that has journal expansion (CARB bearings). The Deublin FS joint does not work with journal expansion at all, unless a special version of the joint is purchased.

The PTX does have a small tab that acts as a seal wear indicator on the nipple to signal when the seal ring is worn out. This tab will do a sufficient job of keeping the nipple from hitting the wear plate because once it hits it will take some of the load off the seal. The seal wear will slow down a bit and the squealing noise from the tab will alert the operators that it is time to replace the seal. The seal life is so long on the PTX joint that the mill will have more than enough time to replace the seal before the nipple touches the wear plate.

Note that the PTX seal life far surpasses what the life observed for the Deublin FS joint in field service. It may be that Deublin must have a solid stop because they need it! The Kadant Johnson PTX wear tab could be presented as a "positive stop" for the piston, although it will eventually wear down. If the mill allows the PTX to run for a very long time after the wear tab contacts the plate, it would wear enough to let the nipple contact wear plate. This would take at least six months to happen.

Deublin should not be allowed to present the lack of flexibility of the FS joint as a positive feature and the "lack" of a positive stop for the Kadant Johnson PTX as a negative feature. The PTX can accommodate more journal length variation, more bracket length variation, more dryer journal thermal expansion, and more seal wear than any rotary joint on the market. This is a very positive feature. One that Deublin cannot match.

With CARB bearings, it is fundamental that the distance from the journal flange to the body flange can vary more than the seal wear allowance, particularly with wide dryers operating at high dryer steam pressures. For these cases, simple stops cannot be used to limit piston travel (like the old PT, Beloit CS, and Deublin FS joints). If a customer does not want all of this flexibility, and if the PTX does NOT have to allow for CARB bearings or bracket / journal length variations, it is possible to provide simple stops, just like the PT, CS, and FS joints. Such stops have not yet been offered. It is expected, however, that most customers will want the added flexibility of the PTX joint. So the PTX joint has been designed to have very long seal life, long seal wear, and an external seal wear indicator.
Professional Services

One of the most effective ways to sell rotary joints and associated components is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the rotary joint and stationary syphon for the specific application.

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

General Customer Availability

<p>| | |</p>
<table>
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<tr>
<td>Ready for Order:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

Lead Time

For standard quotations, the Regional Sales Manager must enter the proposed delivery. There are no default times. Quotations should include the following statements:

- Delivery is typically 6 to 8 weeks from receipt of Purchase Order
- Delivery is subject to acceptance of PO by Kadant Johnson, based on prior order commitments
- Delivery is subject to timely confirmation of dimensional information
- Expedited delivery is available upon request

Additional detailed lead-time information is available in the Visual ERP system.

Pricing

Current list pricing should be obtained from the Kadant Johnson Visual ERP system. Capital projects that include joints and syphons are generally subject to negotiation, both with the OEM suppliers and with paper mills. Current prices in NA range from $3,500 to $6,500 depending on the quantity ordered, whether bearing housing covers are required, whether the joints have sight flow heads, and whether insulating sleeves are required.

Note: Dryer bearing covers, journal insulating sleeves, and Turbulator bars are not included in the standard system list price.

Required Information to Place an Order

To begin engineering for a PTX Joint & Stationary Syphon System, the following drawing sheets must be completed and provided to the factory with the order:

- A41650 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 1 of 3
- A41651 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 2 of 3
- AB7385 Field Measurements for Design of Stationary Cantilever Syphon, Sheet 3 of 3

A copy of each sheet is included with the initial printed distribution of this new product introduction.
General Questions

1. What types of syphons do Kadant Johnson offer?

Stationary and rotating. A cantilevered support tube connected to a rigid rotary joint supports stationary syphons. Stationary syphons do not rotate with the dryer. Rotating syphons are fixed to the dryer shell and rotate with the shell. Kadant Johnson introduced the original close-clearance rotary syphon and now also offers rigid stationary syphons.

2. When are stationary syphons applied?

Stationary syphons have a wide range of application. They are normally proposed on new paper machines and rebuilds, particularly rebuilds of high-speed machines.

3. When are rotary syphons applied?

If the customer requests rotating syphons, Kadant Johnson can provide them. The rotating syphons built by Kadant Johnson have the best performance in the industry and can be used with good efficiency up to 1220 mpm (4000 fpm). Above this speed, the operating differential pressure for rotary syphons become quite high. Rotary syphons perform well at low (non-rimming) speeds.

4. Who manufactures the stationary syphons for Kadant Johnson?

Kadant Johnson manufactures its own joints and syphons. Kadant Johnson sells these to customers in the pulp and paper industry through its direct sales force, in some situations through distributors, or through OEM suppliers.

5. What are insulating sleeves?

Insulating sleeves are cylindrical tubes that isolate the dryer journal from the steam and condensate following through the journal bore. A properly sealed insulating sleeve greatly reduces the heat transfer from the steam to the journal.

6. Are insulating sleeves required?

Kadant Johnson recommends that all dryers have insulation sleeves in the journals. Without sleeves, more heat is transferred to the lube oil and there is a higher risk of cracking the inner race of the dryer bearings. SKF, Beloit, and Voith have reported this. Beloit conducted tests at the Rockton Research Center in the early 1980’s, showing that even at low pressures, there was a significant increase in inner race temperature without sleeves.

It is possible to install syphons without sleeves without serious problems, at least on lower pressure dryers, but the mill must warm up the dryers at a slower rate. Rapid warm-ups can cause the journal to heat up before the inner race, expand at a faster rate than the bearing race, put stress on the race, and cause premature failure.

Note that the recommendation for insulating sleeves is not a competitive disadvantage -- regardless of whose syphons (rotating, stationary, Beloit, Voith, Valmet, Deublin, etc.), the same issue exists.

7. What if a dryer journal is not large enough for an insulating sleeve?

The best solution is to use in-place machining to bore the journals to a large enough diameter to accept the sleeves. There are various field service groups capable of doing this work. Kadant Johnson Services can coordinate this work, if requested.
8. What should be the difference in temperature between the steam and the dryer outside surface?

The difference between the steam and outside dryer surface temperatures is normally considered to be "acceptable" if it lies in the range of 22-33 °C (40-60 °F). This is not a bad benchmark, for most dryers, but is not an independent parameter. See TAPPI TIP 0404-39 ("Methods for measuring dryer surface temperature") for further information.

Kadant Johnson PTX Joint

1. What does "PT" stand for?

The PT joint is a “Piston Type” joint. The carbon seal ring seals against the end of this piston. The piston can move axially in the joint body (end cap) to facilitate installation, accommodate seal ring wear, and allow for thermal expansion of the journal. The piston travel of the PTX joint is much greater than any competitive joint. This is a distinct advantage.

2. Where did the “X” come from in “PTX”?

The PTX is also a Piston Type joint. The PTX is an enhancement of the original PT joint, to include a number of extra features, especially the extra-long piston travel.

3. What is the expected life of the PTX joint?

The PTX uses the same sealing system as the PT joint and is expected to have equal or longer life in commercial operation. The life depends primarily on the dryer speed and steam pressure. The PTX joint can be run dry, but this does tend to reduce the life of the seal ring. For most papermaking machines, the seal ring life will be in excess of five years, with reports of over 10 years in some cases.

4. How is the PTX joint mounted?

The PTX joint is mounted rigidly to the machine framework, typically with a ring bracket that extends from the face of the PTX joint to the bolt circle of the mating dryer bearing housing cover.

5. Is the PTX a single-flow or dual-flow joint?

The PTX can be supplied in either as a single flow or dual flow configuration.

6. Is the PTX joint mounted to the backside (drive side) or front side (tending side) of the paper machine?

The PTX joint can be used on either the front or backside of the dryer section. If the dryer has a dual-flow joint, it would be most common for the joint to be located on the backside of the machine. With single-flow joints, steam enters through one joint and condensate is evacuated through a joint on the other dryer journal. If the dryer has a single-flow, the condensate is generally removed through the front side journal.
Frequently Asked Questions

7. What are the main features of the PTX joint?

The main features of the PTX joint are:
- Handles wide range of misalignment:
  - Wear (seal) plate (x and y)
  - Piston (50 mm axial travel)
  - Seal ring (18° of angular misalignment)
- Pre-load springs (enhance sealing under vacuum conditions)
- Very long life of the seal ring (5 to 10 years)
- Very rigid mounting (separate ring bracket)
- Low installation weight (lowest in the industry)
- High stiffness (good utilization of material and weight)
- Stainless steel end cap (corrosion resistance)
- Conical body (rigid configuration)
- Tapered ports for steam flow (low flow resistance)
- External seal ring wear indication
- Single-flow or Dual-flow configurations

8. How many sizes of PTX joints are there?

There are two PTX joint sizes: 9750 and 9800.

9. How is the size of the PTX joint selected?

There are two selection criteria: For steam supply (in single-flow or dual-flow configurations), the flow velocity must be kept below specified limits, to minimize pressure loss and erosion. For condensate removal (in single-flow or dual-flow configurations), the diameter of the support tube must be large enough to avoid vibrations during operation.

10. How does the PTX joint handle misalignment?

The flat face on the seal ring accommodates journal run-out. The spherical face on the other side of the seal ring handles angular misalignment of up to 18° – more than what is possible by other limitations of the joint and syphon installation. The seal ring is loaded against the PTX piston. This piston can travel up to 45 mm in the axial direction.

11. Why is the weight of the seal package not included in the comparison of weights with competitive joints?

The weight of the seal package was not included in the weight of the PTX body because it can be installed before the body is installed. By comparison, the Deublin FS body and seal package must be installed all at the same time.
12. Were the support tube lengths the same in the comparison of support tube weight?

Yes, they were. In the comparison, the lengths of the support tubes were the same, and they were representative weights for the same application. Support tube weight is very important. The PT support tube was VERY heavy. It took two people to install one. The PTX tube is much lighter and one person can install it. Also, the reduced weight reduces the amplitude of the vibration, if the machine must pass through the natural frequency of the tube.

13. Is the weight of the ring bracket in the comparison of weights representative?

Yes, the ring bracket shown for the 9750 PTX is indeed representative of the potential, when the bracket is properly optimized, whether the bracket is fabricated or cast. Kadant Johnson has a program for engineering fabricated ring brackets, a family of optimized "standard" cast ring brackets has been prepared, to allow for fast delivery of low-cost brackets. The weight of a bracket that can be used for all applications is naturally higher (and more costly) than an optimized bracket, so Kadant Johnson has elected to optimize the design for the specific application (size of PTX joint, axial offset, and large ring diameter).

14. Is weight really a commercial issue?

Deublin has used weight as a sales feature of the FS joint. So weight is indeed a commercial issue. At least it was before the PTX joint was introduced. Now, the only time that this is an issue is when Kadant Johnson already has some PT joints on the machine and is offering PT joints to complete the machine. Then Deublin will once again highlight the lightweight aspects of their FS joint. Note: the heaviest component on the Deublin FS joint (the body with seal package) weighs more than the heaviest component of the PT joint.

15. Does the customer care about the weight of the bracket? It is only handled during installation.

The customer normally does not care about bracket weight, but it does have to be removed when the dryer bearings are replaced. In general, a lighter weight casting is also a lower cost casting.

16. Does the customer care about support tube stiffness?

The customers do care about machine vibration and subsequent equipment failures. The customer must be educated to realize that cantilever stationary syphons are also mechanical systems that can be damaged by excessive vibration. The PTX has a lower flow resistance and a higher natural frequency than its heavier weight counterpart. This is good for quality, durability, and maintenance.

PTX Cantilever Syphon

1. How is the PTX cantilever syphon attached to the PTX steam joint?

The horizontal syphon pipe passes through and is supported by a long support tube. This tube extends from the joint body, through the journal, to the inside of the dryer. A vertical support bracket that extends from the end of the support tube to the lower end of the vertical pipe supports the vertical syphon pipe.

2. How is the support tube clamped in the PTX body?

The support tube has a large-angle taper that mates with a similar taper in the PTX body. The PTX body has been designed to make this coupling particularly rigid, to further increase the natural frequency of the syphon assembly. The tube is pulled into the body with a hollow bolt. This bolt has been designed as a stretch-element, to prevent the fatigue failures associated with joints that have four small cap screws holding the tube in place.
3. Can the seal ring be replaced without opening the dryer?

Yes, the seal ring can be replaced without opening the dryer. This is quite easy when the PTX joint is used for single-flow or for dual-flow applications. In both cases, the joint is removed from the ring bracket. The seal ring cannot be replaced without removing the joint from the bracket.

4. What is the weight of the support tube?

The weight of the support tube depends on its length and diameter. The Kadant Johnson PTX support tube is tapered, to minimize weight and increase the natural frequency. Representative weights are:

- 9750AFYSCPTX 1.5 m (60" long) → 27 kg (59 lbs)
- 1.9 m (75" long) → 45 kg (98 lbs)

These weights are significantly lower (30-45%) than the previous design.

5. Why is weight significant?

All of the syphon and joint components are easier to install if they are lighter in weight. The reduced weight of the cantilevered components helps to increase the natural frequency of the syphon, to reduce the tendency for vibration, and to allow one person to lift the components into position.

6. What is the weight of the cast vertical support bracket?

The 9800PTX bracket weighs 24 lbs (11 Kg). The 9750PTX bracket weighs 16 lbs (7 Kg).

7. How is the size of the support tube determined?

The support tube diameter is based on the stiffness requirement for the particular application. The stiffness required depends on the intended machine operating speed, felt roll diameters, length of the support tube, and weight of the cantilevered components. Selection charts have been prepared for initial sizing.

8. What size dryer journal bore is required?

The dryer journal should be at least 6 mm (0.25") larger than the support tube diameter. If an insulating sleeve is needed, the bore should be at least 25 mm (1") larger than the support tube diameter. If the journal bore is cored and not machined, more space should be allowed to account for possible core shift. The steam inlet flow area for the 9750 is the area between the support tube O.D. and the journal I.D.

9. What happens if the dryer journal is not large enough for the support tube?

The best solution is to have the dryer journals bored to a larger diameter. This increases the cost and time required for the installation. An optional approach is to “low-tune” the syphon: Design the syphon such that the machine speed passes through the natural frequency of the syphon assembly as it is ramped up to its operating speed. Kadant Johnson Engineering can evaluate the application to see if this option can be offered.

10. Is the PTX syphon shoe “handed”?  

The standard vertical syphon pipe has two bends so that the same syphon shoe can be used in dryers that are rotating either clock-wise or counter-clock-wise. That is, the standard syphon shoes are not “handed”. 
11. Does the PTX require the use of “mini-bars” or “baby-bars”?

The narrow set of Turbulator bars is called Edge Control bars. They are not required, but are recommended. They are provided with the standard syphon shoe, to fill in the gap between the syphon and the flange of the dryer shell.

12. What is the purpose of these Edge Control bars?

Edge Control bars are used to control the edge temperature. Most dryer temperature uniformity problems occur at the edges. Although the combination of the Kadant Johnson stationary syphon, Turbulator bars, and Edge Control bars gives a very uniform heat transfer, there are occasions when the heat transfer rates must be tailored to the particular machine operation. If the dryer edges are hot, the Edge Control bars can be removed. If the dryer edges are cold, the syphon clearance can be adjusted to increase the rate of heat transfer. Dryers without Edge Control bars do not have this flexibility.

13. Can the PTX be used with dryers that do not have Edge Control bars?

Yes, the PTX vertical pipe can be provided with one bend, so that the syphon shoe extends all the way to the dryer shell flange, to the area that would normally have the dryer Edge Control bars. Right and left-handed shoes must be used with this configuration. The standard (straight) shoe can usually be located close enough to the dryer head to eliminate the need for Edge Control bars.

14. Have there been any problems with these syphon shoes coming loose?

There have been a number of installations where competitive syphon shoes have rotated or dropped. Even some of the earlier Kadant Johnson installations had this problem. Kadant Johnson no longer uses set screws to hold the syphon in place until it is clamped. Setscrews cannot be used reliably to hold the syphon in place, so the temporary set screw has been removed to insure that it cannot be left in place.

15. How does Kadant Johnson attach the syphon shoe to the vertical pipe?

The Kadant Johnson stationary syphon shoe is a two-piece cast assembly. The two-piece clamp uses two large cap screws to lock the syphon shoe in place. The force of the two cap screws goes directly into clamping the syphon, not into bending a split collar. There have been no failures of this design.

16. What is the material of the stationary syphon shoe (tip)?

The Kadant Johnson syphon shoe is Teflon. If the shoe contacts the dryer (when, for example, the front dryer bearing housing falls off of its rockers), the shoe will be worn down, rather than damage the dryer shell. A stainless steel shoe, on the other hand, would quickly cut a groove in the dryer shell.

17. How is the vertical support bracket mounted to the support tube?

The vertical support bracket is clamped with two bolts and a split collar. This approach is used for both the fabricated brackets and the cast brackets. In order to make this design reliable, the clamp must be precision bored to match the support tube. There is no locking pin for this clamp. It is designed to withstand the force of the condensate in a flooded dryer running at 2000 mpm (6500 fpm), without failure. A weld bead, however, is placed on top of the tube, to prevent rotation, even if the two bolts are not properly tightened.

18. Is there any reason to make this bracket adjustable?

The syphon must be positioned in the dryer to avoid balance weights, align with syphon grooves, and avoid excessive overhung loads on the rotary joint. The PTX cantilever syphon can be adjusted 100 mm (50 mm each way) to accommodate the normal variations between dryer cylinders.
19. What size vertical / horizontal syphon pipe is supplied with the PTX joint?

The standard vertical leg (syphon) size for the 9750PTX and 9800PTX is 1-1/4". The 9750PTX can be supplied with a 1" syphon on a special order basis. The 9800PTX can be supplied with a 1-1/2" syphon and 2" syphon on a special order basis. No other syphon sizes are available at this time. The cost and price of the syphon will be higher for any size other than 1-1/4", as those are only for special orders.

**Competition**

1. Who are the major competitors in the market segment?

The major competitors are Deublin, Metso, and Voith. Deublin has been quite aggressive in North American and Southern Europe. Metso shows sporadic levels of activities, but appears to be more focused on other product lines. Voith does not have a good product and generally competes only in the capital businesses (new machines and major rebuilds).

2. What product does Deublin offer?

Deublin offers the “FS” series steam joint and syphon. There are three sizes: FS100 (4” joint), FS125 (5” joint), and FS150 (6” joint). The FS100 and FS125 are the most common sizes.

3. What are the features of the Deublin FS joint?

The current design has a separate ring bracket, a flat-face “balanced” seal, an elbow with integral sight flow indicators, a blue painted body, a heavy support tube, a vertical pipe bracket, and a stainless steel shoe.

4. What are the recent enhancements of the Deublin joint?

The Sint Company (Italy) developed the FS joint. There has been very little enhancement of this joint over the past 15 years. The only major design change was the conversion from a single-piece joint body and ring bracket to a separate ring bracket (the single-piece unit was much too heavy to install and service).

5. Is Deublin still focusing its sales on differences in joint weight?

Deublin was previously selling their FS joint in competition with the Kadant Johnson PT joint by focusing on its lightweight, for ease of installation. Kadant Johnson developed the PTX joint to be much lighter in weight than the PT joint and also lighter in weight than the Deublin joint. And stiffer than both of them. Deublin has now reversed their selling strategy by focusing on the higher weight of the FS joint, with a presumed increase in durability.

The Kadant Johnson response: “If you want a heavy joint, we HAVE a heavy joint: The PT. It is much heavier than the FS joint. The real issue, however, is both weight and stiffness. Kadant Johnson has looked at every component on the PTX. The goal was not just to lighten it, but also to make sure that every ounce of weight was contributing to stiffness. The PTX has achieved both light weight and high stiffness.”

The PTX joint is much lighter in weight (have photos, tables of weights, etc comparing the PT with the PTX and with the FS). It is also much stiffer (have natural frequency data). And Kadant Johnson has the technology to know how stiff the joint has to be.

Demonstration: Put a Snap-On polished combination wrench on the table along with a PowerCraft (heavy junk). Which would you rather have? One of them (Snap-On) is much lighter than the other AND it is much stronger. You can pick the one that you want. If you are smart enough to pick Snap-On, you are the one who should make the decision on the rotary joint. (Incidentally, this wrench is one of the four that are needed to completely disassemble and reassemble the PTX joint...).
Frequently Asked Questions

Vibration Issues

All mechanical systems have a natural frequency. If a mechanical system is excited by a vibration that is close to (typically within 20% of) its natural frequency, the system will resonate. The resonance will have high amplitude if there is no system damping. Stationary cantilever syphons are very rigid and have little natural damping, so they are susceptible to resonant vibrations.

Vibration of a cantilever syphon can be induced by:

- Dryer rotational frequency (this is typically much lower than the tube frequency)
- Felt roll frequency (this is often close to the natural frequency of the tube)
- Felt roll half-critical (this often has the largest energy and is the most serious)
- Condensate vortex shedding (R&D tests provide guidelines for this frequency)

Other factors that influence syphon vibration are: Stiffness of the mounting (drive side or rocker mounted housings), felt roll imbalance, felt roll circumferential stiffness variations, and proximity of the felt rolls to the stationary syphon mounting.

Kadant Johnson has several equipment options to offer:

1. Supply a small diameter support tube. This will often require the machine to accelerate through and operate above the natural frequency of the support tube. This is the approach that is normally taken with dryers that have small journal bores. It has the lowest initial cost, but a higher risk of failure.

2. Supply a larger diameter support tube. This may require boring the dryer journal, running without an insulating sleeve (okay for < 75 psig), or reducing the length of the dryer journals (generally not an option). The tube should be large enough to insure that the machine will operate at least 20% below the natural frequency of the support tube. This is the best technical solution. It has the least risk and the highest installation cost.

3. Supply a support bushing on the inside of the dryer, either to limit the vibration of the tube or to support the syphon pipe. This option is normally limited to speeds less than 760 mpm (2500 fpm).

Suggested Approach for Selecting an Equipment Option:

1. Review with the mill the vibration charts, as outlined below, showing the natural frequencies and roll rotational frequencies.
2. Outline the three equipment options.
3. Recommend the larger support tubes as the best technical option.
4. Be prepared to offer the smaller support tube, to keep the cost of installation for the mill to a minimum, with these conditions:
   - Encourage the mill to install a trial joint to insure fit-up and operation
   - The machine should not be operated at speeds near the natural frequency
   - Condensate should be evacuated from the dryers before accelerating to speed
   - Propose the PTX joint (joints with cap screws retaining the syphon support tube in place, like the PT and Deublin FS125, tend to fail due to vibration. The PTX is very tolerant of vibrations)
   - Use Turbulator bars, to allow larger syphon clearances than with the other bars
   - Require approval of the bearing housing cover, to insure adequate support stiffness
   - Provide a bronze bushing as an amplitude limiter on the inside, if possible
Frequently Asked Questions

The above approach shows a strong technical position, establishes doubt on the Deublin joint, and avoids liability for subsequent vibration.

Some PTX applications will require a larger diameter cantilever support. Many factors influence the selection of the tube diameter: Operating machine speed, felt roll diameters, accuracy of roll balance, stiffness of the dryer framing, length of the support tube, diameter of the support tube, stiffness of the bracket and joint body, and the weight of the dryer syphon and its support.

These parameters combine to form a number of critical frequencies. It is possible to design a stationary syphon with its natural frequency above or below the critical frequencies, but it is generally best to be above them. This is called "high-tuning".

Screen potential applications using the attached set of curves. These are based on conservative sizing criteria. The chart covers the 9750 and 9800 PT joints.

Use the chart and the following directions to select the proper size support tube:

1. Calculate the Rotational Frequency, in \( \text{mpm (fpm) / mm (inch)} \), from the machine speed and felt roll diameter.
   \[
   \text{Rotational Frequency} = \left( \frac{\text{Machine speed, mpm (fpm)}}{\text{Smallest felt roll diameter, mm (inches)}} \right)
   \]
2. Find the length of the journal bore, in mm (inches).
   This is the length of the journal, measured from the outside to the inside of the journal (length of the bore). The charts reflect the fact that the horizontal support tube will be somewhat longer than this.
3. Find the support tube diameter from the attached chart, using the Rotational Frequency and the journal length.
4. Check to see if the dryer journal bore is large enough for this tube diameter.
5. Note: The bore must be at least 6 mm (0.25") larger than the support tube diameter. If an insulating sleeve is needed, the bore must be at least 25 mm (1") larger than the support tube diameter.
6. If the above calculations indicate that the existing journal bore is too small for the application, then consult the factory. The dryer journal may have to be bored to a larger diameter.

Example calculation:

**PT Stationary Syphon Sizing**

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<th>Design speed for the machine</th>
<th>914 mpm</th>
<th>3000 fpm</th>
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<tr>
<td>Smallest felt roll diameter</td>
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<td>20 inches</td>
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<tr>
<td>Rotational Frequency</td>
<td>(914 / 508) (\text{mpm/mm}) (3000 / 20) (\text{fpm/inch})</td>
<td></td>
</tr>
<tr>
<td>Dryer journal length</td>
<td>1016 mm</td>
<td>40 inches</td>
</tr>
<tr>
<td>Required Support Tube Dia.</td>
<td>95 mm</td>
<td>3.85 inches</td>
</tr>
<tr>
<td>Required journal bore</td>
<td>95 mm + 25 mm</td>
<td>3.85&quot; + 1.00&quot; (insulating sleeve is required)</td>
</tr>
<tr>
<td></td>
<td>120 mm</td>
<td>4.85&quot;</td>
</tr>
<tr>
<td>Existing journal bore</td>
<td>127 mm</td>
<td>5.0&quot;</td>
</tr>
</tbody>
</table>

Conclusion:
Apply a 9800 PTX joint.
The journal bore is large enough for this application.

The required horizontal support tube diameter may be slightly less than indicated by these charts, but Kadant Johnson Engineering must be contacted to look at the design specifications more closely.
Worksheet calculation:
PT Stationary Syphon Sizing

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<th>No.</th>
<th>Parameter</th>
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<td>Design speed for the machine (enter)</td>
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<td>mpm (fpm)</td>
</tr>
<tr>
<td>2</td>
<td>Smallest felt roll diameter (enter)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>3</td>
<td>Rotational Frequency (value 1 / value 2)</td>
<td></td>
<td>Mpm/mm (fpm/inch)</td>
</tr>
<tr>
<td>4</td>
<td>Dryer journal length (enter)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>5</td>
<td>Required support tube diameter (from chart)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>6</td>
<td>Required journal bore, if no insulating sleeve value 5 + 6 mm (0.25&quot;)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>7</td>
<td>Required journal bore, for insulating sleeve value 5 + 25 mm 1.0&quot;)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>8</td>
<td>Select PT size (select one)</td>
<td>9750</td>
<td>9800</td>
</tr>
<tr>
<td></td>
<td>(diameter &lt; 3.38&quot;)</td>
<td>(diameter &gt; 3&quot;)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Dryer journal bore (enter)</td>
<td></td>
<td>mm (inches)</td>
</tr>
<tr>
<td>10</td>
<td>Does dryer journal bore have to be increased?</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>
Appendix A – Selecting the Proper Size Support Tube

Required Support Tube Diameter

1) Find Rotational freq.
2) Find journal length.
3) Find support tube dia.
4) Find min. journal bore.

Rotational frequency = (machine speed, fpm) / (Smallest felt roll dia, inch)

Note: Minimum concentric journal bore must be 0.25" larger in diameter than support tube. If an insulating sleeve is required, the bore must be at least 1" larger than the required support tube dia. Consult factory with problems.
Appendix A – Selecting the Proper Size Support Tube

Required Support Tube Diameter

Rotational frequency = (machine speed, mpm)/(Smallest felt roll dia, mm)

Note: Minimum concentric journal bore must be 6mm larger in diameter than support tube. If an insulating sleeve is required, the bore must be at least 25 mm larger than the required support tube dia. Consult factory with problems.
Kadant Johnson Rotary Scoop Syphon

General Customer Availability:

<table>
<thead>
<tr>
<th>Ready for Order Date:</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready to Ship Date:</td>
<td>August 2002</td>
</tr>
</tbody>
</table>

The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
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<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
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</thead>
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<tr>
<td>A</td>
<td>22 July 2002</td>
<td>All</td>
<td>Original Issue</td>
</tr>
<tr>
<td>B</td>
<td>02 Aug 2004</td>
<td>3</td>
<td>Flange connection size update</td>
</tr>
<tr>
<td>C</td>
<td>30 Dec 2005</td>
<td>All</td>
<td>Update name to Kadant Johnson</td>
</tr>
</tbody>
</table>
Kadant Johnson has identified a market for rotary scoop syphons for slow-speed pulp and paper dryers, particularly in Asia and Europe. This newly designed rotary scoop syphon serves this market. This new scoop design incorporates the best features of all of the scoop syphons currently on the market.

This new rotary scoop syphon can be used in slow dryers with condensate in the ponding or the cascading stage. The scoop should not be used if the condensate is rimming. An SRS or HDRS conventional rotating syphon can be applied to applications with rimming condensate.

The scoop can be offered for new dryers or as a replacement for existing scoop and bent pipe syphons. The scoop syphon operates by accumulating condensate during its travel through the puddle near the bottom of the dryer. As rotation continues, the scoop mechanically lifts the condensate to the center pipe and discharges it out of the dryer, through the horizontal pipe. The rotation of the dryer, rather than differential pressure, provides the lifting force that removes the condensate. Scoops therefore are only applicable at low speeds where centrifugal forces are less than gravity. Blow-through steam is not essential to evacuate condensate with this configuration. A steam trap arrangement with sensitive air vents is adequate. A sensitive thermostatic air eliminator which vents at temperatures 3° C below steam saturation temperature will remove the air and non-condensable gases.

A simple blow-through system will give slightly better results. With all rotary scoop applications, a system review by Kadant Johnson Systems should be sold with the syphon equipment. The existing traps, for example, may have to be replaced with traps with either internal or external by-pass lines if the dryer speed is to be increased.

Symbol Numbers

<table>
<thead>
<tr>
<th>Symbol Numbers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>996.024/0001</td>
<td>Scoop Syphon for 1.2 meter (48”) diameter dryer (drawing H18760)</td>
</tr>
<tr>
<td>996.024/0002</td>
<td>Scoop Syphon for 1.5 meter (60”) diameter dryer (drawing H18673)</td>
</tr>
</tbody>
</table>

Item | Part Name               |
--- |-------------------------|
3   | Scoop elbow             |
5   | Bent pipe               |
6   | Vertical leg            |
7   | Adjusting tube          |
8   | Counterweight           |
9   | Spring                  |
10  | Hex nut                 |
11  | Washer                  |
12  | Pipe clamp              |
13  | Hex nut                 |
Application Summary

The following defines the applications for rotary scoop syphons:

- Non-rimming dryers (less than 200 mpm is best)
- Dryer diameters 1.2 or 1.5 m (standard configurations); 1.1 m (42”) also available
- Man hole access is required
- Steam system with steam traps (differential pressure control is required for SRS or HDRS syphons)
- Limited blow through capacity
- ¾", 1", and 1 ¼" DIN or ASA flanged connections available for horizontal pipe

Kadant Johnson R&D has tested the scoop syphon over a wide range of operating conditions. A detailed report on the results is pending. The application guidelines (speed and condensing rate) are summarized below in the Operating Conditions section of the NPI.

Unique Selling Proposition

Only Kadant Johnson can provide a rotary scoop syphon solution that integrates the syphon design with the complete steam system for paper drying applications. The Kadant Johnson Rotary Scoop Syphon is designed to be quickly and easily installed, and to provide exceptional quality and reliability in operation.

Customer Value

Following is a brief summary of the benefits of the Kadant Johnson Rotary Scoop Syphon.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel (AISI 304) scoop</td>
<td>Corrosion and erosion resistance, long operating life</td>
</tr>
<tr>
<td>Low clearance syphon gap</td>
<td>Minimizes blow through</td>
</tr>
<tr>
<td>No grinding of scoop required for 57” ID (high pressure 60° diameter dryer)</td>
<td>Optimal condensate evacuation with standard offering for common dryer size</td>
</tr>
<tr>
<td>Scoop can be ground to exactly match the dryer contour (option for smaller diameters)</td>
<td>Improves condensate evacuation</td>
</tr>
<tr>
<td>Syphon pipe exits back of scoop</td>
<td>Lower flow resistance</td>
</tr>
<tr>
<td>Stainless steel (AISI 304) piping</td>
<td>Corrosion and erosion resistance, long operating life</td>
</tr>
<tr>
<td>Reduced weight</td>
<td>Easier installation</td>
</tr>
<tr>
<td>Piping flexibility</td>
<td>The scoop can be used with different syphon pipe configurations</td>
</tr>
<tr>
<td>Pipe connection is 1” DIN and ASA flanged; also available in ¾” and 1¼” flange</td>
<td>Stable mounting, easy installation with flange connection</td>
</tr>
<tr>
<td>Heavy section walls (5 mm)</td>
<td>Improved durability</td>
</tr>
<tr>
<td>Mounting flexibility</td>
<td>The syphon can be bolted directly to the shell – most stable mounting, or held by a 1” straight-thread spring-loaded leg - easier installation</td>
</tr>
<tr>
<td>Stainless steel (AISI 304) spring</td>
<td>Corrosion and erosion resistance, long operating life</td>
</tr>
<tr>
<td>Range of dryer diameters are 1.1 m, 1.2 m and 1.5 m (42”, 48” and 60”)</td>
<td>Fits standard size dryer cylinders</td>
</tr>
<tr>
<td>Low puddle depth due to large capacity design</td>
<td>Reduced operating torque, reduced stresses on syphon</td>
</tr>
<tr>
<td>Internal Spider not required</td>
<td>Scoop is placed close to dryer head</td>
</tr>
</tbody>
</table>
Operating Conditions

Maximum Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Speed</td>
<td>up to 275 mpm (900 fpm)</td>
</tr>
<tr>
<td>Operational Speed</td>
<td>up to 200 mpm (660 fpm)</td>
</tr>
<tr>
<td>Service</td>
<td>steam/condensate</td>
</tr>
<tr>
<td>Flow Capacity</td>
<td>see Performance section below</td>
</tr>
</tbody>
</table>

Maximum limits vary in relation to changes in RPM, pressure, and temperature. Consult Kadant Johnson for safe limitations under specific application conditions.

Performance

For common applications (non-rimming condensate), the effective condensate residual puddle depth will depend on the condensing rate, steam pressure, dryer speed, and blow through flow (if any). In general, the puddle depth will increase with increasing condensing load and decrease with increasing machine speed.

The scoop is capable of evacuating a large amount of condensate, but above a certain point, the effective puddle depth becomes large, unless the unit is operated with a differential pressure (i.e. with blow through).

As a general guide, the scoop can be used effectively without blow through up to the evacuation capacity rating. The evacuation capacity rating is approximated by:

\[
\text{Evacuation Capacity} = \frac{S \times C \times \rho \times f}{\pi \times D}
\]

Where:

- \( S \) = Machine speed
- \( C \) = Scoop capacity
- \( \rho \) = Condensate density
- \( \pi \) = 3.1416
- \( D \) = Dryer inside diameter
- \( f \) = Scoop performance factor

Example:

- \( S = 150 \text{ mpm} \)
- \( C = 1.0 \text{ liter (0.001 m}^3\text{)} \)
- \( \rho = 935 \text{ kg/m}^3 \)
- \( D = 1.45 \text{ m} \)
- \( f = 0.82 \)

\[
\text{Evacuation Capacity} = \frac{(150 \text{ m/min}) \times (0.001 \text{ m}^3) \times (935 \text{ kg/m}^3) \times (0.82)}{(3.1416 \times 1.45\text{ m})} = 25 \text{ kg/min} = 1515 \text{ kg/hr (3340 lb/hr)}
\]
Installation

A manhole opening is required to install the unit. Installation is simple, and requires approximately 15 to 20 minutes per cylinder with the spring-loaded mounting.

1. Position the assembled syphon unit vertically at the approximate final location inside the dryer with the pick up shoe at the bottom (six-o-clock position). The flanged outlet of the elbow fitting should face the condensate outlet end of the dryer (toward the journal).

2. Place the flanged horizontal pipe inside the dryer. Insert the plain end through the journal and connect the flanged end to the scoop syphon flanged connection.

3. Check the location of the syphon, making sure that the horizontal pipe extends through the journal the proper distance for the rotary joint installation.

4. Turn the hex nut to compress the coil spring and to move the counter weight (similar to a pressure plate) up and into contact with the upper part of the dryer shell. Continue to turn the nut until it has reached the weld stop. Tighten the lock nut against the hex nut. The installation is complete.
**Sales Strategy**

Target customers for the Kadant Johnson Rotary Scoop Syphon:

- Older paper machines running at speeds of 200 mpm (660 fpm) or less. The scoop syphon can be used up to a maximum speed of 275 mpm (900 fpm) but the performance will diminish rapidly above 215 mpm (700 fpm). This is important because some target machines will have a lightweight grade that runs much faster than their typical grades. We would not want to eliminate this product if the machine only runs at higher speeds for a small portion of the time.

- During normal operation, condensate is in ponding or cascading stage
- Drying cylinders are:
  - 1.1 m (42") – be sure manhole exists, shorter support required
  - 1.2 m (48")
  - 1.5 m (60")
- Customer is using rotary joints with a rotating syphon pipe or bent pipe stationary syphons, or gravity-lock stationary syphon elbows

**Selling Strategy**

In talking to production supervisors, focus on:

- Reliability and long operating life
- Condensate evacuation capacity
- Performance relative to competition

In talking to maintenance supervisors, focus on:

- Heavy-duty construction
- Fast, easy installation
- Stainless steel construction

**Cross-selling Opportunities**

Kadant Johnson Sales must make every effort to add value to the transactions, in order to retain its position in the market as a complete source for systems and integration. This includes dryer surveys, estimation of drying rate improvements, installation services, and steam system reviews.

When the Kadant Johnson Service and Technical Centers are involved in a project, Kadant Johnson can offer the following bundling opportunities for Rotary Scoop Syphon:

1. Complete seal life and maintenance improvement estimations
2. Review existing steam and condensate systems (Liqui-Movers, valves, thermocompressors, separator tanks)
3. Installation services
4. Prepare assembly drawings for future mill / Kadant Johnson reference
5. Provide on-going service and sales support (through network of reps and direct sales force)
6. Conduct R&D testing of Kadant Johnson and competitive configurations
7. Conduct audit for future machine production limitations
8. Establish blow-through correlations for system design

Sales Collateral / Reference Material

Bulletins / Brochures

- Rotary Scoop Syphon Flyer
- Installation Instructions

Sales Presentations

- PowerPoint Presentation – Rotary Scoop Syphons (download from the Intranet at www.kadant.com)

Videotapes / CD

- Condensate Behavior – stationary camera
- Condensate Behavior – rotating camera
- Rotary Scoop Syphon (Video CD only)
Competition

The major competitors for the Rotary Scoop Syphon are Deublin, Rotary Foremost, Ahlstrom and local OEM manufacturers in Asia.

Deublin Ecosint

According to Deublin’s published literature, the Ecosint scoop syphon is designed for speeds up to 400 mpm (1300 fpm). Although in the next sentence Deublin claims the design is intended for condensate behaving between the ponding and initial rimming conditions. For ponding and cascading condensate, a special 180° discharge pipe is available and acts as a trap to reduce the amount of blow-through as the pickup shoe rotates outside the condensate puddle.

Testing in the Kadant Johnson R&D center shows that the JOCO scoop performs as well or better than any competitor’s scoop at any operating condition. Deublin’s scoop does not perform well above 275 mpm (900 fpm). None of the scoop syphons performed well above that speed.

Photos of the Deublin Ecosint are below.

![Deublin Ecosint Scoop Syphon](image1.png)

Kadant Johnson Scoop
Syphon in operation in the JOCO 4000 dryer.
Professional Services

One of the most effective ways to sell rotary joints and associated components is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of a Kadant Johnson Rotary Scoop syphon in slow speed drying applications.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Pricing & Ordering Information

Ordering Information

General Customer Availability

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Order:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>August 2002</td>
</tr>
</tbody>
</table>

Lead Time

The standard lead-time is defined as the time required under normal business conditions from placement of an order with Kadant Johnson until delivery of the product to the customer.

12 to 14 weeks (sourced from overseas)

When inventory is carried, delivery time is 2 to 4 weeks after receipt of order. For North America, no inventory will be carried unless customer demands cannot be met with standard lead-time.

Pricing

1.1 m (42") Dryer $1375.00 List each (be sure manhole exists)
1.2 m (48") Dryer $1400.00 List each
1.5 m (60") Dryer $1450.00 List each

These prices are for the Scoop Syphon assembly only. Horizontal pipes are sold separately.

Prices are subject to change without notice.

Required Information to Place an Order

- Dryer I.D.
- Journal length
- Confirmation that manhole exists in dryer

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.
Rotary Scoop Syphon

- Applied to non-rimming dryers
- Integrated with dryer drainage system
- Kadant Johnson EL, SN or LN joints
- Quick installation (< 20 minutes)
- Long-term reliability
Rotary Scoop Applications

- Up to 275 mpm (900 fpm)
- Flow capacity is determined by
  - Machine speed
  - Dryer diameter
  - Scoop capacity
  - Entrance factor

Evacuation Capacity = \( S \cdot f \cdot C \cdot \rho / (\pi \cdot D) \)

*where:*

- \( S \) = Machine speed
- \( C \) = Scoop capacity
- \( f \) = Scoop performance factor
- \( \rho \) = Condensate density
- \( \pi \) = 3.1416
- \( D \) = Dryer inside diameter
Rotary Scoop Design

• Stainless steel construction
  – Vertical pipe 1” pipe
  – Horizontal 1-1/4” pipe
  – Flanged elbow
  – Loading spring
• Dryer diameters
  – 1.2 m (48”)
  – 1.5 m (60”)
  – Others special order

Rotary Scoop Syphon Features

• All stainless steel
• Flanged horizontal pipe
• Clamped vertical pipe
• Heavy section walls
• Shoe counterweight
• Mounting flexibility
  – Bolted to shell (optional)
  – Spring-loaded leg
  – Top or bottom dryers
Rotary Scoop Syphon Features

- High entrance factor
- Low flow resistance
- Trapped tuba pipe
- Optimized pipe contour
  - Steam trap operation
  - By-pass trap extension
  - DP control systems

Dryer Diameter Adjustment
Flanged Horizontal Pipe

Rotary Scoop Syphon Benefits

- Corrosion resistant
- Long operating life
- Easy and quick installation
- Applied to both top and bottom dryers
- Reduced operating torque
- Minimized blow through
Kadant Johnson Inc.
Rotocurve® Syphon

DESIGN CHARACTERISTICS

The Rotocurve® Syphon combines the simplicity of a stationary syphon with some of the reliability and stability of a traditional rotary syphon. The Rotocurve® Syphon is installed from outside the cylinder and rotates with the cylinder. Its close syphon clearance is automatically set by the factory prior to installation and no adjustments are required. The Rotocurve® Syphon is able to remove condensate in all stages of condensate behavior and is virtually maintenance free.

APPLICATIONS

- Open gear paper machines
- Paper machines producing multiple grades at speeds below 1800 FPM
- Machines currently using stationary syphons with elbows or bent pipes
- Can be used with existing rotary joints
SINGLE ROTARY SYPHONS

At the inlet end of the syphon, a stainless steel pick-up foot is welded to the vertical condensate pipe and syphon elbow. At the other end, a spring-loaded pressure plate is adjusted outward until the syphon is wedged securely in place. A hex locking nut is tightened to keep the pressure plate in position. This simple arrangement works very well. Tests in Kadant Johnson’s Research Center show a rotary syphon will remain in place at high speeds, even in a completely flooded cylinder.

DESIGN ADVANTAGES

- **Kadant Johnson single rotary syphons have a minimum of components.** Since the components are under minimal fluid loading and stress, they are much lighter and less expensive than their stationary syphon counterparts.

- **The single rotary syphon has a very close clearance of 1/16".** This translates into greater heat transfer efficiency.

- **The pick-up fitting is ground to the radius of the dryer, which insures a uniform clearance around the syphon perimeter.**

APPLICATIONS

The single rotary syphon is intended for applications with low to moderate flows and moderate speeds.
MULTIPLE ROTARY SYPHONS

The multiple rotary syphon consists of two or more single syphons connected to outlet piping. It has the same basic features as the single rotary syphon: close syphon clearance, spring-loaded pressure plate mounting and simplicity of design.

DESIGN CHARACTERISTICS

The multiple rotary syphon has the same design advantages as the single rotary syphon.

APPLICATIONS

The multiple rotary syphon is intended for applications where optimum heat transfer characteristics cannot be achieved with a single rotary syphon, because speed and/or fluid levels exceed certain levels.

In a specific application, Kadant Johnson engineers will computer size a multiple rotary syphon system to assure proper performance.
Defining Dryer Performance
## Dryer Performance Evaluation Objectives

1. Characterize current dryer performance
   - Drying efficiency
   - Runnability and machine efficiency
   - Energy efficiency
2. Compare performance to top industry standards
   - Use dryer performance indicators
3. Define improvement benefits
   - Set priorities
   - Provide a basis for results evaluation

## Field Testing of Dryers

1. Clear definition of machine operating parameters
2. Existing drying rate and drying efficiency
3. CD and MD surface temperatures
4. Sheet temperatures
5. CD and MD pocket humidities
6. Dryer drainage system flows
7. Hood exhaust and supply air flows
8. Fabric permeability and tension
9. Sheet stability
Key Performance Variables

- Effective drying rate
- Steam temperature to dryer surface temperature difference
- Cross direction surface temperature variation
- Wet end sheet temperature rise
- Dryers in falling drying rate zone
- Average and peak pocket humidity levels
- Average and peak hood exhaust humidities
- Pocket ventilation air flow rates
- Hood balance
- Energy Consumption

Comparisons to Top Performance Levels

- Compare to similar top performing machines making same grades
- Compare to TAPPI standards
- Compare to past results from your machine
- Experience of people inside and outside your company
### Dryer Performance Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measured Value</th>
<th>Good Performance</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective drying rate (lb water/hr/ft²)</td>
<td>4.49 @ 15 psig</td>
<td>4.1 @ 15 psig</td>
<td>30 #</td>
</tr>
<tr>
<td></td>
<td>4.34 @ 13 psig</td>
<td>4.0 @ 13 psig</td>
<td>27 #</td>
</tr>
<tr>
<td>DT: steam vs. dryer surface (° F)</td>
<td>39</td>
<td>35 – 40</td>
<td>Average</td>
</tr>
<tr>
<td>Cross direction surface temperature variation (° F)</td>
<td>10</td>
<td>3 – 5</td>
<td></td>
</tr>
<tr>
<td>Number of cold dryers</td>
<td>2</td>
<td>0</td>
<td>Valved out</td>
</tr>
<tr>
<td>Number of dryers required to achieve a sheet temp of 180° F</td>
<td>12</td>
<td>3 – 4</td>
<td></td>
</tr>
<tr>
<td>Estimated sheet moisture leaving unorun</td>
<td>52.5%</td>
<td>&lt; 50%</td>
<td>% wet</td>
</tr>
</tbody>
</table>

### Dryer Performance Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measured Value</th>
<th>Good Performance</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pocket humidity (lb water vapor/lb dry air)</td>
<td>0.27</td>
<td>0.25 – 0.30</td>
<td>4th section</td>
</tr>
<tr>
<td></td>
<td>0.26</td>
<td>0.20 – 0.25</td>
<td></td>
</tr>
<tr>
<td>Peak pocket humidity (lb water vapor/lb dry air)</td>
<td>0.40</td>
<td>0.45</td>
<td>5th section</td>
</tr>
<tr>
<td>Cross-machine pocket humidity variation (lb water vapor/lb dry air)</td>
<td>0.32</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Pocket ventilation air flow (cfm/ft pocket ventilator width)</td>
<td>95</td>
<td>140 – 170</td>
<td></td>
</tr>
<tr>
<td>Main hood exhaust humidity</td>
<td>756</td>
<td>850 – 900</td>
<td>30 # 4000 fpm</td>
</tr>
<tr>
<td>Hood air balance (% supply air to exhaust air)</td>
<td>33</td>
<td>65 – 70</td>
<td>Main</td>
</tr>
</tbody>
</table>
Pressure Moisture

- Accurate press moisture is essential for proper dryer section analysis
  - 1% pressure moisture change
  - 4% evaporation load
WoodFree Fine Paper Drying Rate Chart

![Graph showing drying rate vs. average steam temperature.]

Dryer Surface Temp Measurements

- Valuable in identifying:
  - Poor condensate evacuation
  - Possible problems with dryer felt tensioning mechanisms
  - Improvement potential from installation of additional dryer felting
  - Improvement potential from installation of Turbulator® bars
ΔT: Steam vs. Dryer Surface

- High difference between steam temperature and dryer surface temperature usually indicates poor condensate removal
  - Target difference depends on steam pressure, drying rate, and use of dryer bars
  - Any difference greater than 60°F indicates poor condensate removal

<table>
<thead>
<tr>
<th>Steam Pressure (psig)</th>
<th>No Dryer Bars (° F)</th>
<th>Dryer Bars (° F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>35 to 40</td>
<td>30 to 35</td>
</tr>
<tr>
<td>30</td>
<td>40 to 50</td>
<td>35 to 45</td>
</tr>
<tr>
<td>60</td>
<td>50 to 60</td>
<td>40 to 50</td>
</tr>
<tr>
<td>100</td>
<td>60 to 70</td>
<td>50 to 60</td>
</tr>
</tbody>
</table>

Temperature difference is also dependent on machine speed and drying rate.
**Dryer Surface Temperatures**

![Graph showing temperature variations across different dryer numbers.]

*Good performing corrugating medium machine. Has full width dryer bars in all dryers.*

---

**STEAM TO DRYER SURFACE TEMPERATURE DIFFERENCE**

<table>
<thead>
<tr>
<th>Mill</th>
<th>Corrugating Medium Machine</th>
<th>Grade</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Grade</td>
<td>5/24/94</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td>Midwest USA</td>
</tr>
<tr>
<td>Machine</td>
<td></td>
<td>Speed</td>
<td>2708 Fpm</td>
</tr>
</tbody>
</table>

![Bar chart showing temperature difference across different dryer numbers.]

---

*Has medium machine. Has full width dryer bars in all dryers.*
**STEAM TO DRYER SURFACE TEMPERATURE DIFFERENCE**

**Linerboard Mill**
- Date: 10/3/95
- Location: Southern USA
- Grade: 33 Lb/1000 Ft²
- Machine Speed: 2135 Fpm

Several sections would benefit from additional bottom felting.

Linerboard machine - only the 2nd section has bottom felt.

**Food Board Machine**
- Date: 2/18/97
- Location: Southern USA
- Grade: 178 Lb/3000 Ft²
- Machine Speed: 873 Fpm

Bottom dryer fabrics would provide benefit only at the wet end of the machine. At dry end, there is no difference between the effectiveness of felted and unfelted dryers.

Food board machine with only top felting. Bottom dryers are unfelted.
The tensioning mechanism for the 1st section bottom fabric is not working properly (1st section includes dryers 1 to 17).

Corrugating medium machine
All sections top and bottom felted.

Temperature differences are high in the intermediate section (dryers 8 to 34). This was caused by condensate "carry-over" with the steam cascaded from the main section.

Linerboard machine with cascade type steam and condensate system.
After problem is corrected, intermediate section (dryers 8 to 34) temperature differences are at a good level. As a result, drying rates were improved and the machine speed was increased.
Cross Direction Surface Temperature Variation

- Determined by dryer surface temperature profile measurements
  - Reveal the potential benefit of Turbulator bars
  - Show if dryers are contributing to sheet moisture variation
- With proper drying equipment and good drainage, variation is normally less than 8°F
Dryer surface temperature is low at edges. This is caused by the sheet being too wide for the dryers.

Number of Cold Dryers

- High percentage of cold dryers indicates joint or syphon operational problems
- In many cases, upgrading syphons to a more reliable design can be justified based on increased production capacity
Sheet Temperatures

- Wet end sheet temperature rise should be as rapid as possible while avoiding picking and cockle
- No more than 15% to 18% of the main section dryers should be in the falling drying rate zone
- Sheet temperatures should be high and consistent in the constant rate zone
SHEET TEMPERATURES

Ideal fine paper sheet temperature curve

No more than 15 to 18% of main section dryers should be in falling rate zone.

Rapid sheet temperature increase at wet end

Overdrying Into Size Press
Results in 15% Loss Of Main Section Drying Capacity

No Sheet Temperature Rise
Over Unfelted Dryers After Size Press
This Is Typical
Pocket Humidities

- Target level of 0.20 lb water vapor per lb dry air (industry standard)
- Modern high speed machines cannot achieve 0.20
  - A better target is 0.3 to 0.4 in the first double-felted section
- Pocket humidities have less effect on heavy-weight paper grades
Ideal humidity levels of 0.20 are not achievable due to high evaporation loads and high speeds.

**High Speed High Production Fine Paper Machine**

**Pocket Humidity (lb water vapor / lb dry air)**

**Target**

**Front Edge**

**Dryer Number**

**Pocket Humidity (lb/lb)**

**No Pocket Ventilator**

**DRYER 32**

**3,300 Fpm Newsprint**

**Pocket Ventilator Present**

**DRYER 30**

**CD Position**
Pocket Humidity Air Flow

<table>
<thead>
<tr>
<th>Steam Pressure (psig)</th>
<th>60” Dryers</th>
<th>72” Dryers</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>130</td>
<td>160</td>
</tr>
<tr>
<td>50</td>
<td>140</td>
<td>170</td>
</tr>
<tr>
<td>75</td>
<td>150</td>
<td>180</td>
</tr>
<tr>
<td>100</td>
<td>160</td>
<td>190</td>
</tr>
</tbody>
</table>

Hood Exhaust Humidity

- Open canopy
  - 300 to 450 grains exhaust humidity
- Closed hoods
  - Low and medium humidity
  - 750 to 900 grains exhaust humidity
- High humidity closed hoods
  - 900 to 1,050 grains exhaust humidity
Hood Air Balance

\[
\text{Hood Air Balance} = \frac{\text{lb dry air supplied}}{\text{lb dry air exhausted}} \times 100
\]

- **Open Hood**: 25% to 35%
- **Medium Humidity Closed Hood**: 70% to 75%
- **High Humidity Closed Hood**: 60% to 70%

Dryer Energy Consumption

(BTU/lb water evaporated)

<table>
<thead>
<tr>
<th>Energy Consumer</th>
<th>Good Performance</th>
<th>Poor Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Heating</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>Evaporation</td>
<td>990</td>
<td>1,040</td>
</tr>
<tr>
<td>Air Heating</td>
<td>180</td>
<td>350</td>
</tr>
<tr>
<td>Non-condensable Bleed</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Venting to Condenser</td>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,300</strong></td>
<td><strong>2,100</strong></td>
</tr>
</tbody>
</table>
Dryer Performance Evaluation Objectives

• Characterize current dryer performance
  – Drying efficiency
  – Runnability and machine efficiency
  – Energy efficiency
• Compare performance to top industry standards
  – Use dryer performance indicators
• Define improvement benefits
  – Set priorities
  – Provide a basis for results evaluation
Dryer Drainage Systems

System Design Information

• Accurate projection of drying pressures and speeds
  – Low pressure design point as critical
  – Low pressure conditions determine line sizing
• Accurate projection of dryer condensing loads is essential
  – Computer simulation must account for dryer effectiveness, unorun dryers, pocket humidities, dryer felting, etc.
System Design Information

- Accurate projection of syphon differential pressure and blow-through amounts
- Key to proper line sizing and thermocompressor design

Syphon Design and Selection

- A primary function of the steam and condensate system is to manage and make use of blow-through steam
- Syphon type and flow characteristics dictate blow-through flow amounts
- Selecting syphon type and size is the most important step to designing steam and condensate system
Separator Stations

- Separation efficiency is determined by
  - Vapor velocity through the tank, which is affected by blow-through rates and tank size
  - The design of the separator tanks
- Efficient condensate separation
  - Can potentially increase drying rates, especially in cascade type steam and condensate systems
  - Reduces risk of severe erosion in thermocompressors
Vacuum Condenser

- High vacuum levels are required to drain dryers operating at low pressure
- Required both during normal operation and during upset conditions
Vacuum Condenser Temperature Controlled

Vacuum Condenser Pressure Controlled (preferred)
Condenser Temperature-Pressure Relationship

<table>
<thead>
<tr>
<th>Condenser Temperature (°F)</th>
<th>Condenser Pressure (psig)</th>
<th>Condenser Vacuum (Inches Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>212</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>-3.2</td>
<td>6.5</td>
</tr>
<tr>
<td>190</td>
<td>-5.4</td>
<td>11</td>
</tr>
<tr>
<td>180</td>
<td>-7.6</td>
<td>15.5</td>
</tr>
<tr>
<td>170</td>
<td>-8.7</td>
<td>17.7</td>
</tr>
<tr>
<td>160</td>
<td>-9.9</td>
<td>20</td>
</tr>
<tr>
<td>150</td>
<td>-11</td>
<td>22</td>
</tr>
</tbody>
</table>

Causes of Low Vacuum

- A vacuum condenser should operate at 18” to 20” hg
- If it doesn’t...
  - Improper temperature set point or indication
  - Excessive steam venting from dryers
  - Dirty tubes
  - Air leaks into vacuum system
  - Insufficient cooling water flow
  - Condenser is too small
Corrugator Steam System

General Customer Availability:
Ready for Order Date: Immediate
Ready to Ship Date: Immediate

The information in this product introduction package is confidential to Kadant Johnson and is provided to sales managers, sales representatives, and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

<table>
<thead>
<tr>
<th>Revision</th>
<th>Mark</th>
<th>Date</th>
<th>Page</th>
<th>Change &amp; Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>---</td>
<td>16 March 2012</td>
<td>All</td>
<td>Original Issue</td>
</tr>
</tbody>
</table>
A corrugator steam system has two basic functions: (1) to distribute steam efficiently to each steam-heated component of the corrugator and (2) to remove condensate rapidly so it does not inhibit the heat transfer capability of the system. More specifically, a proper steam system:

1. Delivers dry steam at the desired pressure to every vessel.
2. Continuously removes condensate as it forms.
3. Delivers low-pressure wet shower steam to precondition the medium.
4. Provides a means to purge non-condensable gases (primarily air) from the system during startup.
5. Automatically handles large heat load variations ranging from a stopped corrugator to one producing heavy weight double- or triple-wall at high speed.
6. Accomplishes these functions reliably with minimum maintenance requirements.

The Kadant Johnson corrugator steam system is unlike any in the industry today. It controls the differential steam pressure and blow-through across each roll to achieve the highest possible heat transfer and temperature uniformity, with higher efficiency and less maintenance than any conventional steam trap system. This system addresses the heat transfer problems that Kadant Johnson has found to be plaguing modern high-speed corrugators.

The Kadant Johnson corrugator steam system uses a thermocompressor to ensure maximum steam efficiency. The Kadant Johnson steam system is carefully sized to match the steam joints, syphons, and other steam-handling equipment to ensure consistent, uniform heat transfer at maximum speed. As a result, more heat is delivered to the corrugator and more board is produced, all with less energy.

**Types of Steam Systems**

The two major types of conventional corrugator steam systems are Cascade and Single-pressure.

**Traditional Cascade System**

This is the most common type of corrugator steam system. High-pressure steam is introduced at the single-facers and preheaters where some steam is condensed as it gives off heat to the liner and medium. The remaining steam and condensate are removed through the syphon into a receiver that is at a lower pressure than the preheater or single-facer.

Condensate and steam are separated in the condensate receiver. Because the condensate temperature decreases as the steam pressure drops from 175 psig (12 bar) to a lower pressure, additional steam will "flash" off the condensate. The flash steam plus the blow-through steam are commonly referred to as "salvage steam."

Salvage steam is routed to the first section of steam chests where additional condensation occurs as heat is transferred into the combined board. The blow-through steam and condensate from the first section are collected in a second flash tank, and the salvage steam from this flash tank is used in the second section. Likewise, second section salvage steam is used in the third section.

Flash steam from the last separator is used in the steam showers. Each receiver has a trap through which condensate is discharged to the condensate return system. The condensate that still contains much useful heat is returned to the boiler and is regenerated into steam.

The advantage of a conventional cascade system is its ability to use the majority of the steam heat. A disadvantage is the low capacity and lack of independent temperature control.

**Single-Pressure or “Live” System**

The single-pressure system has an independent live steam supply to the single-facers, preheaters, preconditioners, and steam chests. Each section has its own steam trap.
The advantages of this system are that each vessel or section is operated at full boiler pressure and no flash tanks are required. A disadvantage of a live system is the higher maintenance caused by more steam traps to maintain.

**Kadant Johnson Steam System**

The Kadant Johnson steam system has the high capacity advantage of the single pressure system plus the high thermal efficiency and low maintenance of the cascade system. The temperatures of each of the major steam sections can be independently controlled. The energy efficiency is achieved by boosting and circulating the low-pressure blow through and flash steam back to supply.

The Kadant Johnson single facer steam system optimizes heat transfer, production, quality, and energy efficiency. A trapped system can provide high energy efficiency, but does not optimize heat transfer and production. The objective of a trap is to eliminate steam losses and only remove condensate. However in a high speed syphoning system, blow-through steam is required to efficiently evacuate condensate and produce high heat transfer rates. A different approach to a traditional trapped system must be taken. The Kadant Johnson system uses our knowledge from paper machine steam systems where trapped systems have been discontinued for many years.

The first priority of a corrugator steam system is to provide maximum temperature capability at the liner and medium interface for glue bonding. The Kadant Johnson system provides maximum steam pressure to the corrugator rolls and two preheater rolls immediately prior to the corrugator rolls. Pressure control can be incorporated for corrugators making light weight flutes requiring lower temperatures.
Testing at Kadant Johnson’s W.R. Monroe Research Center has shown that the amount of blow-through steam and velocity through the drilled passages is the critical performance parameter for the drilled corrugator rolls. Too little blow-through steam will cause poor heat transfer and mechanical instability in the rolls. This condition is termed “condensate stall”.

Using too much differential pressure across the drilled rolls produces too much blow-through steam and lowers the pressure in the downstream rolls of the cascade design. The Kadant Johnson system controls blow-through steam from the drilled rolls slightly above the stall point where heat transfer and roll stability degrade. The amount of blow-through steam required has been determined through extensive testing of drilled roll performance. The correct amount of blow-through steam depends on roll geometry, speed, and pressure. Controlling above the stall point minimizes differential pressure across the corrugator rolls, maximizes temperature in the corrugator rolls, and maximizes pressure in the downstream rolls where the blow-through steam is cascaded. This is a unique solution for the control of drilled corrugator rolls and can only be implemented with the understanding of the roll stall point.

High heat transfer is needed in the liner and medium preheater rolls. Kadant Johnson CorrPro™ rotary joints, Turbulator® Tube™ bars, and shaped-foot stationary syphons are used to produce the highest possible roll temperatures. Optimized syphon clearance, differential pressure, and blow-through flow are needed to maximize heat transfer and provide uniform cross direction temperature profiles. A trapped system does not provide sufficient blow-through flow or the correct conditions across the syphon pipe.

Blow-through from the rolls with stationary syphons will be controlled with an external condensate line orifice to minimize blow-through flow and provide a favorable steam balance. Kadant Johnson can define the minimum blow-through requirement to achieve good drainage. Syphons with a proper shaped foot are needed to minimize the blow-through and differential requirement. The drainage condition across the rolls is controlled by differential pressure. Differential pressure is minimized with shaped foot stationary syphons (differential pressures of 2 to 3 psi are commonly used).

It is important to provide proper separation of the blow-through steam and condensate that is removed from the rolls. Condensate separator tanks are used to provide efficient separation. These tanks are designed to achieve at least a 98% steam quality leaving the tank. Level is controlled in the tanks with a level valve and level controller as traps do not provide a reliable method for controlling condensate levels in the separator tanks.

Blow-through steam from the separator is recirculated and recompressed using a high-efficiency Kadant Johnson thermocompressor. The thermocompressor allows for the reuse of blow-through steam and provides high energy efficiency. To ensure proper control, the thermocompressor characteristics are closely matched to the syphon requirements. The condensate line orifices, used to restrict blow-through flow, and the closely controlled differential pressure allows the thermocompressors to be designed to match system requirements. Computational fluid dynamic (CFD) modeling of the thermocompressor provides the highest possible efficiency.

Start-up and air removal must be very rapid. Our research testing has demonstrated that it will take hours to completely remove air from a trapped system. The Kadant Johnson system design removes air within minutes of steam being applied to the rolls.
**Sales Strategy**

**Unique Selling Proposition**

Kadant Johnson’s extensive research into condensate behavior and heat transfer in rotating rolls and corrugator hot plates has been combined with an intimate knowledge of steam joints, syphons, and the integration of these components with the steam system to provide the corrugator with a holistic steam distribution and handling system, one that delivers more heat, more consistently, more efficiently to maximize board production.

**Customer Value**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight integration of steam system with steam joints, syphons, and related components</td>
<td>Maximum heat delivered to the liner and medium</td>
</tr>
<tr>
<td>Blow-through differential control</td>
<td>Maximum steam efficiency and control</td>
</tr>
<tr>
<td>Turbulator® bars mounted inside rolls</td>
<td>Fast heat-up of the system</td>
</tr>
<tr>
<td>Thermocompressor steam booster</td>
<td>Maximum equipment capacity</td>
</tr>
<tr>
<td>Elimination of steam traps, simplified control</td>
<td>Reduced maintenance requirements</td>
</tr>
</tbody>
</table>

**Who to Target**

Kadant Johnson is offering its corrugator steam systems for new corrugator plants and major upgrades to existing corrugator plants that are undergoing significant rebuilds of their existing corrugator lines. The scope of these sales would include the steam boilers, system design, piping, hardware, and installation. These corrugating steam systems apply specifically to “high-end” corrugators. These corrugating plants include those that:

- run at speeds greater than 800 fpm (240 mpm)
- have newer corrugating machines (2000 or later)
- experience high steam consumption
- want to run faster and make more product with less problems

Generally, the decision makers for a corrugating steam system will be in the corporate technology or corporate manufacturing groups. This is particularly true for organizations such as International Paper, Georgia-Pacific, and Rock-Tenn. Influencers include industry consultants and plant management, specifically the plant manager and production manager.

Although a Kadant Johnson steam system can also be used for slower speed, lower production corrugator lines, these plants typically do not have funding for a steam system audit. Correspondingly, we will be focusing marketing and product center sales efforts at the corporate levels in order to be considered for new corrugator plants and major upgrades, where there are funds available for a proper steam system. We will be careful to qualify steam system opportunities for existing corrugator plants.
Selling Strategy

The primary opportunity with a corrugating steam system is for a corrugator to run faster and produce more board. Improving the heat transfer rate will be the start of any conversation leading up to the sale of a corrugator steam system.

Because the investment in a new corrugator steam system can be more than $500,000, it is important to selectively target high-speed, newer machines that are heat-limited.

Qualifying questions

1. Is there a desire to run faster or produce more saleable board?
2. Are there issues with delamination or loss of bonding between the liner and medium?
3. How fast does the single-facer run today?
4. How fast should it run according to the OEM specs?
5. What is seen as the primary limitation to producing more board / running faster?
6. How likely is the plant to fund a major upgrade to the steam system?
7. Does the plant have an approved budget for a steam system audit?

Sales Collateral / Reference Material

Bulletins / Brochures
- Corrugator Steam Systems bulletin
- Corrugating Industry catalog
- Information Request sheet

Sales Presentations
- PowerPoint Presentation - Corrugator Steam Systems (pending, for use with corporate accounts)

Kadant Johnson Research Center

Kadant Johnson Research installed a corrugating test stand and has conducted tests on conventional steam heated rolls as well as peripherally-drilled rolls. These tests have allowed Kadant Johnson to study the behavior of condensate in the rolls, the effect of speed on heat transfer rate and temperature profile uniformity, the transient performance (from start-up and sheet breaks), and the effect of syphon design and operation. This unique testing facility will be used to support discussions and presentations to corporate technology groups.

JOCO 2000

- 0.5 m (20") diameter x 2.6 m (104") face roll
- Rated for 14 bar (200 psig)
- Operating speed 730 mpm (2400 fpm)
- Adjustable condensing rates to 60 kg/m²-hr (12 lb/ft²-hr)
- Real-time measurement of roll temperatures, differential pressure, steam and condensate flow rates
- Real-time observation of condensate behavior inside the roll using CCTV
Ordering Information

**General Customer Availability**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Order</td>
<td>Immediately</td>
</tr>
<tr>
<td>Ready for Ship:</td>
<td>Immediately</td>
</tr>
</tbody>
</table>

**Lead Time**

A plant visit would typically be scheduled to provide an assessment of the current operation and corrugator steam system. The plant visit will take place after the Kadant Johnson Systems Information Request sheet is completed. The Information Request sheet is available from Kadant Johnson Systems.

**Pricing**

The price for a corrugating steam system is determined by the scope of the project. A typical system will range from $500,000 to $800,000. A new boiler and other components will increase the project investment by more than $1 million.

**Required Information to Create a Proposal**

- Company name, location
- Plant contact information
- Single-facer OEM (BHS, Mitsubishi, MarquipWardUnited, etc.)
- Age of single-facer (approximate installation date)
- Speed range
- Type of rolls (conventional or peripherally-drilled)
**Competition**

**Stickle Steam Specialties Co.**  
(USA)  www.sticklesteam.com

- Large installed base, well known in the North American corrugating industry
- Advertise more than 100 years of experience
- Offer consulting, system design, installation, training, and instrument and valve repair
- Offer only steam traps (no rotary joints, syphons, or thermocompressors)
- Offers conventional steam systems, no research or testing capabilities
- Supplier of corrugator steam systems in North America

**Donahue and Associates**  
(USA)  www.donahuesteam.com

- Well known in the industry
- Positioned as the corrugator steam system experts
- Promote the proprietary Donahue steam trap for all heated vessels to trap the steam in the vessel and allow condensate to return to the boiler room for use as boiler feedwater
- Offer only steam traps (no rotary joints, syphons, or thermocompressors)
- Supplier of corrugator steam systems in North America

**Baviera Steam Systems**  
(Spain)  www.rbaviera.com

- Good technology
- Supplier of corrugator steam systems in Europe
- Offer only steam traps (no rotary joints, syphons, or thermocompressors)
- No presence in the USA

**Armstrong**  
(USA)  www.armstronginternational.com

- Promote steam trapping and tracing
- Sales primarily through manufacturer’s representatives
- Limited steam system capabilities, no research or testing capabilities
- Provide steam system training, testing, and monitoring
- Limited to steam specialty products, little “steam systems” activity

**Spirax Sarco**  
(USA)  www.spiraxsarco.com

- Promote over 100 years of experience
- Provide audits, installation and consulting, and repairs, maintenance and spares
- Offer only steam traps (no rotary joints, syphons, or thermocompressors)
- Very little industry recognition with corrugator steam systems
- Strong brand recognition for steam traps
The Role of Heat

In the corrugating process, four basic components combine to produce board:

\[
\text{Liner + Medium + Adhesive + Heat} = \text{Combined Board}
\]

The primary source of heat in a corrugating plant is the steam system. While this is a critical and costly system in any plant, it is often overlooked and often poorly maintained. The plant steam system is typically an “out of sight – out of mind” process. It receives little attention until a problem develops.

The addition of heat on the corrugators serves four purposes:

1. Heat is added to the corrugating medium to soften the thermoplastic fibers. This enables the flutes to be formed without fracturing or losing their shape.
2. Heat is added to the liner to begin the gelatinization process of the adhesive.
3. Heat is added to combined board to evaporate the remaining water from the adhesive. This enables the combined board to be bonded firmly when it is discharged from the corrugator.
4. Heat is added to the liners to provide some drying action. This is used to balance the moisture content of the combined board and control warp.

Step 1. Heat is added to the corrugating medium by passing it over a steam-filled drum called a preconditioner, over a steam shower, or a preconditioner and steam shower mounted in series. Cellulose fibers are similar to plastic in that they become soft and pliable when they are heated. As the fibers become pliable, the medium can be more easily formed into the fluted shape by the corrugating rolls. The medium will retain the fluted shape as it cools. While the preconditioner can only heat the medium, the steam shower can heat the medium and add moisture at the same time. Adding moisture to the medium lowers the temperature required to soften the fiber. Adding moisture also aids in the penetration of the adhesive.

Step 2. Heat is added to the liner by passing the board over a steam-filled drum called a preheater. Preheating prepares the liner for bonding to the medium by adding sufficient heat to begin the gelatinization of the adhesive.

Step 3. The final drying of the adhesive occurs in the double-facer where the combined board is passed over a series of steam-filled chests (i.e., hot plates). Heat transferred to the combined board, and the remaining moisture is evaporated as the adhesive sets. This final drying creates the strong bond required to hold the liners and medium together.
In summary, heat is added to paper and combined board at three positions on corrugating process:

- **At the preconditioner and corrugating rolls**, heat is added to medium to make it pliable. This enables flutes to be formed without fracturing or losing their shape.

- **At the preheaters**, heat is added to the liner to make it receptive to adhesive and provide the quick gelatinization required to form an adequate bond within a very short period of time. Preheaters also provide some drying action that helps balance liner moisture content and control warp.

- **At the double-facer**, heat is added to the combined board through the steam chests to evaporate the remaining water in the adhesive. This enables the combined board to be bonded firmly when it is discharged from the corrugators.

For all these actions to occur, steam must be properly distributed to the various sections of the corrugator, heat must be efficiently transferred from the steam into the liners, medium, and combined board, and condensate must be quickly removed from the steam vessels.
Thermocompressors

What does it do?

- High-pressure “motive” steam entrains lower-pressure “suction” steam
- Mixture is discharged at a higher pressure
  - Pressure of the low-pressure steam is increased
- No heat energy is lost in the process
Thermocompressor Components

How does it work?

Bernoulli’s Theorem

*Pressure and velocity energy are directly related*

*When pressure decreases, the velocity increases*

*When velocity decreases, the pressure increases*
How does it work?

Motive Steam:
Low velocity

Expansion Chamber:
Velocity falls

Discharge Steam:
Low velocity

Motive jet:
Very high velocity

Suction Steam:
Low velocity

Mixing Chamber:
Fairly high velocity

Nozzle Velocities

250 mps

500 mps

300 mps
Thermocompressor Sizing

- Proper prediction of operating pressures, differential pressure and blow-through flow amount is critical
- Low pressure operating condition determines throat size
- High pressure operating condition determines nozzle size
Design Considerations

• Low motive steam pressure
  – Ratio of motive pressure to suction pressure (psia) should be at least 1.4
  – A cascade system is a better alternative when the ratio is less than 1.5

Design Considerations

• Oversized syphons affect the performance of thermocompressor systems
  – Increased risk of venting steam
  – Increased use of high pressure motive steam, which might be more costly than low pressure make-up steam
Thermocompressor Control Methods

• Three methods
  – Differential pressure control
  – Blow-through flow control
  – Managed differential control
Syphon Characteristics

<table>
<thead>
<tr>
<th>Mill Location</th>
<th>Example Paper</th>
<th>Machine</th>
<th>PM1</th>
<th>Reference Syphon Comparison</th>
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<td>Lenoir City, TN</td>
<td>Paper Machine PM1</td>
<td>27-Jun-03</td>
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**Syphon Characteristics**

- **Differential Pressure Control Operating Range**
  - 20 psig
  - 1,500 pph
  - 2,500 fpm
  - 60 psig
  - 1,800 pph
  - 1,800 fpm

**Blowthrough Flow (Lb/hr)**

- **Sections vent on sheet breaks**
- **Does not adjust to flooded dryer conditions or high load upsets**

---

**Differential Pressure Control**

- **Advantages**
  - Simple to understand and operate
  - Can be set to always operate above the “flood recovery point”
  - Less equipment

- **Disadvantages**
  - “Worst case” differential pressures always used
  - High motive use when “worst case” used
  - Sections vent on sheet breaks
  - Does not adjust to flooded dryer conditions or high load upsets
Blowthrough Flow Control

• Reduced / no venting on sheet breaks
  – Automatically senses increase in blowthrough flow on a break and reduces the differential pressure

• Adjusts to flooding dryers or high load situations
  – Senses loss of blowthrough flow and automatically increases differential pressure
Potential Flow Control Problems

• Poor tank design
  – Condensate carry-over causes problems
• Wide speed range
  – Flood recovery point not taken into account
• Grade range
  – Different drying curves affect blowthrough
• Syphon size
  – Oversized rotary syphons have problems
• Dryers out of service

Managed Differential Pressures

• Differential pressures managed through control logic
• Differential pressure adjusted based on speed, pressure, and syphon curves
• Differential pressures reduced on sheet breaks to reduce blowthrough steam and prevent venting
• Simple and robust control method
Desuperheating

- Excessive levels of superheat should not be present in the steam supply to the dryers
  - Steam temperature should be maintained 20°F above saturation temperature
  - 10 to 60°F is acceptable
  - 100°F or above is excessive
Effects of Superheat in Steam

- Heat transfer coefficient is reduced until saturation temperature is reached
- High levels of superheat can reduce drying rate
- Steam joint failures
- Temperatures exceed equipment rating
- Hot dryers during sheet break conditions

Ejector Type Desuperheater

[Diagram showing the components of an ejector type desuperheater including Superheater Steam Inlet, Superheated Steam Outlet, Atomising Steam In, and Cooling Water In.]
Typical Ejector Desuperheater Control

Common Desuperheater Problems

- Temperature transmitter too close to desuperheater
- Oversized water control valve
- Inappropriate desuperheater type
- Pump has insufficient head
- Pump reliability and control
Utilization of Flash Steam

- Using flash steam in low-pressure wet end dryers is the best use of flash steam
  - Cannot use this method when high-pressure is used in wet end dryers (board machines)
- Wet end steam showers, steam boxes, or flash coils in the pocket ventilation system are other possible users
Flash Steam Utilization

Atmospheric Vent

4,700 pph Flash Steam

60,000 pph Condensate From Individual Separators at 287°F (40 psig)

Condensate Return To Boiler

- Best to utilize flash steam in wet end dryers
- Collection tank operates at wet end dryer header pressure
- Tank pressure can be controlled to control pressure difference within system
- Condensate returned to boiler house at low temperature
Improvement Opportunities

Flash steam can be used for steam boxes and showers, PV flash steam coils, etc.

Flash Steam to Wet End Steam Shower

Alternatively Steam Can Be Flashed Into A Low Pressure Header
Troubleshooting Systems

Common System Problems

- Inaccurate differential pressure indication
  - Leads to poor drainage reliability and/or unnecessary venting of steam
- Oversized syphons
  - Syphons must be applied according to condensing load; not one size fits all
- Undersized equipment
  - Steam and condensate headers
  - Separator tanks
  - Condensate lines between separator and pump
Header Sizing

Common System Problems

• Poor rotary joint reliability
  – Leads to loss of drying capacity due to a high percentage of dryers being valved off

• Inadequate motive steam pressure
  – Thermocompressors are dependent on having a high pressure difference between the motive steam and the dryer pressure
  – Inadequate motive pressure leads to poor drainage reliability
Common System Problems

• Excessive venting during sheet breaks, which leads to loss of vacuum and flooding of dryers operated at low pressure
• One possible solution is to reduce venting during breaks through the installation of blow-through flow control or managed differential pressure control
Troubleshooting Systems
Improvement Opportunities

- Increase drying capacity through the installation of dryer bars
- Applicable for machine speeds greater than 1500 fpm
Improvement Opportunities

- Reduce line erosion
  - Relocate level control valves close to the main condensate collection tank
  - Improve arrangement of condensate piping close to main condensate collection tank
  - Enlarge undersized condensate drop pipes (or convert to stationary syphons)

Condensate Handling
Improvement Opportunities

- Improve system turndown capability
- Reduce the frequency that dryers must be manually valved off to reduce drying capacity
- May require system changes
  - Conversion from rotary to stationary syphons
  - Enlarge undersized piping
  - Make conceptual changes to the steam and condensate system

Improvement Opportunities

- Reduce the steam load on the condenser by installing of stationary syphons or smaller rotary syphons
- Reduce usage of high pressure motive steam
  - Convert some or part of the steam system to cascade arrangement
  - Downsize any rotary syphons that are oversized
  - Manage differential pressures
De-Tuned Turbulator® Tube™ Bars

Benefits of De-Tuned Bars

- Reduce sheet breaks with uniform dryer surface temperature
- Reduce torque power to rim
- Reduce drive power to rim
- Reduce speed to rim
- Quick installation time
High-Efficiency Thermocompressor

General Customer Availability

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Record of Changes

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<td>26 Sept 07</td>
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Product Overview

Kadant steam jet thermocompressors are designed to boost low-pressure steam by mixing high-pressure steam with low-pressure steam. It has three basic components: nozzle, mixing section, and diffuser. Optimization of the geometry of the thermocompressor minimizes the consumption of high-pressure steam and maximizes the energy efficiency.

In a typical paper machine installation, the thermocompressor is used to recompress the blow-through steam that is evacuated from the dryers and separated from the condensate in the condensate receiver station.

A thermocompressor is normally identified by its size. The thermocompressor size refers to the flange size of the discharge (outlet) line, which is generally the same size as the low-pressure (suction) line. The motive line size is smaller.

The most common sizes found in the paper industry are 4", 5" and 6". Kadant manufactures thermocompressors from 1.5" up to 24". Other sizes are available. Standard materials include a steel body and diffuser with stainless steel nozzle and spindle. Standard ANSI flange ratings are 600 lb., 300 lb., or 150 lb. DIN flanges are also available.

There are two thermocompressor applications:

1. **Recirculating Thermocompressors**

   Thermocompressors are used to recirculate the blow-through steam in the dryer section. If the Differential Pressure Valve is open during normal operation, a substantial amount of energy is being wasted. This is an indication that the existing thermocompressor is not properly designed to handle the flow.

2. **Booster Thermocompressors**

   Thermocompressors are also used to boost low-pressure steam to a higher-pressure level for increased drying capacity. Maximizing the use of low-pressure steam over a wide range of paper machine operating conditions is an important task.

**Operating Principle**

High-pressure motive steam enters the thermocompressor via the motive steam nozzle where it is expanded from the inlet pressure to that of the design low pressure, or suction value. As the motive steam passes through the nozzle, the pressure energy falls and the velocity energy rises. This rise will continue until sonic velocity is attained in the nozzle throat. A de Laval nozzle is used to continue the acceleration of the motive flow to supersonic velocity if warranted.

The stream of high velocity steam leaves the nozzle and passes through the body to enter the convergent section of the diffuser, where it is brought into contact with the low-pressure stream. Entrainment will occur as the motive jet transfers energy to the low-pressure stream by shear.

The flow progresses through the diffuser throat, and the two streams mix resulting in uniform cross-sectional velocity. As the flows mix, the pressure rises. In the diverging section of the diffuser, area increases, velocity decreases, and pressure rises to the required discharge pressure.
Ratios

The expansion of the motive steam from its inlet pressure to that of the design low pressure is the expansion ratio. The compression of the low-pressure steam from its inlet value to the discharge pressure is the compression ratio.

Theoretically, when the value of these ratios equal 1.86 in absolute terms (i.e., psia), sonic velocity is reached and the thermocompressor has attained the critical pressure ratio. When the value of these ratios exceeds the critical pressure ratio (i.e., when the value is greater than 1.86), supersonic values are encountered. Depending on the values relative to the critical pressure ratio, the ratios are referred to as sub-critical, critical, or super-critical.

Design Considerations

Thermocompressors are purposefully built for a specific application. In other words, its design will be the optimum at a single set of conditions known as the design point. This will normally be the low-pressure condition. The specific volume and flow rate at the low-pressure condition are used to determine the diameter of the diffuser throat thereby determining the size of the thermocompressor.

It is important that the correct design conditions have been collected. Once the diffuser throat bore has been set, the selected bore and the prevailing discharge pressure determine all other flows. Deviations from the design values result in reduced efficiency.

With the exception of the actuator and modulating spindle, thermocompressors have no moving parts. Maintenance problems are rarely encountered.

Assuming the thermocompressor has been correctly specified, satisfactory operation of the equipment will depend on (1) the correct installation, (2) the “quality” (that is, the dryness) of the steam supply, and (3) periodic inspection.

Installation

A thermocompressor can be installed in any convenient position, but it is recommended that, wherever possible, its orientation be in the vertical plane with the discharge connection pointing downwards (as shown above). This will smooth the operation of the actuator assembly and minimize piston wear in the plug guide.

Once the location for the thermocompressor has been determined, due consideration should be given to the three connections: motive, suction, and discharge. Each of these items is discussed on the following page.
The motive connection: Dry steam is a basic requirement for good thermocompressor performance. The motive steam nozzle is designed for 98% or better quality steam to give efficient performance. Wet steam is detrimental to both the performance and the parts of a thermocompressor, because it erodes the nozzle and the diffuser. It is recommended that all steam supply lines come off the top of the main steam supply line and, where necessary, provision be made for draining the steam lines of any residual condensate. The lower the operating supply pressure, the more operating steam required by the thermocompressor. A steam pressure gauge should be located in the motive steam line, as close as possible to the high-pressure steam inlet of the thermocompressor.

The suction connection: The low-pressure suction line should be the same diameter as the suction connection of the thermocompressor. It should also be free from any restrictions. A steam pressure gauge should be located as close to the suction connection as possible.

The discharge connection: The discharge connection should be the same diameter as the thermocompressor discharge outlet. Care should be taken to avoid placing any restrictions or obstructions in the discharge line that will have the effect of increasing the discharge pressure above that of the design value. It is important that the discharge line is the correct size. If the discharge pressure is increased beyond the design value, the thermocompressor will not operate correctly or efficiently.

Steam Supply

For an efficient design, it is essential to know the minimum motive (supply) steam pressure that will be supplied to the thermocompressor.

Under critical flow conditions, the lowering of the steam pressure below that of the design value can cause the thermocompressor to become unstable in operation. Under sub-critical flow conditions, lowering the steam pressure below that of the design value can result in a serious loss of capacity, coupled with a loss of compressive ability.

Conversely, the use of steam pressures above that of the design value will not enhance the performance of the unit. If the steam pressure is considerably above that of the design, the performance could be adversely affected because the throat of the nozzle and diffuser is overloaded.

Wet steam will result in poor performance and will erode the internal components of the thermocompressor. In all cases, the steam quality should be high (dry steam). The supply (motive) steam can be superheated, but any superheat present in the steam supply must be taken into consideration at the final design stage. Significant amounts of superheat will affect the unit’s performance and the steam nozzle and diffuser throats could be undersized.

Inspection

To ensure trouble-free service and obtain maximum operational efficiency, it is recommended that a periodic inspection of the thermocompressor internal components be conducted. The frequency of this inspection will depend on the type of service and the quality of the steam supply. A thermocompressor that is used in corrosive or erosive service must be inspected more frequently than one that is used in non-corrosive or non-erosive service. An acceptable minimum practice would be to inspect the thermocompressor annually. The main components to inspect include the nozzle, diffuser, spindle tip, and the shut-off plug. A visual examination will normally be all that is required. If the diffuser and steam nozzle is smooth and round and neither erosion nor corrosion is found, then replacement is not required.
Troubleshooting Thermocompressor Performance

Although normally efficient and trouble free, thermocompressor performance may be less than optimal. Reasons for poor performance are listed below.

External Causes of Poor Performance

1. Low motive steam pressure
2. Wet motive steam
3. Differential too high
4. Incorrect discharge pressure
5. A change in load
6. Attempting to operate outside the design range

Internal Causes of Poor Performance

1. Eroded or corroded internal parts
2. Blocked nozzles and/or diffusers
3. Cracked or worn parts
4. Leakage from the high pressure area to the low pressure area
5. Misaligned nozzle and spindle assembly

In new installations, clogged steam nozzles could also be a source of trouble. If the nozzle inlet is red or black, look for scale deposits that can be removed by careful scraping and subsequent polishing.
Unique Selling Proposition

Kadant offers a complete line of recirculating and booster thermocompressors. Our high-efficiency design is based on the actual syphon characteristics and drying constraints of the steam section. Kadant is the only company that manufactures syphons and thermocompressors, and engineers steam and condensate systems. This gives Kadant the unique ability to match its thermocompressors to the needs of the specific application.

Customer Value

<table>
<thead>
<tr>
<th>Feature</th>
<th>Customer Value</th>
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<tr>
<td>Thermocompressor and syphon characteristics are matched</td>
<td>Maximized energy efficiency</td>
</tr>
<tr>
<td>Nozzle and throat size based on specific operating conditions</td>
<td>Improved performance</td>
</tr>
<tr>
<td>Retrofit to competitive installations without piping modifications</td>
<td>Low cost upgrade to improved efficiency</td>
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<td>Papermaking process knowledge and application expertise</td>
<td>Improved energy utilization</td>
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<tr>
<td>Dryer drainage systems expertise</td>
<td>Steam system integration</td>
</tr>
<tr>
<td>Managed differential control option</td>
<td>Eliminates “choking”, maximizes performance</td>
</tr>
<tr>
<td>Optimized thermocompressor geometry</td>
<td>Wider operating range, less motive use</td>
</tr>
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Industries and Applications Other than Paper

Petro-Chemical
Processing equipment such as dryers, stills, strippers, and deodorizers usually discharge steam at relatively low pressures. A thermocompressor compresses this vapor to a reusable higher pressure. Thermocompressors are also used for the removal of column head vapors.

Desalination
Multi-stage evaporators used in seawater desalination utilize thermocompressors after the final stage to capture and recycle steam energy that might otherwise be wasted.

Foodstuffs, Chemical, Pharmaceutical
Evaporating systems; for example, for milk, fruit juices, tomato paste, wastewater, chemicals, seawater, and the heating of distillation columns. Significant savings can result from recompressing the vapors removed from the food products and then returning them to the process at a higher temperature.

Breweries
Re-utilization of vapors coming from the boiling / evaporation process.

Pulp / Cellulose Industry
Steam recovery in TMP systems.

General - Waste Heat Recovery Systems
It is in the area of energy conservation that the thermocompressor exhibits its most cost-effective advantage. In this type of application, “waste” high temperature condensate is collected in a centralized flash chamber then flashed at atmospheric temperature and re-circulated. Condensate from heating jackets or kettles can be flashed and recompressed by the Thermocompressor and then recirculated to the jacket.
Selling Strategy

When talking to prospective customers, focus on:

- Kadant has developed advanced analysis tools in conjunction with R&D testing to provide thermocompressors with operating efficiency above that of conventional units.
- Operational efficiency means less motive steam use, higher energy efficiency, and a wider range of operation.
- Kadant’s dryer drainage knowledge gives us the ability to check the sizing of the syphons, separator tanks, flow orifices and lines to ensure correct thermocompressor application.
- Kadant is the only thermocompressor manufacturer that can accurately predict syphon characteristics and match them with thermocompressor performance.
- Kadant has the process knowledge to match the thermocompressor with the paper machine operating requirements.
- Design advantages and distinctions (listed above).
- Technical support and service available worldwide in 150 countries.
- Retrofit capability to S&K and Fulton.

Sales Collateral / Reference Material

Bulletins / Brochures

- Thermocompressor Bulletin
- Thermocompressor O&M Instructions
- Technical Paper – Achieving High Efficiency Thermocompressor Operation

Sales Presentations

- PowerPoint Presentation – Thermocompressors
- Video animation

*The above items are available from the Kadant Johnson Intranet.*
Five Principles of Achieving High Efficiency Thermocompressors
(excerpt from Kadant technical paper presented at the TAPPI Engineering Conference, October 2007)

In order to achieve high efficiency operation of a thermocompressor section, the thermocompressor design must be driven by the actual syphon characteristics and drying constraints of the steam section. Required differential pressures, blow-through steam flows, dryer pressures, condensing loads, and machine speeds are taken into account over the range of grades produced.

1) Minimize the Load on the Thermocompressor

Once the drying parameters are understood, the amount of blow-through steam to be recompressed should be minimized. Differential pressures should be minimized, accurately monitored, and controlled. In many cases, differential pressures are not minimized due to poor transmitter installation and uncalibrated equipment. Differential pressure set points are run at the “worst case scenario”, often with additional safety factors added. Accurate differential pressure indication is the first requirement for proper syphon operation and optimization of thermocompressor motive steam use.

There is often justification for changing from rotary to stationary syphons based on the reduction in thermocompressor motive steam. Since condensate is not subjected to centrifugal forces with stationary syphons as it is with rotary syphons, the differential pressure requirement when using stationary syphons is much lower. Many machines run differential pressures as low as 3 psi with blow-through rates in the 8% to 12% of condensing load range with stationary syphons. This is compared to 12 to 15 psi and 20% to 40%+ blow-through rates with rotary syphons. Stationary syphons inherently will require less motive steam, provided the thermocompressors are properly sized. Modern stationary syphons have proven to be highly reliable, and when matched with dryer bars, drying capacity increases and surface temperature uniformity is achieved.

In some cases, condensate and blow-through steam piping are undersized. This creates excess pressure drop requiring excessive differential pressures. Lowering blow-through flows with proper syphon sizing and design lowers velocity in these lines. The sizing is less critical and erosion is reduced. In one mill, over $100,000 in annual piping replacement cost was due to excessive line velocity caused by poor thermocompressor sizing and operation.

In some cases, the condensate separator tanks are too small to provide efficient condensate / blow-through separation. Condensate carryover with the blow-through steam can result. Erosion of the thermocompressors and inaccurate measurement of the blow-through steam flow is the result. Often the separator tank internals are worn and may even be missing, further allowing for condensate carryover. A proper separator removed 98% or more of the condensate from the dryer discharge.

2) Properly Size Thermocompressors

Thermocompressors should be sized based on actual operating conditions with appropriate safety factors for suction flows. The actual pressures of the motive steam at the thermocompressor rather than “header pressure” values should be used when sizing the thermocompressor. If the motive steam pressure variations are not well understood, poor thermocompressor sizing and operation will result.

The motive steam pressure should be at least 1.4 times the suction pressure (absolute pressure) to achieve good performance. Since care should be taken to minimize the load on the thermocompressor, accurate pressures for suction pressure (i.e., discharge pressure less differential pressure and line losses) should be utilized.
3) **Optimize Thermocompressor Geometry**

Specific geometry variations within the thermocompressor greatly affect its performance and efficiency. Computational modeling shows that two different thermocompressor designs use greatly different amounts of motive steam. In this example, the motive steam pressure (Pm) was 390 psig, the dryer section pressure (Pd) was 120 psig, and the suction pressure (Ps) 108 psig. Blow-through flow was 12,500 pph. Figure 1 shows how, for this set of operating conditions, a high efficiency thermocompressor can be installed which will use less motive steam. In this case, the motive steam was reduced from 8,900 pph to 6,900 pph, a 22% savings. This was realized by optimizing the geometry of the thermocompressor assembly. This is typical of the savings in motive steam that can be gained by using high efficiency thermocompressor geometry in place of conventional designs found in the industry.

![6" TC Projection by CFD Analysis at Pm=390, Ps=108, Pd=120](image)

**Figure 1: Comparison of Two Different Thermocompressor Geometries.**

4) **Properly Manage Differential Pressure and Blow-through Set Points**

Differential pressure control is one of the more common methods to control a thermocompressor loop. Differential pressure requirements to evacuate a given dryer can vary greatly. Machine speed, dryer pressure, syphon type, syphon design, and condensing load dictate the differential requirement. Operators will typically set differential pressures to the level that will prevent dryer flooding for all operating conditions. The “worst case” differential pressure is excessive for most operating conditions, resulting in higher motive steam flows and wasted energy.

Another method that is used to control a thermocompressor loop is to measure the blow-through flow coming from the separator tank and vary the thermocompressor opening to control the amount of blow-through steam flow. Differential pressure varies as the operating pressure and condensing load changes. The blow-through flow is controlled to a constant percentage of the condensing load in the dryers. Controlling blow-through steam flow simulates the syphon requirement, but it does not take into account the minimal differential requirements of syphons. Blow-through flow control requires very good condensate separation in the separator tanks or the...
measurement will be inaccurate. New high efficiency separator tanks are often required to implement blow-through flow control.

A recent Kadant development for controlling dryer evacuation and minimizing blow-through is through managed differential control. Algorithms continuously calculate the required differential pressure based on the syphon curves, operating pressure, machine speed, and sheet-on status. Operators are not required to establish the set points. The correct differential pressure is always present and the amount of motive steam used is minimized. Differential pressure is automatically reduced on sheet breaks to prevent venting and steam waste.

5) Prevent “Over the Top” Operation

The thermocompressor design must accommodate the operating pressure range of the drying system. The diffuser throat size is based on the low pressure operating point and the nozzle size is based on the high pressure operating condition. This can lead to the condition where there can be too much motive steam flow when operating at low discharge pressures. Excessive motive steam flow can lead to “over the top” operation. This condition is also commonly referred to as “choked flow,” although this term is misleading. “Over the top” occurs when the thermocompressor no longer increases suction flow with increasing motive flow. With traditional methods of control, operation in the over the top region will result in the thermocompressor going wide-open, consuming maximum of motive steam. The control action will open the vent valve once the thermocompressor has reached maximum opening. This will result in steam waste and is the most inefficient operating point for the system. “Over the top” operation must be prevented.

Figure 2 shows one example of an “over the top” thermocompressor curve. In this example, three conditions of the same thermocompressor are shown. In the low pressure case, over the top operation occurs at approximately 80% opening. After 80% open, the control loop has a reverse process gain and the control action will force the thermocompressor to run wide open.

“Over the top” operation can be eliminated with proper thermocompressor sizing, utilizing the correct differential pressure set point, and through DCS logic. Managed differential pressure control ensures that the operators do not use excessive differential set points that will force “over the top” operation. Knowing the thermocompressor sizing and operating characteristics, the “over the top” point can be calculated using algorithms programmed into the DCS. The logic prevents the thermocompressor from going into the “over the top” position based on the operating conditions for the thermocompressor. This logic requires a full understanding of individual thermocompressor curves.

Figure 2: An Example of a Thermocompressor Operating “Over the Top”
S&K
Source: www.s-k.com

S&K divides its thermocompressors into two categories based upon the type of performance:

1. Non-critical Compressors refers to units whose absolute pressure at the compressor discharge is less than 1.8 times the absolute pressure at the suction. When the performance is noncritical, a constant pressure can be maintained at the suction of the compressor, at varying capacities, by controlling the motive flow. These types of units are furnished with a spindle that can be controlled either manually or automatically.

2. Critical Compressors refers to units whose absolute pressure at the discharge is equal to or greater than 1.8 times the absolute pressure of the suction. When performance is critical, control cannot be exerted by means of the motive fluid. In order to control the suction pressure of such a unit at varying process loads, it is necessary to maintain a constant load on the compressors by addition of a secondary suction fluid, or to vary the suction pressure at the compressor by introducing an artificial pressure drop in the suction line.

Type 426 Jet Compressors (shown in Fig. 7)

Type 426 Jet Compressors have automatically controlled spindles. They are used when pressure, suction, or discharge conditions vary and it is necessary to control discharge pressure or flow. These units are made in 3” through 24” sizes with flanged connections.

The spindle can be operated with a diaphragm, piston, or motor actuator using any standard instrument signal - electric or pneumatic. The control is activated by temperature, pressure, flow or suction to motive gas ratio.

Type 426 Compressor spindles are designed to act as temporary valves and provide tight shut-off. For temperatures above 400F, spindle and seat are hard-faced to resist wear.

Standard materials are steel body and diffuser with stainless steel nozzle and spindle. Standard flange ratings are 300 lb., but other ratings can be furnished, as required.

Type 439 Jet Compressors

The Type 439 Compressor is the threaded-connection version of the Type 426 Compressor described above. All connections are threaded; otherwise, this unit is the same as the Type 426. Standard materials include cast iron, bronze, and steel, with stainless steel nozzle and spindle.

Type 420 Jet Compressors

The Type 420 Compressor has no regulating spindle. The pressure connection is threaded, the suction and discharge connections are flanged, and the nozzle is threaded into the body for removal and maintenance. This design can be supplied in steel, stainless steel, bronze, or a modified epoxy resin containing silica fillers. Standard materials are ductile iron body and diffuser with stainless steel nozzle.
Competition

Fulton

Source: www.fultonsystems.com

The company was founded in 1924 and serves (primarily) the U.S. paper market. Its greatest advantage is its large installed base in the U.S. Its thermocompressor line offers no technical advantages and is considered “old” technology. According to the company, it has sold more than 2,000 thermocompressors.

Products & Services

Fulton Systems, Inc. is a supplier of products and services for dryer section steam and condensate systems, including dryer drainage. Products include:

- Thermocompressors
- Condensers
- Desuperheaters
- Vacuum Receiver Modules
- Separator Modules
- Collections Modules
- Controllers, Transmitters and Control Valves
- Dryer Drainage Equipment
- High and Low Speed Rotary Joints & Syphons
- Dryer Section Performance Audits
- Steam & Condensate System Design
- Start-up Services

Fulton offers a thermocompressor rebuild program consisting of:

- An evaluation the thermocompressor application.
- Rebuild to original or new performance specifications.
- Rebuilt units will have a new unit warranty.
- Total rebuild price guaranteed not to exceed 65% of list price of new unit.
Körting Hannover AG

Source: www.koerting.de

Körting is a Hannover, Germany-based manufacturer of ejector equipment and systems for process industries. The company was founded in 1871 as GEBRÜDER KÖRTING (Körting Bros.). In that same year, Körting designed and constructed an “injector” as a steam jet boiler feed pump. Within a few years, various types of ejectors were developed building on this earlier design and today are used in various process industries. The company has three divisions:

- Jet-Pumps / Vacuum technology
- Waste gas purification / Environmental technology
- Industrial and process heating / Firing technology

Its thermocompressor line utilizes a high-efficiency design and is considered (by Kadant Johnson) as one of the better designs in the market today.

The Körting line is *priced at a premium* and is not actively marketed in North America. Marketing activities are primarily found in Europe, with some representation in China and Russia.
Professional Services

One of the most effective ways to sell Kadant products is by leading with services. Services include on-site analysis of thermocompressor operation, proper sizing, inspection and trouble-shooting, installation supervision, and installation contracting. Professional services from Kadant can demonstrate to a customer or prospective customer the benefits and financial return of the Kadant equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision and/or installation of Kadant equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Thermocompressor rebuild or replacement

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and employees that are more experienced.

- Explanation of function of the dryer drainage equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

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<td>Ready to Ship Date:</td>
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Lead Time

The standard lead-time is the time required, under normal business conditions, from placement of an order until delivery of the product to the customer.

Typical delivery is six weeks after receipt of order. Delivery information for all orders should be confirmed with the Kadant factory. Thermocompressors are manufactured at the Kadant operations in Summerstown, Ontario, Canada.

Pricing

Consult factory for application-specific pricing. Special versions will be priced higher than standard configurations unless the order quantity is large. A typical thermocompressor price ranges from USD 15,000 to 25,000.

All requests for pricing and application of thermocompressors should be directed to the Systems division of Kadant Johnson (Lenoir City or Ilkley).

Required Information to Place an Order

- P&I diagram
- Green sheet data for paper machine applications
- Motive steam pressure
- Suction steam (low) pressure
- Consultation with Kadant Johnson Systems division
March 3, 2008

**Turbulator Tube Bar Application Summary**

**Product Focus**

**Steam Heated Paper Dryers**

Turbulator bars were developed and patented by Kimberly-Clark in the late 1970’s. The bars increase the heat transfer rate through the dryer shell by inducing turbulence in the rimming condensate film.

**Cooling Roll and Swing Roll Configurations**

Cooling rolls and swing dryers require additional corrosion protection due to the air present in these applications. This also applies to dryers that are routinely shut off during paper machine operation. The cooling roll configuration consists of stainless steel compression bolts, stainless steel nuts, plated hoop rings, and standard stainless steel tube bars.

**Syphon Configurations**

The best way to determine the optimum syphon configuration is to run trials at the Kadant Johnson Research and Development Center.

**Stationary Syphons**

Stationary syphons will provide the best performance at the lowest differential pressures.

**Single Rotating Syphons**

Rotating syphons will provide good thermal performance when elevated differential pressures are available. The syphon sizing should be checked based on the current operating conditions. The rotary syphon blow through flows can be reduced when used with Turbulator bars.
Dual Rotary Syphons

Dual rotary syphons were used in many paper dryers before Turbulator bars were developed. Turbulator bars do not require dual syphons. The best option is to convert to stationary syphons. The next best option is to convert the dual syphons to a properly sized single rotary syphon.

Product Information

The Turbulator Tube bars are designed per AB97-14-4-01, drawing AB9940 and A97-14-4-08, drawings A46376 and A46377.

See the Kadant Johnson intranet for the Turbulator bar NPI showing additional product information. The NPI includes: product overview, sales strategy, product description, targeted customers and applications, competition, and frequently asked questions.

See Kadant Johnson intranet for the PowerPoint presentation.

Technical Description

The current Turbulator bar configuration is the best design available. The design eliminates the issues of previous designs including bar erosion, cap screw failures and spring failures. The NPI describes the features and benefits in detail.

Edge Control Bars

Edge control bars are used between the stationary syphon pick-up fitting and the dryer head. They are required when the sheet extends outboard of the syphon pick-up fitting. Edge control bars minimize the possibility of a wet edge.

Groove Control Bars

Some machines have dryers with grooves in the shell for the stationary syphon. Our testing shows the best solution is to locate the syphon pick-up fitting outside the groove and install
groove control bars in the dryer groove. The best way to determine the equipment configuration is to run trials at the Kadant Johnson Research and Development Center.

Product Implementation

Detailed drawings of the existing equipment are desired. The drawings required include the following:

- Dryer assembly drawing
- Dryer journal and head detail drawings
- Balance weight location and projection into dryer
- Dryer shell detail drawing

Most mills do not have these detailed drawings. When this is the case, Kadant Johnson will obtain the required dimensions during a shutdown. We will need to enter a dryer to obtain the required dimensional information.

See the Kadant Johnson corporate intranet for detailed “Installation Instructions”.

An installation video is also available. The video demonstrates the ease of installation, which can be used to enhance the Sales process.

Competition

There are three significant competitors in North America:

1. Deublin (located in Waukegan, Illinois) has a full line of rotary joints and ancillary equipment that competes with Kadant Johnson in most markets. Deublin’s purchase of Sint (Italy) provided them with a ring bracket mounted face seal joint and a stationary syphon.

   Deublin provides negative comments regarding the stainless steel tube bars Kadant Johnson supplies. They claim that the stainless steel bars can be a problem based on the difference in coefficients of thermal expansion of stainless steel compared to the cast iron dryer.
The following is Kadant Johnson’s response regarding the potential bar movement based on differential thermal expansion. The stainless steel bars have provided very good performance. There have been no issues with the stainless steel bars. They will not abrade the shell. Since stainless steel has a higher coefficient of thermal expansion than mild steel, customers have expressed some concern. If the bars are 50 degrees F (38 C) hotter than the dryer shell, the bars could move 0.013” (0.3 mm) based on the hoop spacing of 27” (686mm). Kadant Johnson configures the bars with a gap between each bar section to accommodate any minor thermal expansion. The mild steel bars will move as well even though the coefficient of thermal expansion is close to cast iron’s coefficient. This is because the bar is going to change temperature faster than the shell. Differential thermal expansion of bars of any type has not been an issue.

Deublin uses a double hoop segment to bolt the ends of the bars together. Since the bars are bolted together they expand and contract like a one piece bar the length of the dryer. With this type of design, if the bars are 50 °F hotter than the shell a 250” (6350mm) bar could move .081” (2 mm).

2. Metso, formerly Valmet, is a global paper machine manufacturer based in Finland. They manufacture their own equipment for their paper dryer applications.

3. Voith is also a manufacturer of paper machines based in Germany. They also manufacture their own dryer equipment.

Kadant Johnson has a proven record of product performance and parts availability that will outperform the OEM equipment.

See the NPI for more details regarding the competition.
International Paper

International Paper has identified several application standards for dryer hardware. These standards are shown on Kadant Johnson USA drawing C2467, and summarized below. Kadant Johnson developed product standards in conjunction with the International Paper Manufacturing Technology Center for Air and Drying System Optimization. These standards apply to all International Paper projects that require IP corporate capital review.

The following summarizes these standards, as well as the reasoning behind the selections. All Kadant Johnson sites should follow these standards when quoting Kadant Johnson products to International Paper for major capital projects.

Turbulator Bar Standards - Projects for International Paper

1. **Bar material**: Carbon steel bars – 0.5” x 1.0” cross section

   Note: The Kadant Johnson carbon steel Turbulator bars will provide the same heat transfer performance as the Kadant Johnson stainless steel Turbulator Tube bars (similar cross-section) when both are operated under the same conditions (the same syphon clearance and syphon shoe design).

2. **Bar count**: (18) axial bars in 5’ (1.5 m) diameter dryers
   (21) axial bars in 6’ (1.8 m) diameter dryers

   Note: Each of the hoop segments are identical, the optimum condensate depth remains similar for both 5’ and 6’ dryers, and the heat transfer rate is high over a wide range of operating conditions.

3. **Hoop segments**: Carbon steel 0.375” x 2” cross-section, bent ends and gussets

   Note: The hoop ends are bent to 90° to form a one-piece solid support for the compression bolts. Each end is reinforced with two 2”x2” gussets (ribs). Differential thermal expansion of the hoop will be taken up by bending of the hoop at the end of the gussets rather than by flexing of the bent ends.

4. **Hoop tensioning**: M16 x 2 compression bolt with two locking nuts
Note: These compression bolts can be installed using a pneumatic driver. They have a long travel to facilitate installation. The nuts can be secured by upsetting the threads (with a hammer and chisel) or by using the second nut to lock it in place. Kadant Johnson and International Paper both prefer the latter method.

5. **Bar connections**: Captured carbon steel pins

   Note: These pins are stepped so that they are captured inside the Turbulator bar when they are installed. They have a larger cross-sectional (shear) area than the equivalent WhizLock bolt and are easier to install. There is no risk of cross threading, under-tightening, or overtightening.

6. **End-gaps for bars**: 10-15 mm (approximately 0.5”)

   Note: The mid-shell (average) temperature of the dryer is less than the operating temperature of the Turbulator bars. As a result, the bars will grow axially more than the dryer shell. The small gap between the ends of the bars allows this expansion to occur without having the bars buckle or slide along the dryer surface when the dryer is heated. The gap also facilitates the installation and alignment of independent segments.

**Stationary Shoe Standards – Projects for International Paper**

1. **Shoe material**: Fully-annealed ductile iron

   Note: Ductile iron has a high tensile strength, but it will not damage the dryer shell if it is fully annealed.

2. **Shoe contour**: Wide face, large internal flow area, large flow radius

   Note: This is a new syphon shoe contour for Kadant Johnson. It is to be proposed for all capital projects for International Paper. The large flow area and increased radius reduce the tendency for erosion of the ductile iron material.

3. **Shoe thickness**: Heavy wall along the back of the “throat”

   Note: Ductile iron will erode / corrode, more so in dryers with aggressive condensate (acidic) and high differential pressures (high blow through flow rates). As such, it is considered a consumable syphon component. The increased wall thickness in the throat, however, allows for more erosion before the shoe must be replaced. This, coupled with the increased flow area and larger radius, will provide acceptable service life in most commercial applications.

4. **Shoe clamp**: Double-bolted, double-cut
Note: This clamping mechanism has been a very successful design for stationary syphon shoes. It prevents the syphon shoe from slipping down the vertical syphon pipe or rotating on the syphon pipe. This design has been adapted to the new shoe.

5. **Clamp orientation**: Circumferential orientation

Note: The circumferential orientation of the syphon shoe clamp reduces the potential for mechanical interference with balance weights on the dryer head or connections on the Turbulator hoops. It also reduces the frontal area of the shoe to minimize drag in the event of heavy drying flooding.

6. **Safety stop**: Stainless steel bolt threaded into the shoe, through the syphon pipe

Note: The double-bolt double-cut syphon shoe clamp is a positive method of securing the shoe. The stainless steel safety bolt provides back-up protection in the event the two bolts fail. The safety bolt prevents the shoe from dropping and prevents it from rotating on the syphon pipe.

7. **Shoe angle**: Straight radial or 60° angle

Note: Kadant Johnson will have three standard stationary syphon shoes for International Paper: Radial straight, right-hand angled, and left-hand angled. The selection will be machine-specific. The shoe that allows the least distance to the dryer shell flange, with the shortest support tube, will be used.

8. **Syphon shoe clearance**: 6 mm (0.25”)

Note: For paper dryers operating above the rimming speed (about 300 mpm, 980 fpm), neither Kadant Johnson nor International Paper would recommend using a cantilever stationary syphon without dryer bars. For paper dryers with Turbulator bars, the syphon clearance should be set at 6 mm (cold clearance). This is the maximum allowable syphon clearance for International Paper projects and it provides high heat transfer rates and uniform cross-machine temperature profiles. The minimum allowable syphon clearance for International Paper is 4 mm (0.16”).

9. **Syphon designation**: HDDS

Note: The abbreviated name for this syphon shoe is HDDS, “Heavy Duty Ductile Stationary”.

**Syphon Support System – Projects for International Paper**

1. **Support tube construction**: One-piece carbon steel construction
Note: The syphon horizontal support tube is machined from one-piece. If a welded segment is required, it will not be in a high-stress, high-load area.

2. **Support tube clearance:** 5 mm

Note: It is recommended that the clearance between the stationary support tube and any rotating component be at least 5 mm (0.2”). The minimum allowable clearance is 3.8 mm (0.15”). This requirement applies to the entire length of the support tube. The minimum allowable clearance requirement cannot be compromised.

3. **Support tube contour:** Tapered tube

Note: The tapered tube provides more clearance between the tube and the journal bore / dryer journal insulating sleeve. The taper also reduces the weight, increases the natural frequency, reduces the bending stress, and increases the flow area outside the tube.

4. **Support Tube Attachment:** Tapered seat and hollow bolt tensioning

Note: A single large-bore hollow bolt is used to lock the horizontal support tube into the tapered seat in the body of the rotary joint. This bolt is used in place of the conventional capscrews that are prone to failure.

5. **Vertical support:** Fully-annealed, one-piece, cast ductile iron bracket

Note: The contoured cast bracket provides increased clearance to the dryer head (for the dryer manhole and balance weights) and increased operating reliability (no welds).

6. **Axial syphon adjustment:** Collar adjustment +/- 2”

Note: The vertical support bracket can be moved toward the dryer head or away from the dryer head, to accommodate variations in the size and position of dryer balance weights or differences in dryer shell construction (flange contours).

7. **Syphon pipes:** Stainless steel tubing, heavy wall

Note: Carbon steel pipes corrode in service and reduce the integrity of the syphon piping. The stainless steel tubing will not corrode. The heavy wall of the tubing provides increased bending stiffness to the syphon pipe that extends below the bottom clamp of the vertical support bracket.

8. **Flow passages:** The selection of flow configuration will be machine-specific.
International Paper prefers that the supply steam flows into the dryer only through the inside of the horizontal support tube (in the annulus between the horizontal syphon pipe and the horizontal support tube).

To accomplish this, there should be steam ports in the horizontal support tube, but not in the rotary joint body. This may not be possible to do this in a dryer that has a small diameter journal bore, and still maintain the required 3.8 mm (0.15”) clearance. Where this is possible, a special PTX body is required (one without steam ports in the body) for 9800 PTX applications. For 9750 PTX applications, a special horizontal support tube is required (one with steam ports in the tube) and a full-length horizontal syphon pipe.

Note: The 9750 PTX joint is generally used for dryers with low steam flow rates, with small diameter support tubes when the dryer journal bore is limited in size. In the standard 9750 PTX joint, steam flows into the dryer through the annulus between the horizontal support tube and the dryer journal (or insulating sleeve). This makes the best use of the limited flow area through small dryer journal bores and minimizes the amount of cantilevered weight. This PTX configuration should be used if needed to provide the required clearance between the support tube and the rotating components.

The 9800 PTX joint is generally used for dryers with large steam flow rates, with larger diameter support tubes when the dryer journal bore is large enough for both an insulating sleeve and a large diameter support tube. In the standard 9800 PTX joint, steam flows into the dryer through an annulus between the dryer journal/insulating sleeve and the horizontal support tube and between the horizontal support tube and the horizontal syphon pipe. This makes use of all of the possible flow area. This PTX configuration should be use if needed to provide additional flow area for large-condensing rate dryers.

Kadant Johnson can provide any of these configurations. The selection for any specific order depends on the flow requirements and the diameter of the dryer journal bore.

**Sales Notes:**

1. Kadant Johnson Sales should use the above specifications for all proposals for major capital projects for International Paper.

2. In order to provide consistency of product offerings and product performance, all proposals for major capital projects for International Paper (in all territories) be sent to Tim Rourke prior to sending to International Paper. In general, for such projects, alternative equipment configurations should not be proposed.

3. If local mill preferences require modification of the proposal, review the requirements with Tim Rourke (Kadant Johnson Product Applications Manager).
4. Tim Rourke will serve as the technical coordinator between Kadant Johnson and the Corporate Technology Group of International Paper. He will serve as a clearinghouse for sharing Kadant Johnson developments, communicating changes to the International Paper requirements, and coordinating service and technical support.

Model of Kadant Johnson HDDS ("Heavy Duty Ductile Stationary") Syphon Shoe
Operating Issues and Problem Solving

The following are issues that have been experienced during the installation and operation of Turbulator bars.

The Turbulator bar design can be installed much faster than any other bar design.

A contractor was installing our bars and it took an excessive amount of time. They did not read our installation instruction, in particular the use of magnets to support the hoop rings. They used safety wire to hold the assembly together prior to tightening the compression bolts. As the compression bolts were tightened the safety wires were removed.
**PRODUCT introduction**

**Turbulator® Bars**

**General Customer Availability:**

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The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

**Record of Changes**

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Product Description

Turbulator bars are a series of equally spaced axial bars that are held against the inside surface of a paper dryer. When properly spaced, these axial bars generate turbulence in the rimming layer of condensate, increasing the drying capacity and the drying uniformity. Other benefits of these bars include improved runnability, shorter response time after a sheet break, and savings in drying energy.

The bars are held against the inside surface of the dryer cylinders with a series of ring segments. The ring segments are tightened with a new compression bolt. Previous designs used various types of coil springs, brass turnbuckles, and cap screws with Belleville washers. The new design is simpler, more robust, and much easier to install.

Concept Overview

The steam inside dryer cylinders condenses as it transfers its (latent) heat to the dryer shell. At low dryer speeds, the condensed steam (condensate) that forms inside the dryer will tumble around in a condition called cascading. The turbulence in this tumbling condensate is very high, so that the heat transfer through cascading condensate is also quite high.
At higher dryer speeds (above the rimming speed), the condensate will rotate with the dryer. There is, however, a natural tendency for rimming condensate to slosh back and forth inside the dryer, as it rotates. This sloshing motion causes some degree of turbulence in the condensate layer that, in turn, helps to keep a high rate of heat transfer through the condensate layer. As the dryer speed increases far above the rimming speed, this natural sloshing motion and the resulting heat transfer rates are progressively reduced.

Johnson Turbulator bars are placed inside the dryer to increase the condensate turbulence to levels much higher than that produced by the natural sloshing motion in a rimming layer. With bars in the dryers being properly spaced, the natural sloshing motion will resonate between the bars, producing very high heat transfer rates, even at high dryer speeds. This resonant behavior in the condensate can cause a significant improvement in both drying capacity and drying uniformity.

Kadant Johnson has videotapes showing this motion in an operating dryer cylinder. No other company in the world has this impressive capability. It should be used by Kadant Johnson Sales to both educate the customer and to show Kadant Johnson’s technical capabilities.

Applications

Turbulator bars can significantly increase the drying capacity and improve the drying uniformity in machines with paper dryers operating above the condensate rimming speed. Turbulator bars may be used in dryers with stationary syphons or in dryers with rotating syphons.

Condensate normally begins rimming at a dryer speed of about 335-365 mpm (1100-1200 fpm). The expected improvement in drying capacity and drying uniformity becomes progressively greater as the machine speed increases. Turbulator bars generally provide measurable improvements at speeds above 410 mpm (1350 fpm), but can also have advantages at lower speeds. A good guideline for application of Turbulator bars occurs when the value of the dryer speed (in fpm) multiplied by the condensing rate (in lb/hr-ft²) is above 10,000.

If bars are not being installed in all dryers, the best location for maximum improvement in heat transfer and drying capacity will be those dryers that are operating with the highest condensing rates (typically those dryers with the highest steam pressures, i.e. dryers in the main section, in the "constant rate" zone).

Edge Control™ Bars

Rotating Syphons. In dryers with rotating syphons, the Turbulator bars should extend from one end of the dryer to the other, with a 50 mm (2") gap at each end. No Edge Control bars are required.

As an option, two Edge Control segments, one for each end, can be provided. These can be used for fine adjustment of the dryer edge temperature profile, if the machine later experiences problems with wet edges or with dry edges. Kadant Johnson Research can provide simulation trials for making these adjustments.

Each of the Edge Control bar segments is 200 mm (8") in length. Each segment is held by one ring. The segments use the same number of bars as the main section of bars and are held with the same compression bolt system.

If the dryer has a syphon groove, the main bars should extend to the edge of the groove. An Edge Groove Control section of bars should be installed in the groove. Because the condensate layer in the groove is larger than the condensate depth on the main portion of the dryer, the Groove Control section will have a smaller number of bars. Kadant Johnson Engineering has details on the Groove Control bar count. If the distance outboard of the groove is more than 100 mm, then a second Edge Control segment should be installed in this area.

Stationary Syphons. There are several Edge Control bar application options for dryers with stationary syphons, depending on whether the dryers have plain bore shells or circumferential syphon grooves.

If the stationary syphon can be positioned close to the dryer head flange (within 100 mm), then no Edge Control bars are required. The swept-back syphon shoes can be used to minimize this distance. Reference syphon shoes
for the PTX are SS2493-2R and SS2493-2L (right- and left-hand ductile iron syphon shoes) and SS2493T-3 (this clamp pad can be used with Teflon tip SS2593T-11 for either right-hand or left-hand installations). Teflon tipped syphon shoes are recommended for longest service life.

As an option, two Edge Control segments can also be provided with the stationary syphons, one for each end. These are also used for fine adjustment of the dryer edge temperature profile. The straight syphon shoe is generally used in these applications. The plated ductile iron shoe is SS2493-4. The Teflon tip shoe is SS2493T-6. Each of the Edge Control segments is 200 mm (8") in length. Each segment is held by one ring. The segments use the same number of bars as the main section of bars and are held with the same pins / compression bolt system.

If the dryer has a syphon groove, the stationary syphon can be placed in the groove with the bars extending from the edge of the groove to the opposite end of the dryer. The syphon clearance should be increased by an amount equal to the depth of the groove.

If the syphon is in the groove and is close to the dryer head flange (within 100 mm), then no Edge Control bars are required. The stationary syphon will increase the turbulence in the condensate in the groove, which will tend to level the dryer temperature profile. The only tool available for fine adjustment with this configuration is the syphon clearance. Increasing the clearance will tend to reduce the temperature below the syphon. Decreasing the clearance will tend to increase the temperature below the syphon. The amount of change depends on the dryer speed. These changes in syphon clearance will also change the depth of condensate in the main section of bars, which in turn will lower the dryer heat transfer capacity. This is an acceptable offering, but it has less flexibility for edge temperature control.

For improved control of the edge temperature profiles, the straight stationary syphon can be positioned just outside the groove. Two Edge Control bar segments are then provided, one in the syphon groove and one at the opposite end. The one at the opposite end has the same number of bars as the main section (unless there is a groove) and it is used for fine adjustments. The segment that is placed in the groove would have a different number of bars than the main section. The number of bars is selected specifically to equalize the dryer surface temperature. Kadant Johnson determines the correct number of Edge Control bars for each application, based on test results from Research.

Note: Kadant Johnson Edge Control Bars are often referred to (in a derogatory fashion) by the competition as “mini-bars” or “baby-bars”.

Benefits

Properly spaced bars will produce resonant waves in the condensate layer, increasing the level of turbulence and the transfer of heat through the rimming layer. This increased heat transfer rate is much more uniform in the cross-machine direction than any dryer syphon configuration. These features can be used in dryers with rimming condensate to:

- Increase the drying rate of machines that are already running at their steam pressure limits
- Reduce steam pressure in dryers that run at the same production.
- Increase the rate of response to changes in steam pressure
- Improve the moisture profile on machines that have poor condensate heat transfer uniformity (dryers with old rotary syphons or any dryers with stationary syphons)
- Improve the moisture profiles and machine runnability, and reduce edge cockles, cracks and sheet picking
- Reduce the time required to thread the tail and widen the sheet

Stationary syphons have a natural tendency to produce hot edges (due to the higher condensate turbulence around the stationary syphon). Turbulator bars produce heat transfer rates that are equally high, so they are a natural addition to a dryer with stationary syphons. For most paper machines running above the rimming speed, the application of stationary syphons must be accompanied by a set of Turbulator bars.
Even for machines that have a good moisture profile and are not limited by drying capacity, Turbulator bars can still provide some advantages. The increase in heat transfer will result in lower operating steam pressures in the dryers. If the mill produces its own electrical power, this will allow the turbine backpressure to be decreased, which increases the power production. Further, with a higher heat transfer coefficient, there is less change in dryer surface temperature when there is a sheet break. This helps in re-threading the machine and in getting back on quality after a sheet break. Further, the bars tend to move the condensate into a rimming condition at a much lower speed. This reduces the drive power consumption and the load on the dryer drive components. For this reason, Turbulator bars can also be applied in dryers that are normally running slightly below or slightly above the rimming speed. Kadant Johnson has several technical “white” papers that cover the above advantages in detail.

Trade Marks

There are a number of manufacturers with competitive offerings. The generic terms for this product are “dryer bars” or “turbulence bars”. The Beloit trademark “spoiler bars” is also often used as a generic term.

The Kadant Johnson trademark for this product is a “Turbulator” bar. The Kadant Johnson mark is a registered trademark (as opposed to a common law trademark). In any publications, proposals, or marketing literature, the word “Turbulator” should be followed by the “®” sign. This registration designation is required only after the first use of the trademark in the publication. Subsequent use of the trademark in the publication does not require continued marking. It is important that the trademark be indicated as registered, in all publications, to preserve the exclusivity of this trademark. Note that a trademark is considered an adjective, not a noun. That is, we should formally refer to this product as “Turbulator bars”, not just as “Turbulators”.

Competitive trademarks are listed below:

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</tr>
<tr>
<td>Deublin</td>
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* This has been the most commonly used trademark in the paper industry. It was a common law trademark of Kimberly-Clark and used by Beloit with permission. Metso has purchased the patents and trademark rights of Beloit and may elect to use this mark as their own.

** Voith has also referred to their configuration of turbulence bars as “spoiler bars.”

*** The Kadant Johnson “Turbulator” trademark applies to all Kadant Johnson dryer bar products, both the Tube bars and the solid bars.

The new Turbulator Tube bars use hollow stainless steel tubes. This feature is unique. The trademark Tube™ bars can be used when referring to the new tube bar configuration, or the trademark “Turbulator Tube” bar can be used.

Installation Information

Kadant Johnson can supply Turbulator bars and install them. Typical installation time, with an experienced crew, can be as low as one hour per dryer. This is the time required once the dryers have been cooled (4 to 6 hours), the dryer drives locked out, the manhole covers removed, and the dryers tested for entry. Once in the dryers, a two-person crew can often install a section of Turbulator bars in less than 10 minutes. A 7.6 m (300”) machine would have five sections and take less than one hour. The new Kadant Johnson Turbulator bars can be installed faster than any competitive design on the market today. The new Kadant Johnson Turbulator bar installation instructions. Special installation techniques can help to insure a fast and trouble-free installation. A video recording of an installation is available through Global Marketing. This can be used to highlight these special techniques.
When the installation services are provided by Kadant Johnson, the Kadant Johnson installation crews will unpack the Turbulator bars, check all equipment, and stage the equipment outside the dryers. No pre-assembly work is required. Crews can be working in several dryers at the same time. Typically, two installers work inside the dryer and the third installer works outside the dryer, acting as a “spotter” and passing equipment through the manhole openings. One additional person is also added, to be available to support the work of multiple crews.

**Kadant Johnson Turbulator Tube Bar Design Features**

- 16 bars per dryer in 1.2 m (4’) dryers
- 18 bars per dryer in 1.5 m (5’) dryers
- 21 bars per dryer in 1.8 m (6’) dryers
- Tubulator Tube bars are hollow tubes, to reduce weight
- Tube bars are stainless steel
- Tube bar cross section is 25 mm wide x 15 mm tall (1.0” x 0.6”)
- Tube bars have higher radial and circumferential stiffness than any other commercial bar configuration
- Tube bar height (15 mm) is close to the traditional Kadant Johnson 12.7 mm height and produces equally high heat transfer rates
- Kadant Johnson can also offer solid low carbon steel bars.
  - The solid steel bar cross section is 25 mm wide x 12 mm tall (1.0” x 0.5”).
  - The solid bars and Tube bars both use the same hoop segments and compression bolts
  - The stainless steel Tube bars are the preferred product offering
  - Bars extend to within 50mm (2”) of the shell flange
  - Bars are positioned about 50mm (2”) from the stationary syphon
  - Standard bar segments are nominally 1.5m (60”) long
  - Standard trim bar segments are nominally 0.75 m (30”) long
  - Custom trim segments make up the balance of the dryer width and are 0.75 to 1.5 m (30 to 60”) long
  - Bars are positioned with a 10 mm space between segments
  - (Metso uses continuous bars. Deublin places the ends of their bars tight together)
  - Bars are held with tensioned rings 10 x 50 mm (0.375” thick x 2” wide)
  - There are three segments per ring for 1.5 m and 1.8 m diameter dryers
  - There are four segments per ring for 1.2 m diameter dryers
  - The ring segments are solid mild steel with pressed mild steel pins
  - The ring radius is designed for the dryer bore (standard sizes for each dryer diameter)
  - Steel compression bolts are used between ring segments to hold the bars in place
  - (Previous versions used coil springs or Bellville washers, which cracked in some installations)
  - Maximum end bar extension beyond the ring is 400 mm (16”) Note: Deublin is 8”
  - Standard ring spacing is nominally 700 mm (28”) Note: Deublin is 40”
  - Bars are held to the ring segments with solid steel pins that are pre-installed in the rings
  - Bars are pre-drilled for these pins – there is no need to tap any holes
  - There is no potential for cross-threading bolts
  - There is no risk of torquing off the heads of bar fasteners
  - Estimated time for installation is less than one hour for a 7.6 m (300”) wide dryer (two experienced installers inside)

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*The proprietary compression bolt is used between the ring segments to hold the bars in place.*
Condensate will resonate between bars if the spacing between the bars is close to the optimum, as specified by the following equation:

\[ S = \pi \sqrt{R_i \delta} \]

where:

- \( S \) = Spacing between bars, mm
- \( \pi = 3.1415 \)
- \( R_i \) = Inside radius of the dryer shell, mm
- \( \delta \) = Average condensate depth in the dryer, mm

This equation indicates that any bar spacing (any number of bars per dryer) will work, provided the optimum condensate depth can be and is achieved. For a proper bar design, the optimum condensate depth will be achieved over a wide range of operating conditions (speed, pressure, condensing load). The equation also indicates that the resonance condition is not affected by dryer speed. Although dryer bars work over a wide range of conditions, there is some loss in the strength and effectiveness of the resonance as the dryer speed increases, particularly if there are many bars and the condensate layer is thin.

Kadant Johnson Research has prepared the white paper "Heat Transfer Performance with Dryer Bars" on the technical details of the new bars. Global Marketing has distributed this technical paper in the same format as the other white papers. This paper should be used first by the internal sales group, to fully understand the bar technology. Results and conclusions can be shared with select customers, to highlight Kadant Johnson’s technical abilities. Comments and questions should be directed to Global Marketing, so the paper can be expanded to cover commercial issues. Eventually, the results will be published in a series of technical articles.

In addition to being a unique design, and in addition to the improved mechanical features (e.g. light weight, much higher stiffness, no springs or fasteners), the new bars have a number of operational advantages. These are outlined in detail, with data, in the white paper “Dryer Surface Temperature Response Characteristics”.

In summary, the operational advantages include:

- Much higher heat transfer than previous design
- Much higher heat transfer than any other commercial configuration
- Much higher heat transfer than any other configuration tested
- Larger operating syphon clearance
- Optimum heat transfer over a wide range of machine speeds without having to adjust the syphon clearance
- Less rimming drive torque

Testing in the Research Center has defined the proper number of bars and optimal condensate depth over a wide range of operating conditions.

This combination results in maximizing shell temperatures while minimizing cross machine temperature deviation.
Sales Strategy

Kadant Johnson has much more to offer the market than just a set of axial bars and a mechanical method of holding them in the dryer. Kadant Johnson Sales must make every effort to add value to the sale of these bars, in order to retain its position in the market as a technical leader and a complete source for systems and integration. Available Kadant Johnson offerings include dryer surveys, estimation of drying rate improvements, installation services, steam system reviews, supervisory control systems, and research testing with commercial size paper dryers.

When the Kadant Johnson Service and Technical Centers are involved in the projects, Kadant Johnson can offer the following bundling opportunities for Turbulator bars:

- Complete drying rate improvement calculations
- Review existing steam and condensate systems for compatibility with upgrade
- Review / develop justification for the purchase of Turbulator bars
- Review other product alternatives for best value (steam system upgrade, rotary syphons)
- Provide Turbulator bar equipment (unique Kadant Johnson design)
- Offer installation and/or supervision services by Kadant Johnson Services or contract firms
- Prepare assembly drawings for future mill / Kadant Johnson reference
- Provide on-going service and sales support (through network of reps and direct sales force)
- Conduct R&D testing of Kadant Johnson and competitive configurations.
- Establish the optimum syphon clearances
- Training services
- Application of “De-Tuned” Turbulator Tube bars (see separate NPI for details)

The installation of Turbulator bars often accompanies the sale of stationary syphons. Kadant Johnson is in a unique position to consolidate all of the above offerings with the sale of stationary syphons, along with:

- Syphon and thermocompressor characteristics matched with steam system design
- Stationary syphon equipment, sizing, and installation
- Installation services (bars, boring journals, syphon alignment)
- Replacement bearing covers (engineering and manufacture)
- Complete drying rate improvement calculations
- Review steam and condensate system (valves, thermocompressors, separator tanks)
- Review mechanical mounting (open gear machine, CARB bearings)
- Conduct audit for future machine production limitations
- Establish blow through correlations for system design

Return on Investment

Drying Capacity. The value to the customer of the increased drying capacity and improved moisture profile can be extremely high – much larger than the cost of purchasing and installing the Turbulator bars. Take the following example of a machine whose production is limited by drying capacity:

- Paper machine production = 200,000 ton per year (typical range is 50,000 to 400,000)
- Profit for incremental production = $100 per ton (typical range is $100 to $250)
- Increase in drying capacity from bars = 5% (typical range will be 2% to 25%)
- Increased profit = 200,000 x $100 x 5% = $1 million per year

If the installed cost of the Turbulator bars is $200,000, then the Return on Investment (ROI) is less than 2.5 months! Most paper mills would accept a project with an ROI that is up to two years, even during very difficult economic times.
Sales Strategy

Sheet Break. There will be additional financial return if the length of time for a sheet break is reduced, as a result of having more stable and uniform dryer surface temperatures. Using the above machine as an example:

- Number of sheet breaks per day = 4 (typical is 2 to 8)
- Normal sheet break time = 6 minutes (typical is 4 to 16 minutes)
- Reduction in sheet break time = 30 seconds (0.5 minutes)
- Increased profit = \[(0.5 \text{ min/break}) \times (4 \text{ breaks/day}) \times (\$100/\text{ton}) \times (200,000 \text{ ton/yr}) / (60 \times 24 \text{ min/day})\] = \$28,000 per year

Drive Power. If a dryer section is running in a cascading mode and the Turbulator bars can move the condensate into a rimming mode, the reduction in drive power can be very significant. This reduction in power is estimated as follows:

- Number of dryers = 40 (typical is 30 to 60)
- Change in drive power = 0.8 kW/meter (typical change 0.2 to 1.0)
- Dryer width = 5 meter (typical is 2 to 10 meter)
- Decrease in power for the machine = 40 x 0.8 x 5 = 160 kW
- Reduction in power consumption = 160 kW x 24 hrs/day x 350 days/year
- Savings per year at $0.07/kw-hr = 1.34 million kW-hr/year = $94,000 per year

Electrical Power. Another potential return is the increase in electrical power production that results from running the dryer section at a lower steam pressure. This increase in power production is estimated as follows:

- Paper production = 200,000 tons per year (typical is 50,000 to 400,000)
- Moisture removed = 1.10 lb-water per lb-paper (typical is 0.8 to 1.6)
- Steam consumption = 1.3 lb-steam per lb-water removed (typical is 1.2 to 1.6)
- Header pressure drop = 20 psig (typical is 10 to 40)
- Theoretical power increase = 0.007 kW-hr/lb-steam (typical is 0.003 to 0.014)
- Turbine efficiency = 70% (typical is 65 to 75)
- Power Production = \[(200,000 \text{ ton/yr}) \times (1.10) \times (1.3) \times (0.007 \text{ kW-hr/lb}) \times (2000 \text{ lb/ton}) \times 0.7 / (8760 \text{ hr/yr})\] = 320 kW
- Value of power production = \[(320 \text{ kW}) \times (8760 \text{ hr/yr}) \times ($0.07/kW-hr)\] = $196,200 per year

Feature Summary

- Kadant Johnson has a consolidated engineering and service offering
- Kadant Johnson can evaluate and offer other dryer alternatives as well
- Kadant Johnson has unequalled capability for testing various configurations
- Kadant Johnson has more than 15,000 installations and more than 20 years of field experience with bars
- Kadant Johnson can conduct a Can-by-Can analysis to ensure proper application of bars
- The Kadant Johnson bars are engineered to operate at the optimum condensate depth
- The hollow stainless steel bars create turbulence over a wide range of machine speeds
- The simple design requires no machining or special installation tools
- The bar segments are designed for quick installation
- The circular ring is engineered to match the dryer internal diameter
- The ring and bar assembly is designed to prevent bar shifting and movement
- All bars are positively attached to rings, with solid pins
- A unique compression bolt system provides maximum reliability
- The Kadant Johnson design does not require star, wave, or Belleville washers under the rings
- Kadant Johnson does not use coil or barrel springs
The new hollow bar design reduces the bar weight while increasing the radial stiffness by 19% and the circumferential stiffness by 21%.
The major competitors are Voith, Deublin, and Metso (formerly Valmet).

The Voith dryer bars are the least competitive on the market today. The bars are mechanically susceptible to damage, the bar performance is sub-standard, and the design is costly. Voith has not been very aggressive in selling dryer bars to the after-market. The Voith dryer bars are generally found only in new Voith machines. Kadant Johnson has replaced Voith bars in several after-market installations. This product has the trademark “Thermo Rim”.

Deublin has been aggressive in the after-market segment, but usually only when the sale includes stationary syphons. The Deublin bars were developed by its Finnish agent (Martti Partio), who used field experience and some limited testing at a Finnish university. Before going out of business, Beloit had an agreement with Deublin for the supply of their dryer bars. Deublin engineered and manufactured bars for new Beloit machines and Beloit MillPro after-market sales, following the Deublin (not Beloit) design standards. Deublin has introduced no subsequent testing, development, or enhancements of this product. It has been mechanically fairly robust, but the design is now out-of-date.

Metso is occasionally aggressive in selling bars into the after-market. Metso has based their design on their internal development work. The design appears to change quite often. There have been a number of iterations in the design, with the focus on ease of installation and more recently on heat transfer performance. Metso does not have the scope of testing capabilities of Kadant Johnson and consequently will have less understanding of the product performance. Kadant Johnson has been asked by customers (and Metso) to provide trouble-shooting support through the Kadant Johnson R&D Center.

Competitive Position

Some product distinction can be made on the basis of the number and size of bars, but the primary product distinctions with competitive configurations is the system for holding the bars to the dryers and the range of support services. There have been failures of a number of installations, from all suppliers, so the mechanical design distinctions can be quite important. Kadant Johnson can also focus on its large range of services that support the sale of bars.

Number of bars per dryer

Kadant Johnson uses 16 bars in a 1.2 m (4’) diameter dryer, 18 bars in a 1.5 m (5’) diameter dryer, and 21 bars in 1.8 m (6’) diameter dryers. With a larger number of bars, it is more difficult at high condensing loads to achieve the thin condensate depth that is required to achieve the highest heat transfer. (See the section on Product Description). Further, the viscous drag of the condensate becomes more significant and the condensate does not resonate as well. With a smaller number of bars, on the other hand, the dryer must have additional condensate to achieve high heat transfer. The larger amount of condensate in the dryers will increase the operating (rimming) drive power by a small amount (see the white paper on “Drive Power and Torque in Paper Machine Dryers”). However, if a larger amount of condensate remains in the dryer when the dryer section is started up, then there will be a significant increase in the power and torque required to reach the rimming speed.

The new selection of the number of bars by Kadant Johnson represents the best commercial compromise between these various factors. This selection was made not by copying others in the market, but rather by conducting several years of testing in the Kadant Johnson Research Center.

Spring Loading

Dryer bars can be at a different temperature than the dryer shell, particularly during start-ups and shutdowns. Without some provision for accommodating the resulting difference in their thermal expansion, the loading pressure on the bars could be lost, at least temporarily, or the hoops could be over-stressed. If the ring segments yield under the higher stress, some of the loading pressure could be permanently lost.
Competition

All dryer bar suppliers have used some type of system to accommodate changes in thermal expansion. Beloit used coil and later barrel springs to load the rings and accommodate differential thermal expansion. Beloit had problems with spring failures. Kadant Johnson also used coil springs to load its bars and had occasional reports of cracked springs. Deublin uses a series of Belleville washers above each bar to accommodate for the differences in thermal expansion. Metso has used a number of different mechanisms for holding the bars. The current Metso design has a pair of springs in a special holder. Voith uses a series of "out-riggers" from central rings resulting in a very complex system.

In the more recent Kadant Johnson Turbulator bar design, stacks of special flat ("Belleville") washer springs were used between the ring segments to maintain tension on an intermediate bolt. The Bellville washers do start to crack after some time in operation. Replacement of the Bellville washers is very time-consuming. This design has been changed with the new Turbulator bars.

The new Turbulator bars do not have any springs. Solid compression bolts provide tension at the ring ends. These bolts have a special collar under the extended socket head to press against one ring while a large nut (and jam nut) press against the adjacent ring. The new Turbulator bars use the bending of the ring ends and the slight bending of the rings in the spans between bars to maintain the clamping force on the bars, basically using the large rings as leaf springs. This avoids the problem of spring failures that have plagued the other suppliers. It is important to note that the deflection of these ring ends is normally less than 0.2 mm. This is well below the elastic limit of the ring.

Bar Fasteners

Conventional dryer bars are typically held to the ring segments with cap screws. Beloit used "Whizlock" self-locking (not self-tapping) cap screws, with pre-threaded bars. Deublin uses standard cap screws with a Belleville flat washer between the bars and the ring segments. These washers flatten as the cap screws are tightened and are used to accommodate thermal expansion. Deublin occasionally installs some of the intermediate rings without cap screws, to reduce installation time. The bars are pre-tapped. The current Metso bars have interlocking channel segments that require no cap screws. This is an interesting design, but it is costly and it is not as easy to assemble.

Kadant Johnson used Whizlock self-tapping fasteners in the past. There was insufficient difference between the torque required to tap the hole and the breaking torque. Occasional fastener failures resulted. Kadant Johnson then tapped the Turbulator bars in advance, to eliminate the tapping torque. There were also a few occasions where the cadmium plating on these fasteners reacted with the spring material, causing spring failures. Kadant Johnson then adopted a special self-tapping cap screw with a much larger difference between tapping and breaking torque. No failures have been reported with this design. The new Turbulator bars use large solid pins to lock the bars to the ring segments. There are no threaded fasteners to break and the pins are "captured" so that they cannot come out. The cross-sectional area of these solid pins is 3x the thread cross-sectional area of the previous fasteners.

Bar Lengths

Beloit installed Spoiler bars that were 3 m (120") in length, with a single custom-length segment at the end. Metso uses continuous bars whenever possible. These can be very difficult to install, particularly in top dryers that have little clearance to the dryer hood panels. Deublin standard bar lengths are unknown, but have been 2.25 m (90") and longer. Kadant Johnson used to have 2.25 m and 1.5 m (90’ and 60’) standard length bars, with a custom length segment at the end. The new Turbulator bars are made up of 1.5 m (60” nominal) standard length segments. Each segment has two 360° rings to hold it in place. A custom-trim segment is placed at the end. If this custom segment would be less than 750 mm (30") in length, then a standard-trim segment of 750 mm (30") is used in place of one of the 1.5 m (60") segments. This way, the custom-trim segment length is always between 750 and 1500 mm (between 30 and 60 inches). These dimensions are nominal. This standardization improves delivery by having only one segment per dryer that must be made to order. The maximum bar length has been limited to 1.5 m (60") to ensure that the bars can be easily passed through the manholes, even for dryers with the hoods located very close to the dryer framing.
Bar End Gaps

Metso uses continuous bars (that are difficult to install). Beloit installed Spoiler bars end-to-end, with a 12 mm (0.5") gap between them. Deublin installs its bars end-to-end also. The rings straddle butt joints between the Deublin bars. Kadant Johnson used to have 12 mm to 25 mm (0.5" to 1") gaps between the ends of the bars.

The new Turbulator bars have 5 to 15 mm gaps between the ends of adjacent bars. Only Kadant Johnson has the testing capabilities to show the impact of spacing between the bars on the cross-machine variations in heat transfer. It is based on this testing that the gap was reduced. A positive gap, however, is required to allow for thermal expansion.

Drawing Information

It is important that accurate design information be available for installation of Turbulator bars. This includes dryer inside diameter as well as the dryer width between dryer shell flanges. The width between flanges is the most critical. The compression bolts in the new Turbulator bars have been designed to accommodate a wide range of dryer diameters*. Voith has access to drawings of its dryers. Metso has access to its own dryer drawings as well as those of Beloit. Deublin has access to none of these drawings. Kadant Johnson has a very large installed base in North America, with records for many of these machines. Drawing records, however, are not always accurate and it is often difficult to complete a comprehensive review of all (known) records. It is best to perform a physical check, just to be sure. Kadant Johnson recommends this approach to its field service representatives.

The compression bolts and hoop segments allow for a range of dryer inside diameters. The range is shown below. If the dryer inside diameter is close to the low end of this range, there is less room to install the compression bolts and the installation can be slightly more difficult.

* 1.5 m (60") Dryer I.D. range: 1430 mm – 1490 mm (56.3" min. to 58.62" max)
* 1.8 m (72") Dryer I.D. range: 1730 mm – 1780 mm (68.07" min. to 70.08" max)

Corrosion Issues

Some mills have experienced problems with rapid corrosion of their dryer bars. These problems are not very common, occurring in less than 2% to 4% of all dryer bar installations. When corrosion problems are encountered, they may be quite severe.

The problem of bar corrosion is not limited to any particular supplier of bars. There have been reports of serious bar corrosion at Augusta Newsprint (Kadant Johnson Turbulator bars), Alberta Newsprint (Voith), Assi Frovi Piteo (Metso channel bars), Bowater Dalhousie (Kadant Johnson) and at Georgia-Pacific, Big Island (Beloit Spoiler bars). All suppliers use common low-carbon mild steel for their bars. The problem is not caused by the bar material.

It appears that the rapid corrosion of the bars is most likely to occur when all of the following factors are present:

- Mild steel bars (the most common bar material)
- Hot condensate (this is normal)
- Dryers that are routinely valved-off for long periods of time (this is done when the steam system does not have adequate turn-down ratio)
- Carbon dioxide drawn into the dryers, forming carbonic acid
- The dryers have rotating syphons (less-effective purging of non-condensable gases)
- Improper boiler feed-water chemical treatment (in particular acidic systems)

Neither corrosion nor erosion, separately, would be able to eat the bars away. It is the combination of corrosion and erosion. The erosive action of the tumbling condensate strips off the protective oxide layer, repeatedly exposing raw steel to the corrosive elements. The installation of stationary syphons helps to purge non-condensable gases from the dryers. An upgrade of the steam system can provide a higher turndown ratio, so that
it is not necessary to valve off dryers. Proper control of the boiler chemicals can reduce the susceptibility of the bars to corrode.

Rather than risk potential bar erosion the Kadant Johnson Turbulator Tube bars are stainless steel. The cost of providing solid stainless steel bars is generally too high to be competitive. The hollow bars, however, can be provided in stainless with a much lower premium in price. This is because there is much less weight required. The standard supply of stainless steel bars is a unique offering from Kadant Johnson.

It is important to note that only the Tube bars are stainless steel in the standard Turbulator Tube bar configuration. The hoops, pins, and compression bolts are steel. These components are not stainless steel because, even when bar erosion has been serious, it has generally been limited to the bars, with much less corrosion of the hoops occurring.

In dryers in which air is intentionally introduced (swing dryers, sweat dryers, and cooling dryers), the level of corrosion is much higher than it is in steam (only) dryers. For these types of dryers, the hoop assemblies should be nickel plated (Kadant Johnson Class 3 plating). The cost of plating must be included in the price.
Competitive Designs

Voith Paper Technology

Voith uses 36 (or 33) bars in a 1.5 m (5') diameter dryer. The bars have a cross-section of 5 mm x 12 mm (0.2" x 0.5"). The bars are held against the dryer by three interlocking ring segments. The rings are curved plates with a 4 mm x 45 mm (0.16" x 1.8") cross-section. The segments interlock with the end of one segment sliding into a 90 mm deep welded socket in the end of the next segment. Select bars are pinned to the dryer inside surface. The ring segments have a series of "out-rigger" supports that press the small cross-section bars against the shell, between ring segments. The ends of the out-riggers are pinned to the bars on 500 mm centers. Bars are one meter in length and are positioned with a 2 mm gap between their ends, with a cap to span the gap. This is the most complex design on the market.

Metso Paper (Valmet)

Metso has three different designs on the market:

- The 1992 design has (32) 6 mm x 20 mm flat bars in a 6' dryer.
- The 1994 design has (24) 12 mm x 20 mm flat bars in a 6' dryer.
- The latest (1996) design has (24) 17 mm high x 20 mm wide x 2 mm thick U-channel bars in a 1.8 m (6') diameter dryer and (20) similar bars in a 1.5 m (5') diameter dryer. U-channel bars are used in place of solid bars to reduce installation weight.

Metso sent bars to Kadant Johnson R&D in 1998 for testing in 2000. This configuration consisted of (18) rows of 12 mm x 25 mm (0.5 x 1.0") bars in the 5' diameter dryer. The bars were held by (10) rings located on 635 mm (24") spacing.

Deublin Company

Deublin originally used an 18 bar configuration for 1.5 m (5') dryers, copied from other suppliers. The 22 bar arrangement was simply scaled up for 1.8 m (6') dryers based on diameter (18 x 6/5). Bar cross-section is 9.5 x 25 mm (0.375" x 1.0"). Deublin now uses 22 bars in both 1.5 m (5') and 1.8 m (6') dryers. Deublin originally used three ring segments in 1.8 m (6') dryers. These segments were not interchangeable (one had 8 bars, the others each had 7 bars). This design may still be encountered. Deublin now supplies two segments per ring, one "single-band" and one "double-band" (holding the bars on each side of a bar gap). Segments are held apart with threaded studs through gusset-reinforced ring ends. Rings are placed on 1000 mm (40") centers. Bars are held to the rings with cap screws, with wave washers between the bars and the rings. Bars are pre-tapped. The bars extend from one dryer flange to the stationary syphon, with 50 mm (2") gaps at the end. There are no gaps between bar segments. Bar extension beyond the rings is limited to 200 mm (8").

Beloit Corporation

Beloit used (25) bars in both 1.5 m and 1.8 m (5' and 6') dryers. Bar cross-section was 9.5 mm x 19 mm (0.375" x 0.75"). Beloit supplied five segments per ring. Each segment was identical, with five bars each. Segments were held apart with a threaded stud that captured a steel coil spring (previous stainless steel barrel springs cracked). One segment connection did not have a spring. This segment connection was used to take up dryer diameter variations. Rings were placed on 610 mm (2') centers. Bars were held to the rings with Whizlock self-locking fasteners and were pre-tapped. The bars extended from one dryer flange to the other, with 50 mm (2") gaps at the end. There were no gaps between bar segments.
### Competitive Configuration Summary

<table>
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<tr>
<th>Company</th>
<th>Number of Bars</th>
<th>Ring Segments</th>
<th>Ring Loading</th>
<th>Bar x-section</th>
<th>Ring x-section</th>
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<td>3</td>
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<td>3</td>
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<td>9.5 x 50 mm</td>
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<td></td>
<td></td>
<td>Compression bolt</td>
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<td>(0.375 x 2&quot;)</td>
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<td>KJ old</td>
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<td>24</td>
<td>3 or 6</td>
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(*) Deublin has recently eliminated the use of the wave washers under the rings. The wave washers were too hard to install. Deublin now uses serrated bolts to hold the rings to the bars. Deublin uses 5/8" threaded steel studs to tighten the hoops. The studs are only 3.5" long, making installation difficult. Deublin uses zinc plated Whiz lock M10 bolts and zinc plated nuts.
Professional Services

One of the most effective ways to sell Kadant Johnson products is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the Kadant Johnson equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance sessions
Ordering Information

General Customer Availability

<table>
<thead>
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<th>Ready for Order:</th>
<th>Immediate</th>
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</thead>
<tbody>
<tr>
<td>Ready for Ship:</td>
<td>Normal lead time</td>
</tr>
</tbody>
</table>

Lead Time

Kadant Johnson Turbulator Tube bars have been designed with a series of simple standardized components with the bar layouts engineered in advance. The new bars are made from a series of standard lengths, one standard trim length (if needed), and a single custom trim segment. Most of these components have been manufactured in advance, for fast delivery. Typical delivery, from date of receipt of purchase order, is 3 to 4 weeks. Delivery information for rush orders should be confirmed with the Kadant Johnson factory, but 1 to 2 weeks delivery can normally be provided, if needed.

Standard delivery from the machinery builders is typically much longer. Deublin has quoted 6 to 8 weeks delivery.

Pricing

List prices for Turbulator bars are dependent on the length of the dryer. These prices are based on cost of manufacture. Because of the high value of this product to the customer, price discounting should be the exception. The typical selling price of the Turbulator bars for one dryer is $3,000 to $4,000. This does not include the cost of installation, but it is still only a fraction of the value of the benefit that these bars bring to the customer. These bars should be bundled with other products and services, to support a price that more closely matches the return on the investment to the mill.

For price sensitive applications, the conventional solid low carbon steel bars can be offered as an alternative. It is best to discount the price of the solid bars, both because the solid bars are a lower cost solution and because this highlights that the competition only offers low carbon steel bars.

Prices are subject to change and factory should be consulted for current pricing.

Required Information to Place an Order

- Internal diameter of the dryer
- Internal dryer width between shell flanges
- Drawing of dryer (if available)
- Type of syphon installed
- Syphon groove (if existing) width, depth, and location for front and back

Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.
1. What are Turbulator bars?

   Turbulator bars are axial bars, installed on the inside of dryers and used to induce turbulence in the condensate layer, to improve the rate and uniformity of heat transfer (drying rate) of the dryers.

2. Is the name “Turbulator” bar a trademark?

   Yes. Kadant Johnson has registered and uses the trademark “Turbulator”. This mark should always be noted with a “®” in its first use and be used as an adjective. That is, we should recommend “installing Turbulator bars” and not “installing Turbulators”. Beloit used the trademark “Spoiler” bars for turbulence bars. Generic names are turbulence bars or dryer bars. Voith uses the trademark “Thermo Rims”.

3. Are Turbulator bars required in all dryers, regardless of dryer speed?

   The Turbulator bars increase the rate and uniformity of heat transfer in dryers in which the condensate is rimming (that is, the condensate is rotating with the dryer shell and not tumbling around inside the dryers). Condensate is normally rimming above about 335 to 365 mpm (1000 to 1200 fpm). Turbulator bars produce the greatest impact at the higher machine speeds. Typically, Turbulator bars would be installed in dryers running above 410mpm (1350 fpm). Note that Metso does not recommend the use of bars in the first drying cylinder. They are afraid that the sheet will pick due to the hotter surface temperature. On a well-design steam system, picking should not be a problem.

4. What are the dimensions of the new Kadant Johnson Turbulator Tube bars?

   They are 15 mm x 25 mm (0.6” x 1”) hollow tubes. The ring segments are 9.5 mm (3/8”) thick. The ring segments are pressed apart by proprietary compression bolts.

5. How many bars are used in each paper dryer?

   In 1.5m (5’) diameter dryers, there are 18 bars (six bars are attached to each ring segment). In 1.8m (6’) diameter dryers, there are 21 bars (seven bars are attached to each of the ring segments).

6. What design is Metso (Valmet) offering today?

   Metso dryer bars are ‘U-shaped’ channels, about 17 mm (0.67”) x 20 mm wide. They are made in Helsinki from 2 mm (0.08”) thick mild steel. The rings are also made from thin wall channels. The U-channels face each other and notches in the ring segments and the bars interlock. No cap screws are required. The design was introduced in 1995. Prior to that, Metso had problems with corrosion of the cap screws and having the bars coming loose from the dryers. The rings are spring-loaded by a pair of coil springs, captured between segments with a rod that is caught under the ends of the ring channels.

7. Can stationary syphons be installed without Turbulator bars?

   Yes, they can be installed without Turbulator bars, but normally Turbulator bars would be installed at the same time. The stationary syphons “plow” through the rimming condensate and produce higher turbulence. This causes higher dryer surface temperatures and non-uniform drying. Further, the clearance between the syphon and the dryer shell can be increased and still achieve high heat transfer with Turbulator bars. Without Turbulator bars, the syphon clearance must be less and there is more susceptibility for the syphon to contact the shell and cause shell or syphon damage.
8. What are typical dryer syphon clearances?

Operating clearances for most modern rotating syphons (those which are attached to the dryer shell) are about 1.5 mm (0.060") for dryers without bars. For dryers with bars, consult the factory for syphon clearance. The syphon clearance should be set to a clearance that is specified for the bars that are installed. The combination of syphon and bars determine the heat transfer. Kadant Johnson will not recommend clearances for competitors' bars.

Operating clearances for stationary syphons depend on the number of Turbulator bars in the dryer and the design of the syphon. For Kadant Johnson, the clearance is 5 to 9 mm (0.20-0.35"). The optimum can be established from test results, using CBC calculations for the dryer condensing load, speed, pressure, type of syphon, and bar configurations. The optimum clearance can also be established from specific simulation at the Kadant Johnson Research Center, if needed.

It is best to focus on the fact that the number of bars and the bar cross-section has been selected specifically to match the performance of the PTX stationary syphon. This design has resulted in having the syphon clearance within a practical and predictable range.

9. What should be the difference in temperature between the steam and the dryer outside surface?

The difference between the steam and outside dryer surface temperatures is normally considered “acceptable” if it lies in the range of 16 to 33 °C (30 to 60 °F). This is not a bad benchmark, for most dryers, but is not an independent parameter. See TAPPI TIP 0404-39 (“Methods for measuring dryer surface temperature”) for information.

Aside -- There have been occasions where Spoiler bar springs have failed and the bars have not been in contact with the dryer. As a result, the bars do not generate the intended amount of turbulence in the condensate layer and the temperature difference is found to be quite large, up to 50 °C (90 °F).

10. What can be done to evaluate the performance improvement with Kadant Johnson Turbulator bars?

There are two approaches: The Kadant Johnson Can-by-Can analysis tool can be used to make analytical predictions. Alternatively, one of the dryers in the Kadant Johnson R&D Center can be used to simulate the existing operating conditions, and to demonstrate the actual improvement. Contact Kadant Johnson R&D to schedule trial time.

11. Why does Deublin use 22 bars in a 1.8 m (6') diameter dryer?

Because Deublin does not know what they are doing. They do not have access to an R&D facility for testing and evaluating their product.

12. How long does it take to install a set of Turbulator bars in a paper dryer?

The time depends on the size of the dryer and the crew. Typically, once the dryer is ready for entry, it will take 3-4 hours to install a full set of the original Kadant Johnson bars. It can take 4 to 6 hours to install competitive dryer bars.

*The new Turbulator Tube bars can often be installed in less than one hour.* A Kadant Johnson crew of two people can install a full segment of bars in about 10 minutes. That is, it takes only one hour for a 5-segment dryer. This is MUCH less than the time required for any other commercial configuration.
13. If a machine that has dryers equipped with bars still has a hot (or cold) edge problem, what can we propose?

The first step would be to do a dryer section study or an inspection to confirm the equipment is properly installed. If the dryer has a syphon groove, Edge Control Turbulator bars (“mini”-bars) may be needed. If there is a large area of the shell without bars, outboard of the stationary syphon, a segment of Edge Control bars may be needed. As a last resort, we could propose the Thermal Barrier Coating technology called PERMAX. This can be quoted through Kadant Johnson Canada.

14. What product do we offer to customers who have 1.2 m (4 ft) diameter cylinders?

Kadant Johnson can offer the conventional solid bars for 1.2 m (4’) dryer cylinders. The assembly will have 16 bars with 4 hoop segments, each with 4 bars. Reference Three Rivers assembly drawing TA-1448-1678-01. Depending on delivery, special hoops can be supplied so that the Turbulator Tube bars can be offered. Because there are so few orders for bars for 1.2 m diameter dryers, the hoop segments are generally not kept in stock.

15. Why was this product not released for sale sooner?

We were not able to distribute any materials on this new product until patent protection had been obtained.

16. Is it possible to make both 6 mm tall bars and 12 mm tall bars work?

Yes, but there is more to the story. We do not want a bar configuration that only works very well under specific design conditions. Rather we want a bar configuration that operates close to the optimum over the widest possible range of operating conditions (speeds, condensing loads, pressures, etc.), with a syphon clearance that is not too small, and with condensate volumes that are not too large. There are a number of different bar configurations that will work. The configuration that Kadant Johnson offered in the past worked well. The new one will work even better. That is, it has an even better balance of features.

17. If 12 mm tall bars work, why change to higher bars?

Kadant Johnson has been using 12.7 mm (0.50”) tall solid bars. The new tube bars are 15 mm tall. The 15 mm bars retain the high heat transfer of the previous bars, and have higher mechanical stiffness. The goals for selection of the tube cross-section were:

1. Achieve equal or better performance than we had before,
2. Offer an assembly that is easier (faster) to install than any other configuration on the market,
3. Provide a set of bars that are much more robust (stiffer) than anything Kadant Johnson or others have offered in the past,
4. Have an assembly with no springs, fasteners, or Bellville washers to fail,
5. And eliminate the tap-tite bolts that had heads that could break off and get caught under the syphon shoe.

Many customers have said, “all bars are the same.” We now have a product that is distinctive. If there were no distinctive features, then we have only to negotiate the lowest possible price, which is not a good position to be in.

18. What do we tell customers who were previously told that bars with 12 mm height were optimum?

The “better” should be presented as not simply “taller is better”, but rather it is the combination all of the features that make the new configuration better (that is, the height, the width, the configuration, the mounting, the integration with the PTX joint and syphon, etc.).
19. Are the new Tube bars wider?

Yes. The new bars are wider in cross-section. The old bars were 0.50” x 0.75” (12 mm x 20 mm in Europe). The new bars are 15 mm x 25 mm.

20. Are the new Tube bars stiffer?

Yes, the new bars are stiffer than any bars ever sold. The new bars will be stiffer in the radial direction (to keep the bars flat against the dryer) and stiffer in the circumferential direction (to keep the bars from bending when they hit the puddle of a non-rimming dryer). That is, the stiffness (moment of inertia) will be larger than any competitive bar configuration, include the old Kadant Johnson bars.

21. Are the new Tube bars heavier?

No, the new bars are much lighter in weight, even though they are significantly stiffer than the old bars. In fact, the bars will be less than half of the weight of the old bars.

22. Will the driver power increase with the larger bars?

No. With bars in a dryer, the condensate will rim at a significantly lower speed. As a result, the power required to move from the cascading speed to the rimming speed will be significantly reduced. The details are in the white paper “Drive Power and Drive Torque in Dryers with Turbulator bars” (you can download this from joco.com). The drive power is reduced when compared to the drive power for a dryer that is running without bars, but with the same amount of condensate in the dryer.

Since we are generally working with stationary syphons, the amount of residual condensate in the dryer when it gets ready to accelerate to operating speed will actually be much less than the amount of condensate that will build up in the dryer once the condensate is rimming. And, during the acceleration from stopped through rimming to the operating speed, there is no sheet on the dryers anyway.

The amount of condensate that we will have rimming with the new bars will be virtually identical to the amount of condensate that we should have had in the dryer with the old bars. And, the amount of power (and torque) required when the condensate is rimming is virtually unchanged by the amount of condensate that is in the dryer, whether there are bars in the dryer or not. There is data in the white paper to support this also. We saw this phenomenon very clearly when we ran the dryer with a 150 mm deep rimming layer - there was no change in the drive power until the condensate layer collapsed. This is shown in the video clip on the flooded dryer performance.

23. Do the new Tube bars have to be stiffer than the old bars?

The new Tube bars do not have to be much stiffer than the old bars. We have had very few problems with the old bars. But each of our competitors (except for Voith) has stiffer bars than the old Kadant Johnson bars. With the new tube bars, we are able to use a standard bar cross-section, and greatly increase the bar stiffness (this helps in installation, by the way), and reduce the weight (this also helps with installation), AND reduce the cost of the bars. Not a bad combination!
24. Could a smaller cross-section tube bar be used instead?

Yes, a smaller (ex. ½” x ¾”) tube bar could be used in Europe instead of the new bars, but this is not advisable. There would be two problems with this approach: We have to explain to our global customers why we do not have global consistency in our product offerings. And we would have to try to explain why there is a 30% reduction in the bar stiffness in the circumferential direction.

25. Could 12 mm tall solid bars be used with the new fastening system?

Yes, 12 mm tall solid bars could be used. They are, however, heavier, harder to install, and look the same as every other supplier's bars. We can use the new compression bolts, new rings, and the stepped pins (with a shorter length) with solid bars. We considered making these changes as the parts became available, but decided that would dilute the impact of making all of the changes at one time. By making all of the changes at once, the new Kadant Johnson bar configuration will be clearly recognized as being very unique.

26. What are the key features of the new Tube bars?

Focus on these key points:

- The new Tube bars were designed from the ground up.
- The old bars were good, but these Tube bars are better.
- The new Tube bars represent the best collection of features that we have found.
- The new Tube bars are lighter in weight and easy to install, yet stiffer than any configuration of bars on the market.
- The cross-section of the new Tube bars has been optimized for operation with the PTX syphon.
- The bars were designed so that we could have the maximum syphon clearance with the new bars, yet have an operating condensate depth that is not large.
- The new fastening system is 100% reliable. The pins cannot come out of position once the bars are in place.
- The compression bolts lock the hoops in place, without any springs, washers, or turnbuckles to fail.

27. Do the new Tube bars increase the condensate heat transfer coefficient compared to the old Kadant Johnson bars?

The heat transfer from the new Tube bars will be as high or higher than the old bars. The amount of improvement depends on how close to the optimum the old bars were operated. What we have found is that, most commercial turbulence bars are not operated at their optimum conditions. That is, the new bars can replace the old bars in existing dryers and provide a significant increase in the drying rate because they are designed and set up to operate at the optimum conditions.
28. Will the heat transfer of the new Tube bars be better than that of the competitive bars?

There are a multitude of dryer bar configurations whose performance is clearly sub-standard. There are also many that are good. But we can clearly say that no other dryer bar configuration in operation today produces heat transfer rates that are higher than that produced by our new Tube bars. We can say this, because we have tested them all! We have looked at tall bars, thin bars, wide bars, spiral bars, stepped bars, many bars, few bars, thick condensate layers, thin condensate layers, high speeds, low speeds, high DP, and low DP. No one else (particularly not Deublin) has run as many tests as Kadant Johnson Research.

With all of this testing, we have found ways that we can get high heat transfer rates from many different configurations of bars. But, just because we can achieve a high heat transfer rate does not mean that the configuration is a good commercial design.

We have used our test results, and our design expertise, to develop a configuration that not only gives high heat transfer results, but also is easy to install, robust, and consistent in performance.

29. Does the amount of condensate in the dryer increase when we change the cross-section of the bars?

If we have a 1.5 m diameter dryer, with 18 bars, we need the same amount of condensate in the dryers to get the highest heat transfer coefficient, whether the bars are 12 mm tall or 20 mm tall. The new bars are simply designed to operate at the correct condensate depth and the syphon clearance is set to achieve this value.

30. What happens to the drive power during low-speed operation?

Turbulator bars are developed for dryers with rimming condensate (or in dryers where we want to get the condensate to rim). Once the condensate is rimming, the dryer drive power is only marginally affected by the amount of condensate that is rimming in the dryer. This can be seen in the data presented in “Drive Power and Torque in Paper Machine Dryers” (this paper is available for download on joco.com).

This data also shows that Turbulator bars reduce the speed at which rimming occurs, reduce the power required to get the condensate to rim, and reduce the torque required to get through the transition. The real question is whether the new bars increase the amount condensate in the dryer when the dryer is getting ready to be accelerated to rimming speed.

A dryer that is running with the correct amount of condensate in the cylinder will have more residual condensate in the bottom of the dryer when the dryer is stopped, compared to a dryer that has bars but has less than the optimum amount of condensate. Stationary syphons, however, will quickly remove most of the residual condensate from the dryer, long before the dryer is accelerated back up to operating speed. So the drive power, in both cases, will be quite small.
31. How were the specific design features selected? Are any of the features really unique?

A series of design objectives were specified (ease of installation, robust, stiff, high performance, etc.). A number of tests were then conducted at the Kadant Johnson Research Center. We tested tall bars, short bars, many bars, few bars, wooden bars, steel bars, t-bars, louver bars, stepped bars, and many other configurations. Based on all of this data, and the design objectives, the best composite of features was selected.

Philosophically, every product design is a compilation of many common components. It is the combination of components in a unique configuration that makes the product distinctive (different) and better. We must focus on this new bar design as being different from all other designs on the market. The new bars are easier to install, are more robust, give higher heat transfer performance, and operate over a wider range of machine conditions.

32. How are differences in thermal expansion rates accommodated without springs?

The ring segments and the hollow bars are elastic members that elastically deflect in response to the differences in thermal expansion of the dryer shell and the bar assembly during start-up and shutdown of the machine.

33. Do the different metals (stainless steel bars, mild steel ring segments, cast iron shell) cause any negative reactions inside the dryer? Is there potential for galvanic corrosion to occur?

It is quite common to put stainless steel, mild steel, and cast iron components together. This is done routinely in many steam system and paper dryer applications, without a problem. Whenever dissimilar materials are put together, there is a potential for galvanic corrosion to occur. Aluminum and magnesium, for example, would be expected to experience rapid corrosion in a steam environment. The potential for galvanic corrosion can be evaluated by looking at the relative electromotive potentials. For stainless steel, mild steel, and cast iron, there is very little difference. That is why there is no problem putting these materials together.

Stainless steel, however, has a significantly higher resistance to corrosion than cast iron, and an even larger resistance to corrosion than mild steel. That is why stainless steel is used for all of the non-wearing syphon pipes. Stainless still is also used in cooling rolls, sweat dryers and swing dryers, where there is inherently a lot of air in the system to allow the mild steam components to corrode.

We have not seen any occasions where stainless steel components inside a dryer have eroded, even when they replaced cast iron and mild steel parts that had been experiencing a high degree of corrosion and erosion. We can be very confident that the stainless steel bars will not corrode.
34. Does water get inside the bars? If yes, what happens to the water inside the bars? Will the bars corrode faster? Cause increased drive load?

Yes, water will get inside the bars. The amount of water in the bars will be close to the average condensate depth in the dryer. A dryer with Tubulator bars and this small amount of water inside the bars will have less weight than a dryer with solid bars of this or even a smaller cross-section. The drive load for the dryers with Tubulator bars will be no different than a dryer with solid bars, but the inertia of the dryer will be less with Tubulator bars. This is because the condensate has less weight than steel. The inside of the bars will not corrode. The stainless steel pipes (that have very large steam and condensate velocities in them) do not corrode. It is highly unlikely that a small film of water laying inside a stainless steel tube bar would corrode either.

A related question is whether the water in the bars reduces the rate of heat transfer to the dryer. The short answer is, we have tested the net result and the performance of the new Tubulator bars is higher than that of any other configuration (commercial or otherwise) that we have tested. And we have tested a LOT of different configurations.

*If you have other questions that you would like to have added to this list, please send them to Kadant Johnson Global Marketing.*

###
Turbulator® Tube™ Bars

- Axial bars inside the dryer cylinder
- Held in place by segmented hoops
- Increase condensate turbulence
- Improve heat transfer rate
- Improve heat transfer uniformity
- Improve runnability
New Turbulator Bars

- Robust construction
- Eliminate springs and washers
- Eliminate tap-tite bolts
- Fast installation
- Improved performance
New Turbulator Bars

• Bar options
  – Stainless Tube bars (0.6 x 1”)
    • Will not corrode, lighter weight
  – Solid steel bars (0.5 x 1”)

• Installation system
  – Compression bolts
  – Integral locking pins
  – Segmented hoops

Turbulator Bar Unique Design

• Rigid rings
• Compression bolt
• No springs
• No tap-tites
• No wave washers
• Patented design
Turbulator Tube Bars

- Stainless steel
- 25 x 15 mm
- High radial stiffness
- High circumferential stiffness
- One-third the weight
- Lower shipping cost
- Easier to install

Turbulator Bar Stepped Pins

- Pins are captured
- Can not loosen
- No cross-threading
- No broken heads
- MUCH faster to install
**Compression Bolt**

- Symmetrical design
- Air wrench tightening
- 2x cross-sectional area
- Eliminated SCC
- Easy to remove

**Corrosion Issues**

- Rapid corrosion of bars is most likely to occur when all these factors are present:
  - Mild steel bars
  - Hot condensate
  - Dryers that are routinely valved-off
  - Carbon dioxide drawn into dryers
  - Rotating syphon (less-effective purging of NCG)
  - Improper boiler feed-water treatment
Turbulator Tube Bars

- Stainless steel
- Will not corrode
- No thinning
- No replacements
- No loss of performance
- Mechanically reliable
Spring Loading – 1978

Spring Loading – 1978
Johnson Turnbuckle – 1985

Johnson Turnbuckle – 1985
All-Thread Stud – 1987
Belleville Wave Washer – 1994

Belleville Wave Washer – 1994
Compression Bolt – 2002

*Patent pending
Ring tabs deflect 0.16 mm

Compression Bolt Range

Range = 88 mm
Turbulator Bar Performance

- Correct bar spacing = $\pi \sqrt{R \times \delta}$
- Fewer bars: Condensate volume too big
- More bars: Condensate depth too thin
- Highest heat transfer
  - of any commercial design
  - of any tested design
  - over wide speed range with fixed syphon clearance
- Lower drive torque in rimming conditions
Optimizing Heat Transfer

- High values at resonance
- Loss with speed is typical
- Optimum clearance depends on:
  - Syphon design
  - Syphon shoe location
  - Dryer diameter
  - Condensing rate
  - Bar configuration
  - Number of bars
**Engineering Standards**

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**Edge Control™ Bars**

- Fine adjustment of dryer edge temperature profile
- Number of bars are selected specifically to equalize the dryer surface temperature
- Can be placed inside or outside of the groove
Bar Applications – Operational

• Speeds > 460 mpm (1500 fpm)
• Heavy condensing loads
• Improved uniformity
• Stationary Syphons
• Near-rimming

Drive Power and Torque
Affect on Dryer Drive Power

- Rimming speed occurs below 300 mpm
- Drive power required to rim decreases
- Drive power reduction can be up to 60%
- Drive power reduction is most significant with large amounts of condensate

Comparison of Drive Power Required to Rim

<table>
<thead>
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<th>Rim Depth, mm</th>
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<th>With dryer bars</th>
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</table>
Affect on Dryer Drive Torque

- Drive torque required to rim decreases
- Drive torque reduction is up to 15%
- Torque reduction is most significant with larger amounts of condensate
- Speed at which maximum torque occurs is reduced with bars

Drive Torque Comparison

- Without dryer bars
- With dryer bars

Rim Depth, mm

Torque, Newton-meters/meter
### Features of Turbulator Bars

- Tube bars are stainless steel
- Bar height is engineered to operate at the optimum condensate depth
- No machining or special installation tools
- Segments designed for fast installation
- No coil or barrel springs
- No wave, star, or Belleville washers
- Unique compression bolt system provides maximum reliability

### Features of Turbulator Bars

- Robust ring and bar assembly to prevent bar shifting and movement
- Radial stiffness of tube bar increased 19%
- Circumferential stiffness of tube bar increased 21%
- Light weight bars for fast installation
- Patented design
- Can-by-Can analysis ensures proper application
Benefits of Turbulator Bars

- Increase drying capacity
- Improve moisture profile
- Increase rate of response to changes in steam pressure
- Increase electrical power production
- Reduce potential for bar corrosion

Benefits of Turbulator Bars

- Reduce sheet breaks with uniform dryer surface temperature
- Reduce steam pressure
- Reduce torque power to rim
- Reduce drive power to rim
- Reduce speed to rim
- Quick installation time
Turbulator Bar Installation
De-Tuned Turbulator® Tube™ Bars

General Customer Availability:

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The information in this product introduction package is confidential to Kadant Johnson, and is provided to sales managers, sales representatives and customer service members to assist in selling the product. This document may not be copied in whole or in part to a customer or other party not affiliated with Kadant Johnson.

Record of Changes

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Product Summary

De-tuned Turbulator Tube bars are used to produce dryer surface temperatures that are significantly below those of conventional Turbulator bars, but with cross-machine temperature uniformity that is just as good. This makes the De-tuned Tube bars particularly applicable to wet end, after-coater, and after-size dryers that must operate at low steam pressures.

Technical Description

Turbulator bars are a series of equally spaced axial bars that are held against the inside surface of a paper dryer. When dryers with Turbulator bars have the "right" amount of condensate, the condensate develops resonant waves between the bars. The condensate and the bars are then "in tune" and the heat transfer rate is increased.

The increased turbulence in the rimming layer of condensate increases both the heat transfer rate and the heat transfer uniformity. The increased heat transfer rate increases the drying capacity. It also helps to improve machine runnability, produce a shorter thermal response time after a sheet break, and (indirectly) provide reductions in drying energy. The improved heat transfer uniformity improves the cross-machine moisture profile and resulting sheet quality.

In many applications, cantilever stationary syphons are used to improve the stability of inadequate steam and condensate systems. These improvements result from the low operating differential pressures and low operating blow through flow rates of the stationary syphons.

These stationary syphons replace conventional rotary syphons, but they must be used with Turbulator bars. Without Turbulator bars, stationary syphons can produce a non-uniform heat transfer profile. Turbulator bars greatly improve the uniformity of heat transfer, but they also greatly increase the rate of heat transfer. This is normally a positive aspect of dryer bars, but high heat transfer rates can be a problem in dryers that must operate with low surface temperatures.

Many high-speed dryer sections have been converted to stationary syphons (for improved steam system performance) and dryer bars have been added (for improved uniformity), but the dryer sections end up with either high dryer surface temperatures and sheet linting, picking, and stealing (sheet follows the dryer) or the need to operate at even lower steam pressures (and correspondingly deeper vacuum levels at the vacuum condenser and correspondingly higher vacuum condenser water flow rates).
For some applications, “De-tuned” Turbulator bars may be a good solution. The De-tuned bars operate a long way from the resonant frequency so that the heat transfer rate is not improved. With conventional bars, it is practically impossible to operate far enough away from the resonant frequency to avoid increasing the heat transfer rate. It takes way too much or way too little condensate to get completely away from resonance.

The Kadant Johnson De-tuned Tube bars, however, use the same (practical) condensate depth, but drastically reduce the number of bars (down to 6 per dryer). Kadant Johnson has found that the heat transfer rate with this configuration can be kept low, while the uniformity of heat transfer remains high.

Mechanical Design

The Kadant Johnson De-tuned Tube bars use the same Tube bars, ring segments, and compression bolts that are used with the regular Kadant Johnson Turbulator Tube bars.

For 1.5 m diameter dryers (60”), there are normally (18) Tube bars. The detuned bars would have 6 bars. That is, each of the 3 ring segments hold only (2) bars instead of (6). These bars are positioned in the second and fifth positions on each segment. Short 50 mm (2”) long tube bars are positioned over the un-used ring pins and welded into place. These short tubes are welded with the same procedures as the Edge Control bars. The short tubes welded into position to help facilitate installation (it would take longer to position the 4 small spacers under each ring segment during installation). The spacers support the ring segments between bars and maintain the mechanical stability of the entire assembly.

The ring segments for the 1.5 m diameter dryer are symmetrical. That is, all three segments are identical and can be installed in any position.

The 1.8 m diameter dryers (72”) normally have (21) Tube bars. This was ideal for normal applications. Research trials have not yet been conducted with De-Tuned bars in a 1.8 m diameter dryer. Specific trials will be conducted when there is a potential application. For immediate orders for De-Tuned bars in 1.8 m dryers, the ring segments that are used for the 1.8 m diameter dryers can be configured to hold (7) De-tuned Tube bars. That is, each ring segment will hold either (2) or (3) bars. In this case, one of the three segments of the ring will be different from the other two, and the two segments that are identical must be installed with the right orientation. That is, the first segment will have bars in the first, fourth, and seventh positions. The second segment will have bars in the third and sixth positions. The third segment will have bars in the second and fifth positions. (The second and third segments are identical, but one of them must be turned around). Again, short tube spacers are positioned over the un-used ring pins and welded into place.

For immediate orders, the above system will be used, as these ring segments are already in stock.

Note: Depending on the results of Research testing, ring segments with (6) pins may be used in the future for 1.8 m diameter dryers, for the de-tuned configuration. Each ring segment would have Tubes in the second and sixth positions, with spacer tubes tack welded onto the ring segments in each of the remaining positions. When these 24-bar rings are used, each segment will have (2) bars and each segment will be identical, just like the configuration for the 1.5 m diameter dryers, but they will not be symmetrical. That is, they must each be installed in the right orientation. If this configuration is selected, Kadant Johnson may elect to go to(24) Tube bars for conventional applications, just to reduce the number of hoop configurations that are kept in inventory. This decision has not yet been made.

See the New Product Introduction Package for the Turbulator Tube bars for additional information on the mechanical design, competitive products, Groove Control bars, Edge Control bars, and selling features and benefits of the Kadant Johnson Turbulator Tube bars.

Edge Control Bars

For those dryers with an area outside the stationary syphon that is greater than 400 mm, Edge Control bars are required. These short bar segments should also have the same number of bars as the main bars (that is, either 6 or 7 bars, depending on the ring segment used).
**Product Description**

**Groove Control Bars**

For those dryers that have syphon grooves, the grooves should be filled with Groove Control bars. The groove control bars should also have the same number of bars as the main bars (either 6 or 7). Because the bar spacing is so much larger than the optimum for maximum heat transfer, the slight difference in condensate depth (in the groove) is not expected to cause any additional loss in heat transfer. This has not, however, been confirmed yet in Research testing or in field operations.

*Research trials are recommended for any applications outside the range of current testing.*

**Trade Marks**

The Kadant Johnson trademark for its dryer bars is “Turbulator” bar. This mark has been registered. The new bars have a common law trademark “Tube bars”.

When these Tube bars are de-tuned, the correct common low trademark is “De-Tuned Turbulator Tube bars” or simply “De-Tuned bars” for short.

“Turbulator” is a registered trademark (as opposed to a common law trademark). In any publications, proposals, or marketing literature, the word “Turbulator” should be followed by the “®” sign. This registration designation is required only after the first use of the trademark in the publication. Subsequent use of the trademark in the publication does not require continued marking. It is important that the trademark be indicated as registered, in all publications, to preserve the exclusivity of this trademark. Note that a trademark is considered an adjective, not a noun. That is, we should formally refer to this product as “Turbulator bars”, not just as “Turbulators”.

The trademarks “De-Tuned Tube” or “De-Tuned” should be followed by a “™” sign.

Competitive trademarks are listed below:

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<tr>
<th>Company</th>
<th>Dryer Bar Trademark</th>
<th>Type of Trademark</th>
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</thead>
<tbody>
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<td>Turbulator bars</td>
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<td>Kadant Johnson</td>
<td>Groove Control bars</td>
<td>™</td>
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<tr>
<td>Voith Paper Technology</td>
<td>Thermo Rim bars**</td>
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<tr>
<td>Metso Paper</td>
<td>Dryer bars</td>
<td>Generic name</td>
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<tr>
<td>Beloit Corporation</td>
<td>Spoiler bars</td>
<td>™</td>
</tr>
<tr>
<td>Deublin</td>
<td>Turbulence bars</td>
<td>Generic name</td>
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</table>
Installation Information

Kadant Johnson can supply installation services as well as Turbulator Tube bars and De-Tuned Tube bars. Typical installation time, with an experienced crew, can be as low as one hour per dryer. This is the time required once the dryers have been cooled (4 to 6 hours), the dryer drives locked out, the manhole covers removed, and the dryers tested for entry. Once in the dryers, a two-person crew can often install a section of Turbulator bars about 10 minutes. A 7.6 m (300") machine would have five sections and take less than one hour.

The new Kadant Johnson Turbulator bars can be installed faster than any competitive design on the market today.

The installation time would be similar, or slightly less, for De-Tuned Tube bars.

If contracted to handle the installation, the Kadant Johnson installation crews will unpack the Turbulator bars, check all equipment, and stage the equipment outside the dryers. No pre-assembly work is required. Crews can be working in several dryers at the same time. Typically, two installers work inside the dryer and the third installer works outside the dryer, acting as a “spotter” and passing equipment through the manhole openings. Usually, Kadant Johnson will also provide one additional person, to be available to support the work of multiple crews.
The new Kadant Johnson De-tuned Turbulator Tube bars provide the advantage of improved heat transfer profiles without causing a large increase in drying capacity. De-tuned bars are the ideal solution for those high-speed wet-end, after-size, and after-coater dryers that have stationary cantilever syphons and require low dryer surface temperatures to prevent sheet picking and linting.

The Kadant Johnson De-tuned Tube bars are held against the inside surface of the dryer cylinders with the same series of ring segments that are used with the normal Turbulator Tube bars. The ring segments are tightened with the same compression bolts that are used with the Tube bars.

**Concept Overview**

Condensate normally begins rimming at a dryer speed of about 335-365 mpm (1100-1200 fpm). At this speed, the condensate will rotate with the dryer. There is, however, a natural tendency for rimming condensate to slosh circumferentially back and forth inside the dryer, as the dryer rotates. This sloshing motion creates turbulence in the condensate layer that, in turn, helps to keep a high rate of heat transfer through the condensate layer. As the dryer speed increases far above the rimming speed, this natural sloshing motion and the resulting heat transfer rates are progressively reduced.

Kadant Johnson Turbulator bars are placed inside the dryer to increase the condensate turbulence to levels much higher than those produced by the natural sloshing motion in a rimming layer. When the bars are placed in the dryers, the rimming speed decreases, to 200-300 mpm (650-1000 fpm). If properly spaced inside the dryer, the natural sloshing motion will resonate between the bars, producing very high heat transfer rates, even at high dryer speeds. This resonant behavior in the condensate can cause a significant improvement in both drying capacity and drying uniformity.

Condensate will resonate between bars when the spacing between the bars is close to the optimum. This optimum spacing is approximated by the following equation:

\[ S = \pi \left( R_i \delta \right)^{1/2} \]

where:

- \( S \) = Spacing between bars, mm
- \( \pi = 3.1415 \)
- \( R_i \) = Inside radius of the dryer shell, mm
- \( \delta \) = Average condensate depth in the dryer, mm

High heat transfer rates occur whenever the condensate depth is close to the value given by this equation, over a fairly wide range of operating conditions (speed, pressure, condensing load). Most dryer bar configurations have between 18 and 36 bars per dryer. The specific number would normally be selected to correspond to the dryer diameter, syphon location, operating conditions (speed, pressure, condensing load), bar configuration (bar height, width, and contour), syphon design, and syphon clearance (condensate depth).

The new Kadant Johnson De-tuned Tubes are designed to use only a few dryer bars (typically, only 6).

With this low number of bars, the bars are too far apart for the first-order resonance of the condensate layer to occur. As a result, the bars do not generate a high rate of heat transfer. However, Research tests have shown that the bars still produce a uniform quarter-wave that results in a uniform heat transfer profile. This is ideal for those dryers that have stationary syphons and also require low drying rates.

This combination of low heat transfer rate and high heat transfer uniformity is very unique. It allows cantilever stationary syphons to be used effectively in dryers that require low surface temperatures.
Applications

De-tuned Tube bars should be applied to dryer sections that:

- Are operating well-above the rimming speed (i.e. above 600 mpm), and
- Have manhole openings for installing the bars, and
- Have stationary or rotating syphons, and
- Require low surface temperatures, and
- Can not achieve steam pressures that are low enough, or
- Require very large vacuum condensers to achieve low steam pressures.

Note: If the dryer is not operating well above the condensate rimming speed (above about 600 mpm), then the De-tuned bars will not be able to reduce the heat transfer by very much.

Stationary syphons have a natural tendency to produce hot edges (due to the higher condensate turbulence around the stationary syphon). Normal Turbulator bars with the correct syphon clearance will produce heat transfer rates that are equally high, so they are a natural addition to a dryer with stationary syphons.

The De-tuned bars, however, do not produce heat transfer rates that are as high as regular Turbulator bars. The operating syphon clearance, therefore, must be adjusted so that the heat transfer rate under the syphon is just as low. The correct syphon clearance for good profile uniformity and low overall heat transfer rate is determined from Research trials.

Positive results have been achieved in Research trials for 1.5 m diameter dryers running at 900 mpm, using the configuration recommended below. One commercial installation is pending with this design.

Research trials are strongly recommended for all other operating conditions, to insure that the right combination of bar count and syphon clearance is selected.

Benefits

De-tuned bars will produce quarter-resonant waves in the condensate layer, increasing the uniformity of heat transfer through the rimming layer, but not increasing the rate of heat transfer. The heat transfer will be more uniform in the cross-machine direction than any dryer syphon configuration (rotating or stationary). These features can be used in dryers with rimming condensate to:

- Allow the installation of stationary syphons in low pressure dryers
- Improve the cross-machine moisture profile uniformity
- Lower dryer surface temperatures
- Reduce the amount of blow through steam going to a vacuum condenser
- Reduce or eliminate the amount of steam that is vented to atmosphere
- Put the thermocompressors back in range
- Reduce the flow rate of high-pressure (“motive”) steam
- Reduce the flow rate of condenser water
- Lower rimming drive torque
- Allow larger operating syphon clearance

There are no competitive offerings for De-tuned Turbulator Tube bars. This is the only dryer configuration that can operate with stationary syphons, produce low heat transfer rates, and achieve high profile uniformity.
**Sales Strategy**

**De-Tuned Bar Design Features**

- 6 Tube bars per dryer in 1.5m (5') diameter dryers
- 7 (future 6) Tube bars per dryer in 1.8m (6') diameter dryers
- Tube bars are hollow stainless steel tubes, to reduce weight and eliminate corrosion
- Tube bar cross section is 25 mm wide x 15 mm tall (1.0” x 0.6”)
- The Tube bars create uniform turbulence over a wide range of machine speeds
- High radial and circumferential stiffness
- De-Tuned Tube bars designed with the same mechanical features as normal Tube bars
- Bars are held with standard 10 mm thick x 50 mm wide (0.375” x 2”) ring segments
- There are three segments per ring
- The circular ring is designed for 1.5 and 1.8 m diameter dryers (standard sizes for each dryer diameter)
- The bar segments are designed for quick installation
- Compression bolts are used between ring segments to hold the bars in place
- Bars are held to the ring segments with solid pins that are pre-installed in the rings
- Bars are pre-drilled for these pins – there is no need to tap any holes either before or at assembly
- Tube bar spacers are welded to the rings where the normal bars are removed
- The Kadant Johnson De-tuned bars are engineered to operate at a pre-determined condensate depth
- The simple design requires no machining or special installation tools
- The ring and bar assembly is designed to prevent bar shifting and movement
- All bars are positively attached to rings, with solid pins
- Turbulator Tube bars do not require star, wave, or Belleville washers under the rings
- Turbulator Tube bars do not use coil or barrel springs

**Bundling Product Offerings**

Kadant Johnson has much more to offer the market than just a set of axial bars and a mechanical method of holding them in the dryer. Kadant Johnson Sales must make every effort to add value to the sale of these bars, in order to retain Kadant Johnson’s position in the market as a technical leader and as a complete source for dryer systems and integration.

Available Kadant Johnson offerings include dryer surveys, estimation of drying rates, installation services, steam system reviews, supervisory control systems, and research testing with commercial size paper dryers.

When the Kadant Johnson Service is involved in the project, Kadant Johnson can offer the following bundling opportunities for Turbulator bars:

- Complete drying rate improvement calculations
- Review existing steam and condensate systems for compatibility with upgrade
- Review / develop justification for the purchase of Turbulator bars
- Review other product alternatives for best value (steam system upgrade, rotary syphons)
- Provide Turbulator bar equipment (unique Kadant Johnson design)
- Offer installation and/or supervision services by Kadant Johnson Services or contract firms
- Prepare assembly drawings for future mill / Kadant Johnson reference
- Provide on-going service and sales support (through network of reps and direct sales force)
- Conduct R&D testing of Kadant Johnson and competitive configurations
- Inspection of dryer cylinders, rotary joints, and syphons
- Establish the optimum syphon clearances
- Training services
The installation of Turbulator bars often accompanies the sale of stationary syphons. Kadant Johnson is in a unique position to consolidate all of the above offerings with the sale of stationary syphons, along with:

- Syphon and thermocompressor characteristics matched with steam system design
- Stationary syphon equipment, sizing, and installation
- Installation services (bars, boring journals, syphon alignment)
- Replacement bearing covers (engineering and manufacture)
- Complete drying rate improvement calculations
- Review steam and condensate system (valves, thermocompressors, separator tanks)
- Review mechanical mounting (open gear machine, CARB bearings)
- Conduct audit for future machine production limitations
- Establish blow through correlations for system design

### Sales Collateral / Reference Material

A brief addendum PowerPoint presentation has been prepared to support the sale of the De-tuned Turbulator bars, as noted below. Additional materials are available to support the sale of the normal Kadant Johnson Turbulator Tube bars, also as noted below.

#### Bulletins / Brochures

- Turbulator Bar Flyer
- Installation Instructions

#### Sales Presentations

- PowerPoint Presentation – De-tuned Turbulator Tube bars (download from the members section)
- PowerPoint Presentation – Turbulator Bars (download from the members section at JOCO.com)
- Small Turbulator bar models (for sales calls)
- Large 1.5 m (5’) x 1.5 m (5’) face model
- Turbulator bar segment and stand for trade shows or large presentations

#### Videotapes

- Condensate behavior – stationary camera
- Condensate behavior – rotating camera
- Turbulator bars
- Installation Video Clip
**Competitive Position**

So far, none of the competitors have offered a De-tuned bar configuration. All of their products are focused on increasing the rate of heat transfer. Even if competitors attempt to copy the Kadant Johnson concept of De-tuned bars, only Kadant Johnson has the ability to duplicate the mill operating conditions, demonstrate the performance of the De-tuned bars, and optimize the dryer configuration for the best heat transfer uniformity.

The mechanical features of the Kadant Johnson Tube bars are quite unique and offer a number of advantages over the various configurations of competitive bars. Refer to the New Product Introduction Package for the Turbulator Tube bars for specific details on the mechanical features of the new Tube bars.
Professional Services

One of the most effective ways to sell Kadant Johnson products is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the Kadant Johnson equipment for the customer’s specific application.

Installation & Rebuild Services

This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services

Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering and lead times
- Troubleshooting and preventive maintenance session
### Ordering Information

#### General Customer Availability

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<td>Ready for Ship:</td>
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#### Lead Time

Kadant Johnson Turbulator Tube bars and De-tuned Tube bars have been designed with a series of simple standardized components with the bar layouts engineered in advance. The new bars are made from a series of standard lengths, one standard trim length (if needed), and a single custom trim segment. Most of these components have been manufactured in advance, for fast delivery. Typical delivery, from date of receipt of purchase order, is 3 to 4 weeks. Delivery information for rush orders should be confirmed with the Kadant Johnson factory, but 1 to 2 weeks delivery can often be provided, if needed, with some charge for expediting.

Standard delivery from the machinery builders is typically much longer. Deublin, for example, will typically quote a delivery of 6 to 8 weeks.

#### Pricing

List prices for De-tuned Turbulator bars are dependent on the length and diameter of the dryer, but will normally be priced the same as normal bars. (There are fewer bars, but each order requires special processing and welding of spacer tubes onto the ring segments).

Because of the high value of this product to the customer, price discounting should be the exception. The typical selling price of the Turbulator bars for one dryer is $1,800 to $3,600. This does not include the cost of installation or Edge Control bars. The de-tuned bars should be bundled with other products and services, to support a price that more closely matches the return on the investment to the mill.

*Prices are subject to change without notice.*

#### Required Information to Place an Order

- Internal diameter of the dryer
- Internal dryer width between shell flanges
- Drawing of dryer (if available)
- Type of syphon installed and its location
- Width, depth, and location for front and back syphon grooves (if they exist)

#### Ordering Services

Kadant Johnson services are available for installation, training and maintenance services. For a quote, contact Kadant Johnson.
De-Tuned Turbulator® Tube™ Bars

Turbulator Tube Bars

- Axial bars inside the dryer cylinder
- Held in place by segmented hoops
- Increase condensate turbulence
- Improve heat transfer rate
- Improve heat transfer uniformity
- Improve runnability
Turbulator Tube Bars

- In some applications, high heat transfer rates are not desirable:
  - Dryer surface temperature is too high
  - Picking and linting occurs
  - Sheet quality is reduced
  - Sheet stealing occurs
  - Deep vacuum may be required to reduce steam temperature
De-Tuned Turbulator Tube Bars

- Half-resonant waves are created
- Heat transfer uniformity does improve
- Heat transfer rate does not increase

Uniformity Improves

Dryer Surface Temperature Profiles

- Johnson PTX, De-Tuned bars, 1.7 bar
- Dual rotary, large clearance, no bars, 2.0 bar
De-Tuned Bars Applications

- Stationary or rotating syphons
- Low surface temperature required
- Cannot achieve low steam temperatures
  or
- Requires large vacuum condensers to achieve low steam temperatures

Unique Design

- Hollow bars
- Rigid rings
- Compression bolt

- No springs
- No tap-tites
- No wave washers
Turbulator Tube Bars

- Stainless steel
- 25 x 15 mm
- High radial stiffness
- High circumferential stiffness
- One-third the weight
- Lower shipping cost
- Easier to install

Stepped Connecting Pins

- Pins are captured
- Can not loosen
- No cross-threading
- No broken heads
- MUCH faster to install
Compression Bolt

- Symmetrical design
- Air wrench tightening
- 2x cross-sectional area
- Eliminated SCC
- Easy to install
- Easy to remove
Engineering Standards

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<td>Groove control</td>
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Features of De-Tuned Tube Bars

- Tube bars are stainless steel
- Bar count is selected to produce:
  - Low heat transfer
  - Uniform dryer surface temperature
- No machining or special installation tools
- Segments designed for fast installation
- No coil or barrel springs
- No wave, star, or Belleville washers
- Unique compression bolt system provides maximum reliability
Features of De-Tuned Tube Bars

- Robust ring and bar assembly to prevent bar shifting and movement
- Radial stiffness increased 19%
- Circumferential stiffness increased 21%
- Light weight bars for fast installation
- Patent pending design
- Kadant Johnson Research Center trials:
  - Application demonstration
  - Design optimization

Turbulator Bar Performance

- Correct bar spacing = $\pi \sqrt{R \times \delta}$
- Fewer bars: Condensate volume too big
- More bars: Condensate depth too thin
- Highest heat transfer
  - of any commercial design
  - of any tested design
  - over wide speed range with fixed syphon clearance
- Lower drive torque in rimming conditions
Achieving Low Heat Transfer

- Reduced number of bars
- Develop half-resonant waves
- Bar count depends on:
  - Syphon design
  - Syphon shoe location
  - Dryer diameter
  - Condensing rate
  - Bar configuration

Design operating point

De-Tuned Turbulator Bars

- Allows installation of stationary syphons in low pressure dryers
- Improves cross-machine moisture profile
- Reduces fiber picking
- Maintains low heat transfer
- Reduces sheet linting
- Reduces steam venting
- Reduces motive steam flow
- Reduces vacuum condenser flow rate
Benefits of De-Tuned Bars

- Reduce sheet breaks with uniform dryer surface temperature
- Reduce torque power to rim
- Reduce drive power to rim
- Reduce speed to rim
- Quick installation time
General Customer Availability:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready for Order Date:</td>
<td>Immediate</td>
</tr>
<tr>
<td>Ready to Ship Date:</td>
<td>Immediate</td>
</tr>
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</table>

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Record of Changes

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<thead>
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<th>Revision</th>
<th>Mark</th>
<th>Date</th>
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<tr>
<td>A</td>
<td>---</td>
<td>20 July 2008</td>
<td>All</td>
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Turbulator bars are a series of equally spaced axial bars that are held against the inside surface of a drying cylinder. When properly spaced, these axial bars generate turbulence in the rimming layer of condensate, increasing the drying capacity and the drying uniformity. Other benefits of these bars include improved runnability, shorter response time after a sheet break, and possibly savings in drying energy (typically a secondary effect).

Turbulator bars have been applied to thousands of paper dryers, such as the one shown above, but to a limited number of Yankee dryers. This NPI covers the application to Yankee dryers. A separate NPI covers the application of Turbulator bars to paper dryers.

Yankee dryer diameters are typically quite large, ranging from 12 feet to 18 feet (3.7 to 5.5 m). These dryers are characterized by an internal center “stay”, as shown on the cover of this NPI and in the image below. The center stay is a structure that holds the two dryer heads together. This is necessary because the steam pressure places a large force on the heads as a result of their large diameters. These stays can be individual cross-machine beams (common for 12’ diameter Kimberly Clark Yankee dryers) or cylindrical cast iron structures (the most common configuration and as shown on the NPI cover and in the image below). Multiple rotating syphons or multiple rotating cross-machine headers are used to evacuate the condensate from these dryers. Because of the center stay, stationary syphons cannot be used in Yankee dryers.
Kadant Johnson Yankee dryer Turbulator bars are held against the inside surface of the dryer cylinders with a series of tensioned ring segments. This is the same approach that is used for Turbulator bars in paper dryers. The ring segments are tightened with a unique compression bolt and the bars are held in position by integral pins.

**Concept Overview**

The steam inside dryer cylinders condenses as it transfers its (latent) heat to the dryer shell. At low dryer speeds, the condensed steam (condensate) that forms inside the dryer will tumble around in a non-rimming condition, either in a puddle or cascading. The turbulence in this tumbling condensate is very high, so that the heat transfer to the dryer shell is quite high.

At higher dryer speeds (above the "rimming" speed), the condensate will rotate with the dryer. There is, however, a natural tendency for rimming condensate to slosh circumferentially back and forth inside the dryer, as the condensate rotates. This sloshing motion causes some degree of turbulence in the condensate layer that, in turn, helps to keep a high rate of heat transfer through the condensate layer. As the dryer speed increases far above the rimming speed, this natural sloshing motion and the resulting heat transfer rates are progressively reduced.

Kadant Johnson Turbulator bars are placed inside the dryer to increase the condensate turbulence to levels much higher than that produced by the natural sloshing motion in a rimming layer. With bars in the dryers being properly spaced, the natural sloshing motion will resonate between the bars, producing very high heat transfer rates, even at high dryer speeds. This resonant sloshing behavior in the condensate can cause a significant improvement in both drying capacity and drying uniformity.

Kadant Johnson has videotapes showing this motion in an operating dryer cylinder. No other company in the world has this impressive capability. It should be used by Kadant Johnson Sales to both educate the customer and to show Kadant Johnson’s technical capabilities.

A brief summary for Turbulator bar applications for Yankee dryers and MG cylinders:

- The bars have value if and only if the condensate is rimming.
- Adding bars will not improve the drying capacity or uniformity if the condensate is cascading.
- The rimming speed depends on the amount of condensate in the dryer.
- Adding bars to a dryer with cascading condensate may cause the condensate to rim and reduce drive power.
- If there is too much condensate in the dryer, the condensate will not rim and bars will increase drive power.
- With old syphon headers, there can be a lot of condensate in the dryer.
- When Turbulator bars are installed, old cross-machine headers should be replaced by HDRS syphons.
- The Yankee dryer shell flexes as it goes through the pressure roll nip.
- Modern condensate headers are suspended from the center stay, to avoid the flexing of the shell.
- An HDRS syphon mounted on the shell must also be able to move with the shell (that is, be spring loaded).
- Kimberly-Clark put spoiler bars in all of their high-speed tissue plain shell Yankee dryers, with good results. Note: This is not a reference. It is for internal knowledge only.
- Most of the K-C Yankee dryer bars were bolted to the Yankee shell surface. We do not want to do this.
- The Kadant Johnson Turbulator bar design uses tensioned hoops to hold the bars against the dryer surface.
- Each application of Turbulator bars to Yankee dryers will be custom-made.
- Turbulator bars should only be sold as part of a complete solution, not as equipment at a cost-plus price.
- An approximate price for Turbulator bars for a 12' diameter x 150" face width Yankee dryer is $40k, buried in a package price. For reference, the price for a new Yankee dryer is about $1 million.
Applications

Large diameter dryers are used as “Yankee” dryers, typically for production of tissue and towel grades, and as “MG” (machined glazed) cylinders, typically for the production of wrapping papers and coated board grades. Some machines with Yankee dryers and most machines with MG cylinders have paper dryers either before the dryer or after it (pre-dryers and after-dryers).

Yankee dryers often operate at very high speeds, commonly over 1800 mpm (5900 fpm). In most applications, the Yankee dryer is the only drying cylinder on the machine. Its drying capacity is augmented by a high-velocity, high-temperature air hood, as shown below for tissue paper production.

The wet tissue web is pressed directly onto the surface of the Yankee dryer and it sticks there. A creping doctor blade is used to remove the sheet from the surface of the Yankee dryer, “creping” or wrinkling the sheet in the process. This creping effect helps to provide improved softness for facial and toilet tissues. Because of this creping action, the reel speed will be less than the speed of the Yankee dryer, perhaps by as much as 20%. In these cases, the Yankee dryer speed is generally considered to be the “machine speed”, rather than the reel speed.

The inside surface of most Yankee dryer shells will have circumferential grooves (a “ribbed shell”). This is most common on Yankee dryers over 12’ in diameter. The Yankee dryer shown on the cover of this NPI has a grooved shell. These grooves allow the steam to condense on the side of the ribs and have the heat conducted through the ribs into the shell, bypassing the condensate that has collected at the bottom of the grooves between the ribs.

The condensate must be removed from each of these grooves to keep the grooves from filling up and reducing the heat transfer. Small syphons (“dippers” or “soda straws”) are used for this purpose. These dippers are shown in the schematic at the right.
Turbulator bars are not applicable to grooved shell Yankee dryers. Since most Yankee dryers over 12’ diameter have grooved shells, the market potential for Turbulator bars in Yankee dryers is limited.

MG cylinders, on the other hand, generally operate at much lower speeds than Yankee dryers, commonly 300-1000 mpm (1000-3200 fpm). MG cylinders typically have plain shells (no internal grooves). Turbulator bars can be applied to these cylinders, provided the minimum operating speed is above the condensate rimming speed.

Turbulator bars can significantly increase the drying capacity and improve the drying uniformity in machines with plain-shell (non-grooved) Yankee dryers or MG cylinders that are operating above the condensate rimming speed.

Condensate normally begins rimming in a large diameter dryer at a dryer speed of about 450-500 mpm (1500-1650 fpm). The expected improvement in drying capacity and drying uniformity becomes progressively greater as the machine speed increases. Turbulator bars generally provide measurable improvements at speeds above 560 mpm (1850 fpm), and very dramatic improvements at higher speeds (up to 20% improvement).

Yankee Turbulator Bar Construction

Yankee dryer Turbulator Tube bars are a series of hollow stainless steel tubes that extend across the width of the dryer, from one end of the dryer to the other. These bars are rigidly held against the inside dryer surface by a series of tensioned circumferential hoops. This is similar in concept to the construction used for paper dryers, but the Yankee dryer construction is even more rigid.

Some of the specific design details are listed below:

- The number of Turbulator bars and number of hoop segments depend on the dryer diameter
- Turbulator Tube bars are hollow tubes, to reduce weight and installation time
- The Tube bars are stainless steel, 25 mm wide and 15 mm tall (1.0” x 0.6”)
- The stainless steel Tube bars are the preferred product offering
- Solid mild steel bars can be provided instead of tubes, but tubes are recommended
- The solid steel bar cross section is 25 mm wide x 12 mm tall (1.0” x 0.5”)
- The solid bars and Tube bars both use the same hoop segments and compression bolts
- The Tube bars have higher radial and circumferential stiffness than other commercial bars
- Standard bar segments are nominally 745 mm (29”) long (this is shorter than used in paper dryers)
- Bars are positioned with a 10 mm space between segments
- There is a 50 mm (2”) gap between the end of the bars and the Yankee dryer shell flange.
- Note: Metso uses continuous bars and Deublin places their bars tight together (both are bad designs)
- Bars are held with tensioned rings. These are 75 mm (3”) wide (heavier than the rings used in paper dryers)
- The ring segments are solid mild steel with integral mild steel pins
- The ring radius is custom designed for the bore of the Yankee dryer or MG cylinder
- Steel compression bolts are used between ring segments to tension the rings and hold the bars in place
- The compression bolt is shown in the box below
- The torque values for these compression bolts are 25-35 ft-lb (this is higher than used in paper dryers)
- Bars are positioned under the ring segments with solid steel pins that are pre-installed in the rings
- Bars are pre-drilled for these pins – there is no need to drill or tap any holes
- The bars are not held by threaded bolts, so there is no potential for cross-threading fasteners
- There is no risk of breaking off the heads of bar fasteners
Condensate Syphon System

The condensate removal system in Yankee dryers and MG cylinders may be a series of cross-machine headers with radial dipper straws, a series of cross-machine headers with drilled holes, a series of cross-machine headers with circumferential dippers, a number of bent pipe scoop syphons, or several rotating syphon shoes (such as the Kadant Johnson HDRS style). Schematics of some of these configurations are shown below.
The Yankee dryer on the left has six cross-machine headers with the pick-up straws in a circumferential orientation. The pick-up straws can also be oriented in a radial direction, as shown on the right. In both cases, the straws can extend into the grooves on the inside of ribbed shell dryers.

The dryer on the left is an MG cylinder with a plain shell. This dryer has two scoop syphons with full-width pick-up slots. The colored slide on the right shows a Metso (Valmet) configuration with several cross-machine headers.

All of the above syphon configurations are complex and costly, both to purchase and to install. None of them are suitable for use with Turbulator bars. These syphon systems should be replaced with a series of HDRS rotating syphons. In plain-shell dryers, the syphon shoes are positioned between the Turbulator bars. The number of syphons will typically be selected based on condensing load and the configuration of syphons being removed.

Steam System

The installation of Turbulator bars should always include the upgrade of the steam and condensate system. This includes resizing the thermocompressor, sizing the syphons, and checking line, valve, and tank sizes. This may be a good opportunity to upgrade to a high-efficiency thermocompressor, to improve the entrainment ratio, reduce the use of motive steam, and minimize the potential for venting steam.

NOTE: A steam system can be sold without the addition of Turbulator bars to the dryer, but Turbulator bars should NOT be sold without a steam system upgrade. Kadant Johnson should refuse to sell its Turbulator bars for a Yankee dryer or MG cylinder when a competitor is supplying the steam system.

Turbulator Bar Benefits

Properly spaced Turbulator bars will produce resonant waves in the condensate layer, increasing the level of turbulence and the transfer of heat through the rimming layer. This increased heat transfer rate is more uniform in the cross-machine direction than any dryer syphon configuration (except for ribbed-shell Yankee dryers). The higher heat transfer rate and heat transfer uniformity can be used in dryers with rimming condensate to:

- Increase the drying rate of machines that are already running at their steam pressure limits
- Reduce steam pressure in dryers that are running at a production limit
- Shift some of the drying from the hot air hood to the Yankee dryer / MG cylinder (lower energy cost)
- Improve the moisture profile on machines that have poor condensate heat transfer uniformity
- (The above benefit can be particularly significant in dryers with rimming condensate and old header systems)
- Increase the rate of response to changes in steam pressure
- Reduce the time required to thread the tail and widen the sheet (on MG cylinders)

Even for machines that have a good moisture profile and are not limited by drying capacity, Turbulator bars can still provide some advantages. The increase in heat transfer will result in lower operating steam pressures in the dryers. If the mill produces its own electrical power, this will allow the turbine backpressure to be decreased, which increases the production of electrical power from the turbine generator.

Further, with a higher heat transfer coefficient, there is less change in dryer surface temperature when there is a sheet break. This helps in re-threading the machine and in getting back on quality faster after a sheet break.

Further, the bars tend to move the condensate into a rimming condition at a much lower speed. This reduces the drive power consumption and the load on the dryer drive components. For this reason, Turbulator bars can also be applied in dryers that are normally running slightly below or slightly above the rimming speed. Note, however, that if the dryer is running at a low speed and the condensate is not rimming, and will not be rimming even with Turbulator bars, then the drive load with bars will be much higher than without bars.
Theory
Condensate will resonate between bars if the spacing between the bars is close to the optimum, as specified by the following equation:

\[ S = \pi \sqrt{R_i \delta} \]

where:

\[ S = \text{Spacing between bars, mm} \]
\[ \pi = 3.1415 \]
\[ R_i = \text{Inside radius of the dryer shell, mm} \]
\[ \delta = \text{Average condensate depth in the dryer, mm} \]

This equation indicates that any bar spacing (any number of bars per dryer) will work, provided the optimum condensate depth can be and is achieved. For a proper bar design, the optimum condensate depth will be achieved over a wide range of operating conditions (speed, pressure, condensing load). The equation also indicates that the resonance condition is not affected by dryer speed. Although dryer bars work over a wide range of conditions, there is some loss in the strength and effectiveness of the resonance as the dryer speed increases, particularly if there are many bars and the condensate layer is thin.

Kadant Johnson Research has prepared the white paper "Heat Transfer Performance with Dryer Bars" on the technical details of Turbulator bars. Global Marketing has distributed this technical paper in the same format as the other white papers. This paper should be used by the internal sales group to fully understand the bar technology. Results and conclusions can be shared with select customers, to highlight Kadant Johnson's technical abilities. Comments and questions should be directed to Global Marketing, so the paper can be expanded to cover commercial issues.

In addition to a unique design, and in addition to the improved mechanical features (e.g. light weight, much higher stiffness, no springs or fasteners), Yankee dryer Turbulator bars have a number of operational advantages. These are outlined in detail, with data, in the white paper "Dryer Surface Temperature Response Characteristics".

In summary, the operational advantages include:

- High heat transfer
- Higher heat transfer than competitive configurations
- Higher heat transfer than any other configuration tested
- Optimum heat transfer over a wide range of machine speeds without having to adjust syphon clearance
- Less rimming drive torque

Testing in the Research Center has defined the proper number of bars and optimal condensate depth over a wide range of operating conditions.

This combination results in maximizing shell temperatures while minimizing cross machine temperature deviation.
Installation Information

Kadant Johnson can supply Turbulator bars AND install them.

Kadant Johnson Turbulator bars can be installed faster than any competitive Yankee dryer design on the market today. Special installation techniques can help to insure a fast and trouble-free installation.

However, installation times for Yankee and MG cylinders will be much longer and more difficult than in a paper dryer. Expected installation time, with an experienced crew, is 6-8 hours. This is the time required once the dryers have been cooled (another 4 to 6 hours), the dryer drives locked out, the manhole covers removed, and the dryers tested for entry.

When the installation services are provided by Kadant Johnson, the installation crews will unpack the Turbulator bars, check all equipment, and stage the equipment outside the dryers. No pre-assembly work is required. Typically, three installers work inside the dryer and the fourth installer works outside the dryer, acting as a “spotter” and passing equipment through the manhole openings.

The procedures for installing tube bars in Yankee dryers are based on our experience with conventional paper dryers and one Yankee dryer. The procedures will be refined over time, but the following gives an idea of the current concepts.

The proposed installation procedure will use a series of magnetic clamps to hold the hoops in position during installation. After each hoop segment is assembled, the dryer is progressively walked around, installing one hoop segment and their associated bars at a time. After all of the segments are installed, the compression bolts are tightened progressively to the specified torque. We plan for three (3) installers inside the dryer, one (1) assistant to handle the equipment and serve as the designated safety watch, and two (2) people to handle the manual dryer rotation and maintain the dryer ventilation equipment.

The installation cost will consist of mobilization and demobilization of these six (6) people, mill-specific safety training, lock-out / tag-out procedures, and opening, cooling, and ventilating the dryer. The cost will have to include the removal of any remaining competitive dryer bars (including flush-grinding any fasteners that have been broken off. If the dryer has old bars that must be removed first, the removal of the old bars should take about (6-8) hours.

Kadant Johnson can provide the installation tooling (installation magnets, torque wrenches, and associated hand and air tools). The mill should provide manway gaskets (for both heads), manway removal and installation, and dryer ventilation equipment. The dryer should be vacuum-cleaned after installation, to ensure that no debris is left in the dryer at the end of the installation.
Sales Strategy

Sales Strategies

Kadant Johnson has much more to offer the market than just a set of axial bars and a mechanical method of holding them in place. The price of Yankee dryer Turbulator bars will be much higher than competitive bars and significantly higher than the price of Turbulator bars that are used in conventional paper dryer applications.

We would much rather lose an order for Yankee dryer Turbulator bars with a high price than to receive an order at a discounted price. The technology and the risk are too high for low-margin sales.

Kadant Johnson Turbulator bars should be proposed as part of a complete package that includes the steam and condensate system, new rotary syphons, Turbulator Tube bars, and installation services.

Other associated Kadant Johnson offerings include dryer surveys, estimation of drying rate improvements, steam system audits, supervisory control systems, and research testing (with commercial size paper dryers, not Yankee dryers).

The installation of Turbulator bars often requires the replacement of the existing syphon equipment. Kadant Johnson is in a unique position to integrate the syphon upgrade with the installation of Turbulator bars and the upgrade of the steam system. When the Kadant Johnson Service and Technical groups are involved in the projects, the following bundling opportunities can be offered for Turbulator bars:

- Complete drying rate improvement calculations
- Review steam system (valves, thermocompressors, separator tanks) for compatibility with upgrade
- Establish blow through correlations for system design
- Syphon and thermocompressor characteristics matched with steam system design
- Review / develop justification for the purchase of Turbulator bars and system upgrades
- Provide Turbulator bar equipment (unique Kadant Johnson design)
- Review mechanical joint mounting (hollow shaft reducer, platforms for joints, CARB bearings)
- Upgrade to new ring bracket mounted rotary joints
- Replacement bearing covers (engineering and manufacture) for improved rotary joint mounting
- Installation and / or supervision services (bars, syphons, thermocompressors, desuperheaters, etc)
- Prepare assembly drawings for future mill / Kadant Johnson reference
- Provide on-going service and sales support (through network of reps and direct sales force)
- Training services (joint repair and maintenance, steam system operation)
- Conduct audit for future machine production limitations

Return on Investment

Drying Capacity. The value to the customer of the increased drying capacity and improved moisture profile can be extremely high – much larger than the cost of purchasing and installing the Turbulator bars. Take the following example of a machine whose production is limited by drying capacity:

<table>
<thead>
<tr>
<th>Production</th>
<th>50,000 ton per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit for incremental production</td>
<td>$200 per ton</td>
</tr>
<tr>
<td>Increase in drying capacity from bars</td>
<td>5% (typical range will be 2% to 20%)</td>
</tr>
<tr>
<td>Increased profit</td>
<td>50,000 x $200 x 5% = $500,000 per year</td>
</tr>
</tbody>
</table>

If the installed cost of the Turbulator bars is $200,000, then the Return on Investment (ROI) is less than 5 months! Most paper mills would accept a project with an ROI that is up to two years, even during very difficult economic times.

Sheet Break. There will be additional financial return if the length of time for a sheet break is reduced, as a result of having more stable and uniform dryer surface temperatures. Using the above machine as an example:

<table>
<thead>
<tr>
<th>Number of sheet breaks per day</th>
<th>4 (typical is 2 to 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal sheet break time</td>
<td>6 minutes (typical is 4 to 16 minutes)</td>
</tr>
<tr>
<td>Reduction in sheet break time</td>
<td>30 seconds (0.5 minutes)</td>
</tr>
<tr>
<td>Increased profit</td>
<td>(0.5 min/break) x (4 breaks/day) x ($200/ton) x (50,000 ton/yr) / (60 x 24 min/day) = $14,000 per year</td>
</tr>
</tbody>
</table>
**Sales Strategy**

**Drive Power.** The reduction in drive power is not as significant with a Yankee dryer as it is with paper dryers (since there is only one dryer on the machine). The value, however, can be estimated as follows, if the dryer is running in a cascading mode and the Turbulator bars can move the condensate into a rimming mode:

<table>
<thead>
<tr>
<th>Change in drive power</th>
<th>= 0.8 kW/meter (typical change 0.2 to 1.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryer width</td>
<td>= 5 meter (typical is 2 to 7 meter)</td>
</tr>
<tr>
<td>Decrease in power for the machine</td>
<td>= 0.8 x 5 = 4 kW</td>
</tr>
<tr>
<td>Reduction in power consumption</td>
<td>= 4 kW x 24 hrs/day x 350 days / year</td>
</tr>
<tr>
<td></td>
<td>= 33,600 kW-hr / year</td>
</tr>
<tr>
<td>Savings per year at $0.07/kw-hr</td>
<td>= 33,600 x $0.07 = <strong>$2,352</strong> per year</td>
</tr>
</tbody>
</table>

**Electrical Power.** Another potential return is the increase in electrical power production that results from running the dryer section at a lower steam pressure. This increase in power production is estimated as follows:

| Paper production   | = 50,000 tons per year |
| Moisture removed   | = 1.10 lb-water per lb-paper (typical is 0.8 to 1.6) |
| Steam consumption  | = 1.3 lb-steam per lb-water removed (typical is 1.2 to 1.6) |
| Header pressure drop | = 20 psig (typical is 10 to 40) |
| Theoretical power increase | = 0.007 kW-hr/lb-steam (typical is 0.003 to 0.014) |
| Turbine efficiency | = 70% (typical is 65 to 75) |
| Power Production   | = (50,000 ton/yr) x (1.10) x (1.3) x (0.007 kW-hr/lb) x (2000 lb/ton) x 0.7 / (8760 hr/yr) = 80 kW |
| Value of power production | = (80 kW) x (8760 hr/yr) x ($0.07/kW-hr) = **$49,000** per year |

**Trade Marks**

The generic terms for Turbulator bars are "dryer bars", "turbulence bars", and "spoiler bars". There are a number of manufacturers with competitive offerings, although few with Yankee dryer installations.

The Kadant Johnson trademark is a “Turbulator” bar. This mark is a registered trademark. In any publications, proposals, or marketing literature, the word “Turbulator” should be followed by the “®” sign. This registration designation is required only after the first use of the trademark in the publication. Subsequent use of the trademark in the publication does not require continued marking. It is important that the trademark be indicated as registered, in all publications, to preserve the exclusivity of this trademark. Note that a trademark is considered an adjective, not a noun. That is, we should formally refer to this product as “Turbulator bars”, not “Turbulators”.

Competitive trademarks are listed below:

<table>
<thead>
<tr>
<th>Company</th>
<th>Dryer Bar Trademark</th>
<th>Type of Trademark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kadant Johnson</td>
<td>Turbulator bars*</td>
<td>®</td>
</tr>
<tr>
<td>Kadant Johnson</td>
<td>Turbulator Tube bars**</td>
<td>™</td>
</tr>
<tr>
<td>Voith Paper Technology</td>
<td>Thermo Rim bars***</td>
<td>™</td>
</tr>
<tr>
<td>Metso Paper</td>
<td>Dryer bars</td>
<td>Generic name</td>
</tr>
<tr>
<td>Common usage</td>
<td>Spoiler bars****</td>
<td>Generic name</td>
</tr>
<tr>
<td>Deublin</td>
<td>Turbulence bars</td>
<td>Generic name</td>
</tr>
</tbody>
</table>

* The Kadant Johnson “Turbulator” trademark applies to all Kadant Johnson dryer bar products, both the Tube bars and the solid bars.

** The Turbulator Tube™ bars use hollow stainless steel tubes.

*** Voith has also referred to their bar configuration of turbulence bars as "spoiler bars."

**** This was a common law trademark of Kimberly-Clark and used by Beloit with permission. This is no longer a trademark.
Sales Strategy

Feature Summary
Kadant Johnson has a very unique offering for Yankee dryers:

- Kadant Johnson has a consolidated engineering and service offering
- Kadant Johnson can evaluate and offer other dryer alternatives as well
- Kadant Johnson has unequalled capability for testing various configurations
- Kadant Johnson has more than 15,000 installations and more than 20 years of field experience with bars
- Kadant Johnson can conduct a drying and steam system analysis to ensure proper application of bars
- The Kadant Johnson bars are engineered to operate at the optimum condensate depth
- The hollow stainless steel bars create turbulence over a wide range of machine speeds
- The simple design requires no machining or special installation tools
- Turbulator tube bars are held with rigid hoops with rigid compression bolt couplings
- Compression bolts have a larger adjustment range to assist with installation and dimensional variations
- Stainless steel tube bars do not corrode
- Tube bars are lighter and easier to handle than solid steel bars during installation
- Tube bars would do less damage to the shell (due to lighter weight) if there is a failure
- There are no small threaded fasteners that could be cross-threaded or corroded
- Bars are NOT continuous in the cross-direction (less differential thermal expansion between bars and dryer)
- The residual condensate volume is matched to the bar count for maximum heat transfer and profile uniformity
- Kadant Johnson can provide proven rotating syphons - Special HDRS syphons (not “elephant foot” syphons)
- Spring-loading the HDRS shoe on the shell avoids drilling holes in the shell
- HDRS syphons replace CMD headers and avoid the need for hoops to bridge the headers
- HDRS syphons can have rigid syphon support from the Yankee center stay
- Radial pipes are matched to the condensing load and speed
- Steam system and thermocompressor upgrades provide for energy efficient operations
- Inspection and operation guidelines can be provided by Kadant Johnson
- The bar segments are designed for quick installation
- The circular ring is engineered to match the dryer internal diameter
- The ring and bar assembly is designed to prevent bar shifting and movement
- All bars are positively attached to rings, with solid pins
- A unique compression bolt system provides maximum reliability
- The Kadant Johnson design does not require or use star, wave, or Belleville washers
- Kadant Johnson does not use coil or barrel springs in its bar designs

Sales Collateral / Reference Material

Bulletins / Brochures
Installation Instructions (pending)

Sales Presentations
PowerPoint Presentation – Yankee Turbulator Bars (download from the Kadant Johnson intranet)
Small Turbulator bar models (for sales calls)
Turbulator bar segment and stand for trade shows or large presentations

Videotapes
Condensate behavior – stationary camera
Condensate behavior – rotating camera
Turbulator bars
There are a limited number of large diameter dryers with plain shells and correspondingly a limited number of applications for dryer bars in large diameter dryers. The major competitors are likely to be Voith, Deublin, and Metso. None of them have many commercial installations to use as references. Technical information on what their offerings have been, or might be, is very limited.

**Competitive Position**

Some product distinction can be made on the basis of the number and size of bars, but the primary distinction in offerings with competitive configurations is likely to be the range of support services. Kadant Johnson should focus on its large range of services that support the sale of bars. Mechanically, the system for holding the bars to the dryers may also be used as a point of distinction. There have been bar failures in a number of installations (on paper dryers), from all suppliers, so the mechanical design distinctions can be quite important.

1. Some dryer bars are bolted directly to the dryer shell. In order to accommodate axial thermal expansion and flexing of the shell as it passes through the pressure roll nip, the holes in the bars may be slotted or the ends of the bars interconnected with one fastener per bar. These bars require the shell to be drilled and tapped, in either one or two places for each bar segment. The fasteners are normally quite small (#10). Each time the shell is drilled, there is a potential for opening up a through-shell leak path. Such a leak can take the dryer out of service. Yankee dryers cost about $1 million and delivery is typically 8-12 months. Experience has shown that every few years, one of the bars will fail. If not caught immediately, the failed bar will take out the rest of the bars. It takes 2-4 days to remove the failed bars and install new bars in the dryer.

2. Dryer bars used by Kimberly Clark consist of short interlocking segments that are each bolted directly to the dryer shell with one small fastener. This is a very inexpensive approach, although the installation time is long, the tapped holes in the shell can result in through-shell leaks, and the bars are susceptible to failure. Kadant Johnson will not supply dryer bars that are bolted to the shell.

3. Bars that are held by mechanical systems against the shell will likely have some type of spring-loading system to accommodate the radial expansion of the dryer. Experience has shown that all types of spring-loading systems (coil springs, wave washers, and Bellville washers) eventually fail. This can be expected after 5-10 years of service life, but the service life can also be much less than that.

*The new hollow bar design reduces the bar weight while increasing the radial stiffness by 19% and the circumferential stiffness by 21%.*
4. A few ribbed shell Yankee dryers have spoiler bar clips. There are two types of spoiler bar clips that are used in ribbed shell Yankee dryers: A U-shaped wedge that is driven into the groove and a strap clip that is bolted to the top of the ribs. Escher Wyss introduced the spoiler bar "clips" in the 1980’s. The improvement in heat transfer, if any, was quite small. Kadant Johnson does not offer spoiler bar clips for ribbed shell Yankee dryers.

5. Deublin has provided dryer bars to a limited number of plain shell Yankee dryers. Two of them are Burgo Treviso (a 4.5m Yankee) and Ahlstrom Bossa, Torino (a 16 ft Yankee with 72 rows of bars). Another was Georgia-Pacific Camas PM14 (12 ft Yankee with a 105" sheet width, 5800 pph condensing load, 2650 fpm, with two HDRS 1.25 sch 160 syphons). There are (40) bars with 3/8” x 1” cross-section. This machine had trouble with drying after the bar installation.

6. Deublin Yankee dryer bars are similar in design to the Deublin paper dryer bars. The hoop segments, however, bridge over the top of existing CMD headers or the bars are cut out to make room for rotary syphons. The Deublin bars are solid mild steel (not stainless steel and not tubes). The bars are 875 mm long and are held to circumferential hoops with Whizlock bolts. The hoops are 80 mm wide and are tensioned with "all-thread" studs and jam nuts. The Whizlock capscrews can be cross-threaded during installation. The heads can break off if over-tightened (and do eventually break off anyway). The bars in the dryer are either continuous or butted together. This results in more differential axial thermal expansion between the bars and the dryer shell.

7. Voith uses a mechanical hoop assembly for securing their bars. We have limited information, but on a 12’ diameter Yankee dryer, Voith used (48) 0.25” tall x 0.50” wide bars. This was at Kruger Lennoxxville PMS (Canada).

8. We are aware of only one large cylinder with bars in Finland: UPM Tervassari PM7. This is a 7 m diameter (23 feet) x 4.84 m reel trim MG cylinder that runs 250-900 mpm, making release papers. The dryer probably runs under both rimming and non-rimming conditions. Metso installed bars in December 2003. They were still in the dryer four years later. The bars are held mechanically (with hoops). The dryer does have a pressure roll on it. The nip load is not as high as a tissue machine, but still high (no value available).

9. The Kadant Johnson Turbulator bars do not have any springs, Whizlock capscrews, or all-thread studs. Solid compression bolts provide tension at the ring ends. These bolts have a special collar under the extended socket head to press against one ring while a large nut (and jam nut) press against the adjacent ring. Turbulator bars use the bending of the ring ends and the slight bending of the rings in the spans between bars to maintain the clamping force on the bars, basically using the large rings as leaf springs. This avoids the problem of spring failures that have plagued the other suppliers. It is important to note that the deflection of these ring ends is normally less than 0.2 mm. This is well below the elastic limit of the ring. Turbulator bars use large solid pins to lock the bars to the ring segments. There are no threaded fasteners to break and the pins are “captured” so that they cannot come out. The cross-sectional area of these solid pins is 3x the threaded cross-sectional area of competitive fasteners. Turbulator bars are made up of 745 mm (29” nominal) standard length segments. Tube bars of this standard length are kept in stock. Each segment has two 360° rings to hold it in place. A custom-trim segment is placed at the end. The maximum bar length has been limited to 745 mm to ensure that the bars can be easily passed through the manholes, easily installed, have a higher holding force, and have very small differential thermal expansion. Turbulator bars have 10 mm gaps between the ends of adjacent bars. This is required to allow for thermal expansion and ease of installation.

10. Corrosion Issues. Some mills have experienced problems with rapid corrosion of their steel dryer bars. These problems are not very common, occurring in less than 2% to 4% of all paper dryer bar installations. When corrosion problems are encountered, however, they may be quite severe. To avoid problems with corrosion, Kadant Johnson recommends stainless steel tube bars.

The cost of providing solid stainless steel bars is generally too high to be competitive. The hollow bars, however, can be provided in stainless with a much lower premium in price. This is because there is much less weight required. The standard supply of stainless steel tube bars is a unique offering from Kadant Johnson.
It is important to note that Tube bars are always stainless steel, never mild steel. It is also important to note that the hoops, pins, and compression bolts are steel. These other components are not stainless steel because, even when bar erosion has been serious, it has generally been limited to the bars, with much less corrosion of the hoops occurring.

Reference Installations
The first installation of Kadant Johnson Turbulator Tube bars was at Levent Kagit San. Ve Tic, Kemalpasa PM1 (Turkey). This was Kadant Johnson Europe, order 48213.211. This installation was completed in July 2008. The dryer has a plain shell, 4200 mm diameter (165”), and a face width of 4900 mm (193”). The dryer has (4) rows of bars and uses circumferential rings with (8) segments. The machine speed was increased to 650 mpm (not limited by the dryer). The drive load decreased and the profile uniformity improved. Four HDRS rotary syphons were supplied with this order.

Note: Kadant Johnson has other installations of Yankee dryer bars, but these older design bars.

Professional Services
One of the most effective ways to sell Kadant Johnson products is by leading with services. Professional services from Kadant Johnson can conclusively demonstrate to a customer or prospective customer the benefits and financial return of the Kadant Johnson equipment for the customer’s specific application.

Installation & Rebuild Services
This service includes training prior to installation, supervision, and/or installation of Kadant Johnson equipment, and inspection of all equipment installed. Specific services include:

- Training on the proper techniques of installing Kadant Johnson equipment
- Supervising or performing the actual installation
- Providing inspection services to assure a quality installation
- Rotary joint repair – on-site or off-site exchange program

Training & Education Services
Training programs are designed to give the greatest impact in the shortest period of time. They include specific topics tailored to meet the customer’s equipment specs and application requirements. All seminars are designed to benefit both new personnel and more experienced employees.

- Explanation of function of the rotary joint and syphon equipment
- Tips and techniques to improve performance and life of wearing components
- Guide to installation, repair, and maintenance of Kadant Johnson equipment
- Recommendations on spare parts usage, ordering, and lead times
- Troubleshooting and preventive maintenance sessions
Sales Strategy

Ordering Information

General Customer Availability

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<tr>
<td>Ready for Order:</td>
<td>Immediate</td>
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<tr>
<td>Ready for Ship:</td>
<td>Normal lead time</td>
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Lead Time

Kadant Johnson Turbulator Tube bars have been designed to use a series of simple standardized components. Most of these components have been manufactured in advance, for fast delivery. The Yankee dryer Turbulator bars are made from a series of standard tube lengths and a single custom trim segment. The circumferential hoops, however, are always custom made. Typical delivery, from date of receipt of purchase order, is 4 to 6 weeks (dictated by delivery time of the custom circumferential hoop segments). Delivery information for rush orders should be confirmed with the Kadant Johnson factory, but 3 to 4 weeks delivery can normally be provided, if needed.

Standard delivery from the machinery builders would be expected to be much longer, if they are even willing to provide the bars.

Pricing

The price for Turbulator bars for Yankee dryers and MG cylinders depends on the diameter of the dryer and the width, but the price is market-based. Because of the high value of this product to the customer, prices should not be discounted. Further, the market price of the alternatives (Metso bars, Voith bars, new CMD dipper straw headers) will be much higher than the Kadant Johnson solution.

We clearly do not want to put any equipment in a Yankee dryer with a small margin. Yankee dryers are expensive and thermally critical components.

The typical selling price of the Turbulator bars for one dryer is $25,000 to $60,000. This does not include the cost of installation. This price is still only a fraction of the value of the benefit that these bars bring to the customer.

These bars should be bundled with other products and services, including the steam system, to ensure a successful project and to support a price that more closely matches the return on the investment to the mill.

Required Information to Place an Order

It is important that accurate design information be available for installation of Turbulator bars. This includes dryer inside diameter as well as the dryer width between dryer shell flanges and dryer construction. The width between flanges is the most critical. The compression bolts in the new Turbulator bars have been designed to accommodate a wide range of dryer diameters, but the circumferential hoop segments are normally custom-made. Most mills have an assembly drawing of their Yankee dryers and MG cylinders. Copies should be obtained for Engineering reference. Drawing records, however, are not always accurate. It is best to perform a physical check, just to be sure. The following information is typically required to begin Engineering:

- Internal diameter of the dryer
- Internal dryer width between shell flanges
- Drawing of dryer (required)
- Type of syphon currently installed

Ordering Services

Contact Kadant Johnson for a quote on services that are available for installation, training and maintenance.
1. What are Turbulator bars?
   Turbulator bars are axial bars, installed on the inside of dryers and used to induce turbulence in the condensate layer, to improve the rate and uniformity of heat transfer (drying rate) of the dryers.

2. Is the name “Turbulator” a trademark?
   Yes. Kadant Johnson has registered and uses the trademark “Turbulator”. This mark should always be noted with a “®” in its first use and be used as an adjective. That is, we should recommend “installing Turbulator bars” and not “installing Turbulators”. Generic names are spoiler bars, dryer bars, and turbulence bars. Voith uses the trademark “Thermo Rims”.

3. Are Turbulator bars applicable to all Yankee dryers and MG cylinders?
   No. Turbulator bars are not applicable to Yankee dryers with ribbed shells.
   They are also not applicable to dryers that are operating routinely below the rimming speed. The rimming speeds are typically about 450-500 mpm (1500-1650 fpm). Turbulator bars produce the greatest increase in heat transfer at the higher machine speeds.

4. What are the dimensions of the Kadant Johnson Turbulator Tube bars?
   They are 15 mm x 25 mm (0.6” x 1”) hollow tubes which are held against the dryer shell by a series of ring segments. The ring segments are pressed apart by proprietary compression bolts.

5. How many bars are used in a dryer?
   The number of bars depends on the dryer diameter. Kadant Johnson has standards for selecting the number of bars. This is not included in the quotation specifications.

6. Can stationary syphons be used with Turbulator bars in a Yankee dryer?
   No. Yankee dryers have internal center stays. The syphon system must rotate with the dryer. Normally, the existing syphon systems (headers, scoops, dippers) are removed and replaced with several Kadant Johnson HDRS rotating syphon shoes.

7. What are typical dryer syphon clearances?
   Operating clearances for the HDRS in Yankee dryer applications will be selected specifically to match the performance of the bars. The clearance will typically be 1.5 to 2.2 mm (0.06-0.09”).

8. What should be the difference in temperature between the steam and the outside dryer surface?
   The difference between the steam and outside dryer surface temperatures is normally quite high with Yankee dryers and MG cylinders, due to the extra thick dryer shells. A difference of 100 to 150 F would not be uncommon.

9. What can be done to evaluate the performance improvement with Kadant Johnson Turbulator bars for Yankee dryer applications?
   A special Kadant Johnson drying analysis program can be used to make analytical predictions.

Frequently Asked Questions
10. How long does it take to install a set of Turbulator bars in a paper dryer?

The time depends on the size of the dryer and the crew. Typically, once the dryer is ready for entry, it will take 6-8 hours to install a full set of bars. It can take several days to install competitive dryer bars.

11. Why was this product not released for sale sooner?

The market for Turbulator bars is not very large, the application technology is not the same as paper dryers, and the performance is very critical to the operation of the machine (the dryer cannot be valved out and still operate the machine).

12. Will the driver power increase when the bars are installed?

It depends. If the condensate was rimming before the installation of bars, it will continue to rim after the installation of bars. There may be an increase in drive power, but this should be quite small.

If the condensate was not rimming before the installation of bars and it is rimming after the installation of bars, then there should be a significant reduction in drive power after the bars are installed.

If the condensate was not rimming before the installation of bars and it is still not rimming after the installation of bars, then there will probably be a significant increase in drive power after the bars are installed. Bars should not be installed in a dryer if the condensate is not going to be rimming.

Turbulator bars are developed for dryers with rimming condensate (or in dryers where we want to get the condensate to rim). Once the condensate is rimming, the dryer drive power is only marginally affected by the amount of condensate that is rimming in the dryer. This can be seen in the data presented in “Drive Power and Torque in Paper Machine Dryers” (this paper is available for download on the Kadant Johnson Intranet).

This data also shows that Turbulator bars reduce the speed at which rimming occurs, reduce the power required to get the condensate to rim, and reduce the torque required to get through the transition.

13. Could 12 mm tall solid bars be used with the new fastening system?

Yes, 12 mm tall solid bars could be used. We can use the standard compression bolts, custom rings, and standard stepped pins with solid bars. Solid steel bars are, however, heavier, harder to install, more costly, and look the same as every other supplier's bars.

14. What are the key features of the new Tube bars?

Focus on these key points:

- The Turbulator Tube bars were designed from the ground up.
- These Tube bars represent the best integration of design features.
- The Tube bars are lighter in weight and easier to install, yet stiffer than other bars.
- The Tube bar cross-section was optimized for operation with the HDRS syphons.
- The fastening system is very robust and extremely reliable.
- The pins cannot come out of position once the bars are in place.
- The compression bolts lock the hoops in place, without any springs, washers, or turnbuckles to fail.
15. Will the heat transfer of the Tube bars be better than that of the competitive bars?

There are a multitude of dryer bar configurations whose performance is clearly substandard. There are also many that are good. But we can clearly say that no other dryer bar configuration in operation today produces heat transfer rates that are higher than that produced by the Kadant Johnson Turbulator Tube bars. We can say this, because we have tested them all! We have looked at tall bars, thin bars, wide bars, spiral bars, stepped bars, many bars, few bars, thick condensate layers, thin condensate layers, high speeds, low speeds, high DP, and low DP. No one else (particularly not Deublin) has run as many tests.

With all of this testing, we have found ways that we can get high heat transfer rates from many different configurations of bars. But, just because we can achieve a high heat transfer rate does not mean that the configuration is a good commercial design.

We have used our test results, and our design expertise, to develop a configuration that not only gives high heat transfer results, but also is easy to install, robust, and consistent in performance.

16. How were the specific design features selected? Are any of the features really unique?

A series of design objectives were specified (ease of installation, robust, stiff, high performance, etc.). A number of tests were then conducted at the Kadant Johnson Research Center. We tested tall bars, short bars, many bars, few bars, wooden bars, steel bars, t-bars, louver bars, stepped bars, and many other configurations. Based on all of this data, and the design objectives, the best composite of features was selected.

Philosophically, every product design is a compilation of many common components. It is the combination of components in a unique configuration that makes the product distinctive (different) and better. We must focus on the Kadant Johnson Turbulator bar design as being different from all other designs on the market. The bars are easier to install, are more robust, give higher heat transfer performance, and operate over a wider range of machine conditions.

17. How are differences in thermal expansion rates accommodated without springs?

The ring segments and the hollow bars are elastic members that elastically deflect in response to the differences in thermal expansion of the dryer shell and the bar assembly during start-up and shutdown of the machine.

18. Do the different metals (stainless steel bars, mild steel ring segments, cast iron shell) cause any negative reactions inside the dryer? Is there potential for galvanic corrosion to occur?

It is quite common to put stainless steel, mild steel, and cast iron components together. This is done routinely in many steam system and paper dryer applications, without a problem. Whenever dissimilar materials are put together, there is a potential for galvanic corrosion to occur. Aluminum and magnesium, for example, would be expected to experience rapid corrosion in a steam environment. The potential for galvanic corrosion can be evaluated by looking at the relative electromotive potentials. For stainless steel, mild steel, and cast iron, there is very little difference. That is why there is no problem putting these materials together.

Stainless steel, however, has a significantly higher resistance to corrosion than cast iron, and an even larger resistance to corrosion than mild steel. That is why stainless steel is used for all syphon pipes. Stainless steel is also used in cooling rolls, sweat dryer bars and
swing dryers, where there is inherently a lot of air in the system that causes the mild steam components to corrode.

We have not seen any occasions where stainless steel components inside a dryer have eroded, even when they replaced cast iron and mild steel parts that had been experiencing a high degree of corrosion and erosion. We can be very confident that the stainless steel bars will not corrode.

19. Does water get inside the bars? If yes, what happens to the water inside the bars? Will the bars corrode faster? Cause increased drive load?

Yes, water will get inside the bars. The amount of water in the bars will be close to the average condensate depth in the dryer. A dryer with Tubulator bars and this small amount of water inside the bars will have less weight than a dryer with solid bars or even a smaller cross-section. The drive load for the dryers with Tubulator bars will be no different than a dryer with solid bars, but the inertia of the dryer will be less with the Tube bars. This is because the condensate has less weight than steel. Stainless steel syphon pipes (that have very large steam and condensate velocities in them) do not corrode. It is highly unlikely that a small film of water laying inside a stainless steel tube bar would corrode either.

A related question is whether the water in the bars reduces the rate of heat transfer to the dryer. The short answer is, we have tested the net result and the performance of the new Tubulator bars is higher than that of any other configuration (commercial or otherwise) that we have tested. And we have tested a LOT of different configurations.

If you have other questions that you would like to have added to this list, please send them to Kadant Johnson Marketing.

###
PT™ Steam Joints for Yankee Dryer

PT (Piston Type) Series

- Introduced in 1991
  - More than 15,000 in operation
- Incorporates latest seal technology
  - Extended seal life
  - Enhanced reliability
  - Improved maintenance
  - Accommodates thermal expansion
PT Seal Technology

- Proven seal package
- Handles up to 18° of misalignment
- Compensates for axial movement
- Balanced seal

PT Seal Technology

- Corrosion resistant parts
- Uniform seal face load
- Spherical face seal ring
- Tolerates misalignment
- Polished surface finish
PT Joint Configurations

2000 Series

6000 Series

9000 Series

2000 Series PT Steam Joint

- Rod-supported
- Through-flow design
- Support rods are mounted into bearing cover
- Sizes 2” to 6.5”
2000 Series PT Steam Joint
6000 Series PT Steam Joint

- Overhang or underhung bracket-mounted
- Through-flow design
- Bracket is mounted to bearing cover
- Sizes 2” to 4”
6000 Series PT Steam Joint

9000 Series PT Steam Joint

- 360° ring bracket-mounted
- Through-flow design
- Optional integral bearing cover/bracket
- Sizes 3” to 6.5”
9000 Series PT Steam Joint

9000 Series PT Steam Joint
## Application Data

- Steam and condensate service
- Pressure: 150 psig (10 bar)
- Temperature: 450° F (232° C)
- Speed: 500 RPM

## PT Installation and Maintenance

- Lightweight, easy-to-handle
- No shims required
- External seal wear indicator
- Increased seal wear range
- Simple carbon replacement
<table>
<thead>
<tr>
<th>PT Distinctive Features</th>
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<tbody>
<tr>
<td>• Reversed seal – in compression</td>
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<tr>
<td>• Spring loaded design seals at low pressure (vacuum)</td>
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<td>• Larger limits for misalignment</td>
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<tr>
<td>• Extended seal travel</td>
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<tr>
<td>• Large flow area through the rotary joint</td>
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Yankee Dryer Steam Systems

Basic Yankee Dryer Types

• Smooth bore shell
  – Older but still common
  – Two types of syphoning systems
    • Scoop type syphoning system – usual two headers
    • Traditional rotary type syphons – two to four per dryer
  – High speed smooth bore Yankees benefit from bars
    • In some cases, bars bolted in place
      – Requires drilling and tapping dryer shell
    • Kadant Johnson now offers bars for Yankees with hoop style support system

• “Ribbed” shell
  – Most (or all) new Yankee dryers have grooved cylinders
    • Achieve higher heat transfer rates
  – Soda straw syphoning system used
Yankee Dryer System Design

- In general, each Yankee dryer and syphon system is an individual.
- Each steam system must be tailor made
- Even replacement dryers will be different.
- Predicting differential pressure loss and blowthrough flow for the syphon system is the most important design requirement
System Design

• Condensing load and syphon flow characteristics must be accurately established
• Determining condensing load
  – Kadant Johnson Yankee drying programs
  – Condensate rise tests useful on existing Yankee cylinder
• Methods for establishing the syphon flow characteristics:
  – Observed operating parameters
    – Existing blowthrough flow indication
    – Existing differential pressure
  – Kadant Johnson syphon analysis
    • Allows syphon system to be modeled

Analyzing Syphon “Flow Characteristics”

• Pressure losses in a Yankee syphon system
  1. Inlet joint
  2. Inlet insulation sleeve (negligible if insulating sleeve bore is greater than steamfit bore)
  3. Stay steam distribution
  4. Straw
  5. Condensate collection header nozzle
  6. Riser pipe friction loss
  7. Centrifugal force
  8. Outlet insulation sleeve
  9. Outlet steam joint
Yankee Internal Components

- Tending side steam input
- Drive side condensate output
- Ribbed shell
- Condensate riser pipes
- Man hole
- Hollow center shaft
- Insulating sleeve
- Header support
- Siphon Header
- Condensate Straws
**Condensate Header Dipper Tube Pattern**

**Dryers up to 14 foot diameter**
- 2 straws per groove plus 8 in dryer taper areas

**Dryers 14 foot diameter and above**
- 3 straws per groove plus 12 in dryer taper areas

**Yankee Syphon Flow and DP Graph**

- **Flood Point**
- **Normal operation**
- **Thermo compressor Design**
Tissue Machine Systems

- Thermocompressor systems used almost exclusively on Yankee dryers
- Very high blowthrough flows
  - Condensate “soda straw” systems have high open area
- High differential pressures typical
- Design of thermocompressor critical
  - High efficiency designs are advantageous
- Blowthrough flow used for control
  - Produces correct velocity in syphon “straws”
- Flash steam from high temperature condensate should be used in process

Yankee Dryer System Schematic
Thermocompressor Control

• Method 1 - Control thermocompressor from pressure control loop
  – Used when motive steam pressures are low and blowthrough rates are high
  – Used if motive flow is a high percentage of total make-up
  – Thermocompressor opens fully, then make-up valve
  – Blowthrough meter controls valve at thermocompressor inlet

• Method 2 - Control thermocompressor motive based on blowthrough flow meter
  – Used if motive steam pressure is high
  – Used if blowthrough flow rates are relatively low
  – Motive steam flow is only a portion of dryer condensing load

Pressure Controlled Thermocompressor
Blowthrough Controlled Thermocompressor

- High efficiency thermocompressors are an advantage on Yankee Systems
  - Blowthrough flows and differential pressure high
  - Motive steam flow can often equal or exceed Yankee condensing load
    - Causes system to vent
  - High efficiency thermocompressors reduce the motive steam requirement and reduce venting
    - Can reduce motive steam use by 20% to 25% over conventional thermocompressor designs
Flash Steam Utilization

Flash Steam Used In Steam Shower

Low Pressure Flash Tank Established
Flash steam used for process
Yankee Dryer Design

- Each Yankee dryer is an individual
- Steam system must be tailor-made
- Replacement dryers and through-dryer development will be unique
Component Locations

Yankee Dryer Total $\Delta P$

- Inlet nozzle
- Inlet insulation sleeve
- Stay
- Straw
- Condensate collection header nozzle
- Riser pipe friction loss
- Centrifugal force
- Outlet insulation sleeve
- Outlet steamfit
Steamfit – Through-Flow Type

Good flow pattern, little frictional resistance

Dryer Journal / Insulating Sleeve

Double Seated Type

Front Insulating Sleeve

Gasket

Front

Packing Ring
Steamfit / Insulation Sleeve

- Expansion of steam into insulating sleeve
- Size of insulating sleeve bore and pressure loss

Dryer Cylinder

- Stay steam distribution area inlet velocities of 6 to 10 mps
- Higher velocities can impact on the dryer shell
- Older dryers can have numerous types of steam distribution arrangements
Steam Distribution and Condensate Removal

- Pipe Header
- Condensate Pipe
- Header Support Bracket
- Condensate Removal Straws
- End Straw Positioner

Header Supports

- 6 HEADERS FOR > 14 FOOT DRYERS
- 4 HEADERS FOR < = 14 FOOT DRYERS
Condensate Header Dipper Tube Pattern

Dryers up to 14 foot diameter
- 2 straws per groove plus 8 in dryer taper areas

Dryers 14 foot diameter and above
- 3 straws per groove plus 12 in dryer taper areas

Header Layout
Old Type Soda Straw

- Erosion of pick up pipe
- Flooding of straw entrance to header

MG Scoop Plain Dryer

Up to 400 mpm full-width pick up slot
Header Dipper

Condensate Cone Detail

- Without cone, high turbulence, poor extraction and erosion problems can occur
Valmet Yankee

No need for expansion units

MG Cylinder Operating Curve

Understanding of total steam and condensate system enables Yankee / MG operating curves to be produced.
Corrugating

Industry Overview

Corrugated is an extremely durable, versatile, economical, and lightweight material used for custom-manufactured shipping containers, packaging, and point-of-purchase displays – used to make cartons.

Corrugated board is the combination of at least two sheets of paper, more typically three sheets of paper. The layers on the outside are known as liners and the fluted or wave-shaped material in the middle layer is called corrugating medium. Corrugated board is manufactured to specific applications and may have unique flutes or sheet weight specification resulting in different thicknesses.

Quick Industry Facts:

- $25.2 billion market in the U.S. and Canada, 600 manufacturing plants in the U.S. and Canada producing corrugated.
- Manufacturing plants are categorized into three types: corrugators, sheet plants, and sheet suppliers.
- Trend is to deliver customized solutions to specific application challenges, contain costs while adding value, provide fast response to prototyping, just-in-time delivery, and provide products that are recoverable, recyclable, and environmentally friendly.

Corrugators are plants that combine paper into corrugated board. Typically, these plants also have equipment that converts the corrugated board into finished corrugated products: boxes, shipping containers, point of purchase display, and other distribution packaging. There are approximately 600 corrugator plants throughout the U.S. and Canada.

Sheet plants purchase corrugated board and convert them into boxes, shipping containers, and other distribution packaging. These plants are usually smaller than corrugator plants but are usually highly specialized in their product mix. There are more than 800 sheet plants in the U.S. and Canada.

Sheet suppliers combine corrugated board into corrugated sheets exclusively for purchase by sheet plants. There is no other converting equipment to make finished boxes. There are approximately 50-60 sheet suppliers in the U.S. and Canada.

*Kadant Johnson equipment would most commonly be used by corrugator plants.*

Equipment and Processes:

A corrugating plant is usually composed of one or two corrugating machine lines. A typical corrugating line consists of a series of equipment pieces which process the various types of paper as they pass through to form the corrugated material. Each series of equipment has its own set of operating challenges and when an issue arises the issue impacts the performance of the entire machine.
Unwind Stand – The unwind stand allows quick paper grade and roll changes and allows splicing from one roll to the next while the machine continues to operate. These machines generally handle two rolls at a time. On high speed machines it is common for the machine to have two unwind stands per single facer and one in front of the triple stack. This equipment does not require the use of rotary unions.

Large preheater rolls – Large preheater rolls add temperature to the sheet and helps control tension. Prior to making board, the liner and medium sheet needs to be heated to soften the fibers and to get both sheets to a similar temperature. With the temperature changes, the sheets stretch. Each of the preheater rolls has a tension control or wrap arm that can add sheet contact to the heating surface, controlling temperature. The rolls require a self supported or rod supported rotary joint.

Single facer – The single facer is the main part of the corrugating process, this machine forms the flutes and bonds the fluting medium to the single face liner. The single facer is comprised of small preheat rolls (often both liner and medium), a pressure roll, an upper corrugating roll, and a lower corrugating roll.

The medium enters the machine and passes around a small final preheat roll. The sheet, which may or may not have a steam shower adding moisture to assist with the flute formation, passes in-between the upper and lower fluting rolls and is formed into shape. As the formed sheet follows the second flute roll, an applicator system applies liquid starch to the tip of the fluted sheet.

*The liner sheet follows a similar process when entering the single facer.

From there, the single wall continues to exit the single facer and festoons on the bridge to cool and allow adhesives to set up.

*Often a second single facer with all of the components as described above, follows the first for quick transitioning from one flute style to another.

The single facer requires the use of several rotary joints. Typical rolls using the rotary steam joint are the liner preheater, upper corrugating roll, lower corrugating roll, pressure or belt roll, and medium preheater (preconditioner roll).
**Preheat Stack Dryers** (also referred to as double or triple stack) – Preheaters often have two or more dryers (usually mounted on top of each other) depending on how many single facers the corrugator line has. The bottom dryer is used for heating the second liner. The other preheater rolls re-heat the single wall in preparation for attaching the second liner. If the corrugator line has the ability to manufacture double wall or triple wall, additional dryers may be added to handle each additional single wall sheet.

Preheaters generally require self supported or rod supported steam joints.

**Glue Station** – As sheets exit the preheat stack dryers, the sheets enter the glue station where adhesive is applied again on the tips of the fluted medium. If there are multiple walls, board is being manufactured. In this case, each single wall fluted medium will have adhesive attached.

Some manufacturers use heated rolls in this process, others do not. When heated rolls are used rotary joints are required. This is only typical on older machines.

**Double Backer** (also referred to as a double facer) – The double backer is positioned between the glue station and the slitter/scorer. This machine consists of hot plate sections which the combined board passes over. A driven belt runs the length of the double backer and moves at the same speed as the combine board. The belt presses the board tightly against the hot plates cooking the remaining moisture out. The hot plates complete the process of bonding the sheets together. Each section of the hot plates may be controlled to different pressures to ramp temperatures and dry the sheet in the most efficient manner.

The double backer is similar to the dryer section of a paper machine. The steam system is closely monitored and adjusted to provide the correct temperature. Liqui-mover® pumps are a solution to
Corrugating

Industry Overview

Improve start up performance and condensate removal for lighter grades that require cooler section control. In some cases, there may be a dryer at the front of the double backer.

Steam systems are employed in the operation of corrugating units to perform several functions:

1) To preheat the corrugating material for easy fluting formation.
2) To heat the sheet so that it will absorb the adhesive easier.
3) Maintain surface temperatures on the heating surfaces of the corrugating rolls, pressure roll, preheater rolls, and preconditioners.
4) Control the temperatures in the steam chest or double backer section. The adhesive applied by glue applicator to the flute tips is generally a starch base which gels and becomes an adhesive at fairly low temperatures.

Corrugator OEMs (see OEM profiles for more information):

BHS
  • CRC
  • Peters
MarquipWardUnited
Mitsubishi
Fosber
Isowa
Agnati

Problems to look for:

Downtime
Heat transfer
Keeping up to date with technology
Steam leaks
Lack of expertise
Preventative maintenance

What and where to sell:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Service</th>
<th>Product:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugator Roll</td>
<td>Steam</td>
<td>SX, EL, LJ, CorrPro</td>
</tr>
<tr>
<td>Pressure Rolls</td>
<td></td>
<td>Flexible Hose</td>
</tr>
<tr>
<td>PreHeat and Preconditioner Rolls</td>
<td>Steam</td>
<td>SX, EL, LJ, Flexible Hose</td>
</tr>
<tr>
<td>Double Backer</td>
<td>Steam</td>
<td>SX, EL, LJ, Flexible Hose, Liqui Mover Pumps</td>
</tr>
</tbody>
</table>
### Corrugating

#### Industry Overview

**Industry Terminology:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesive</td>
<td>Adhesive is typically cornstarch.</td>
</tr>
<tr>
<td>Applicator Roll</td>
<td>The applicator roll transfers adhesives to the tips of the fluted medium.</td>
</tr>
<tr>
<td>Bridge</td>
<td>The deck above the machine on which the formed board slides. Its purpose is to support the festooned single face board between equipment and in addition, provide board storage for absorbing the constant speed changes.</td>
</tr>
<tr>
<td>Corrugating Rolls</td>
<td>Set of grooved, heated rolls that mesh under pressure.</td>
</tr>
<tr>
<td>Festooned</td>
<td>The accumulation of single face web stored on the bridge to give time to allow the bond to cure and provide a shock absorber between the variations in operating speeds of the single facers and the downstream equipment.</td>
</tr>
<tr>
<td>Flute</td>
<td>A continuous series of arches (flutes) formed in the sheet as it passes between the upper and lower corrugating rolls. The height, shape, and number of flutes per linear foot of corrugated medium determine the flute profile. The most common profiles are C, B, A, and E. Each flute profile requires its own set of matching rolls.</td>
</tr>
<tr>
<td>Kraft</td>
<td>Unbleached linerboard.</td>
</tr>
<tr>
<td>Linerboard</td>
<td>Paper that forms the outer plies of the combined board and prevents the flutes from stretching. Linerboard requires high compression and burst strength. It must also have water resistance properties.</td>
</tr>
<tr>
<td>Medium</td>
<td>Paperboard used in forming the fluted center ply of the single wall board.</td>
</tr>
<tr>
<td>Roll Stand</td>
<td>The roll stand supports the paper roll while it unwinds during corrugating.</td>
</tr>
<tr>
<td>Slitter/Scorer</td>
<td>Equipment that slits newly formed board to the width determined by the customers’ specifications. Can also crush board along predetermined lines, scoring it for future folding.</td>
</tr>
<tr>
<td>Splicer</td>
<td>Equipment which allows transfer from one sheet to another without stopping the single facer.</td>
</tr>
</tbody>
</table>
Corrugating Industry Overview

Competition:

Deublin (USA) –

H Series: Designed for steam and hot oil service. Rated up to 180 RPM for steam service; 350 RPM for oil service, 150 PSI (10 bar), and 365 F (185 C). Sizes available from ¼” to 5”.

Barco (USA) –

C, CS, and Super G Line:

Type C and CS rotary joints are available in sizes from ⅛” to 3”. The nipple is available in either bronze or ferrous material. Barco claims the following features:

- Applied to steam, water, and oil up to 316 C (600 F)
- Seal is under compression
- Seal wear indicator available on all sizes

* Type C joints are dual flow, Type CS are single-flow

Super G rotary joints are what are recommended (by Barco) for corrugating applications. It is a self-supported joint with two carbon guides, available in 1-1/4”, 1-1/2” and 2” sizes and rated up to 17 bar (250 psig) and 316 C (600 F). This joint is used with the Barco hinged syphon elbow made of bronze.

Rocky (Japan) – not many found in the USA but very prominent in the Japanese corrugating market.
BHS, headquartered in Weiherhammer (Germany), has approximately 40% market share in corrugating machinery, corrugating rolls, and services. BHS manufactures corrugating rolls for its own machines as well as single facers for other machinery builders. BHS has operations located in the Czech Republic, Croatia, China, Brazil, and the U.S. A separate business sector was established in 2001 that included Peters, Fact, and CRC companies. They produce approximately 100 sets of corrugating rolls per year and up to 700 different profiles of rolls.

**Preheater** - BHS preheater cylinders have a steam chamber width that is larger than the maximum paper width. They are synchro-driven coupled to the web speed, an important factor for maintaining constant web tension during speed changes. The wrap rolls are rigid tandem rolls ensure efficient heat transfer to the web and liner. Wrap control is adjusted automatically to suit individual board speed and quality. Optimum temperature for each paper grade and speed is achieved when the web reaches the infeed of the heat and traction section.

**Glue Machine** - BHS offer two glue application systems: a pressure roll system with automatic pressure control and a shoe system with spring-loaded pressure shoes.

Both are suitable for micro flutes and large flutes.

**Double Facer DF-P** -
MarquipWardUnited, headquartered in Phillips, Wisconsin (USA) with manufacturing locations in Maryland (USA) and Magyar (Hungary), manufactures single facers, double facers, and glue machines. Its double facers feature gun drilled steam chambers in hot plates and plate stiffners ensuring flat hot plates in all conditions. The models include the Model 600, Cool-Vac, and Pyro™.

Marquip single facers provide solutions for high speed applications and quality board as well as operating reliability with weight paper variety.

The Eagle Glue Machine features a preheat option that preheats the double face liner and the fluted side of the single face web. The added heat increases the speed capability of double wall and heavy weight board combinations.
Mitsubishi, headquartered in Japan, also has locations in The Netherlands and in Hunt Valley, Maryland (USA). The Mitsubishi Heavy Industry division manufactures corrugating machinery including single facers and corrugating rolls.

**H Series** –
- 60G Fingerless Single Facer
- 51C/51B Preheater
- 55D Glue Machine
- 56D Double Facer

**U Series** –

**SH 400 Series** –
- 65H Glue Machine
- 66H Double Facer
Fosber, headquartered in Lucca (Italy), manufactures machinery primarily for the dry end of the corrugating process. Fosber America, a solely owned subsidiary of Fosber S.p.A., is headquartered in Green Bay, Wisconsin (USA). Fosber also manufactures wet end machinery for the corrugator and has acquired Tiruna, a corrugator roll company, with operations in the U.S.

**SMART™ SingleFacer** – high speed, quick flute change cassette machine housed in a cast iron frame. The adjustable pressure roll is vertically offset from the corrugating rolls to reduce vibration.

**CREST™ GlueUnit**
Agnati, headquartered in Italy, has locations in Germany, Asia, North America, and Africa. Agnati manufactures all components of the corrugator.

**Master** Single Facer – flute forming technology using crownless rolls in place of traditional pressure rolls.

**Super90** Single Facer

**Varybond** Glue Machine – the bonding process utilizes an exact amount of adhesive consistent with the board grade being produced. 400mm glue roll diameter to control the centrifugal acceleration from high working speeds.

**GPA Varypress** Double Facer – heat transfer system allows variable pressure across the machine.
Isowa, headquartered in Japan, manufactures corrugating machines as well as corrugating machine equipment. The corrugating machines are the Corrugator CWDX and Double-Deck Corrugator CWDD.

**Corrugator CWDX** – This machine is the ISOWA flagship. Specifications include 2500 mm maximum paper width, 350m/minute maximum production speed, and 95m line length.

**Double-Deck Corrugator CWDD** – This machine incorporates the functionality of the Corrugator CWDX but is built on a double-deck for space saving footprints. The line length on this machine is 68m.

Corrugating equipment manufactured by Isowa includes single facers, glue machines, and double facers.

**CF50 and CF40 Single facers** - The corrugating rolls are enclosed in a cartridge enabling the flute change in 10-15 minutes. Both are beltless.
Converting is the process that takes paper and paperboard from its bare material form and converts it to another finished product, such as printing papers, coated papers, crepe papers, waxed papers, etc.

Converting processes include laminating, coating, printing, folding, gluing, corrugating, decorating, embossing, foil (for food packaging), plastic film, and sheet printing. These processes are done in web and sheet-fed form.

The coating and laminating processes generally use both heated and cooled rolls. Some applications require calendering, while others require pre-conditioning of the product (which is usually an application of heat and moisture). Typical machines used in the converting industry include: Winders/Unwinders, Coating Machines, Tunnel Dryers, and Laminating Machines.

In a coating process, rolls of paper are placed on unwinders and fed through coating machines. The rolls on the coating machine are heated or cooled, depending on the coating applied. Fillers such as clay, starch, wax, or polyethylene are added to the paper and the finished product is then rewound on a rewinder.

Coatings of emulsions for special copy paper, blueprint paper, photographic paper, and pressure sensitive materials use the same process, except the material is cured in tunnel dryers before rewinding. Tunnel dryers may have a dozen or more water cooled rolls.

Laminating of two different types of paper, paper and plastic, or paper and foil is accomplished in one of two ways: an adhesive is used to bond the materials together, or the materials are bonded using pressure. Both methods use heated and/or chilled rolls.

**KADANT JOHNSON PRODUCT APPLICATIONS IN THE CONVERTING INDUSTRY**

Typically, converting processes will have several joint applications using one or all of these three mediums:

<table>
<thead>
<tr>
<th>MEDIUM</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot oil</td>
<td>ELS, SX, RX rotary joints</td>
</tr>
<tr>
<td>Steam or hot water</td>
<td>ELS, SX rotary joints</td>
</tr>
<tr>
<td>Water or glycol (for cooling)</td>
<td>RX rotary joints</td>
</tr>
</tbody>
</table>

Other products used in the Converting Industry include Liqui-Mover pumps, sight flow indicators, and flexible hose.
### SPECIFICATIONS

- **Hot oil**: Up to 510 PSI, 650° F, 200 RPM
- **Steam**: Up to 250 to 310 PSID, 500° F, 100 RPM
- **Water**: Up to 150 PSIG, 250° F, 4000 RPM

### CONVERTING MACHINE MANUFACTURERS

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>MACHINE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windmoeller &amp; Holscher</td>
<td>Flexo, Laminators, Coaters</td>
</tr>
<tr>
<td>Kidder</td>
<td>Flexo Stack Presses</td>
</tr>
<tr>
<td>PCMC</td>
<td>Flexo Presses</td>
</tr>
<tr>
<td>Cobden Chadwick</td>
<td>Flexo Presses</td>
</tr>
<tr>
<td>Black Clawson (Kadant)</td>
<td>Laminators, Coaters</td>
</tr>
<tr>
<td>Wolverine</td>
<td>Flexo Printing Presses</td>
</tr>
<tr>
<td>Allied Gear</td>
<td>Narrow Web Flexo</td>
</tr>
<tr>
<td>Webtron</td>
<td>Narrow Web Flexo</td>
</tr>
<tr>
<td>Mark Andy</td>
<td>Narrow Web Flexo</td>
</tr>
<tr>
<td>Stanford</td>
<td>Slitter/Doctor Machines</td>
</tr>
<tr>
<td>Goebel</td>
<td>Slitter/Doctor Machines</td>
</tr>
<tr>
<td>FMC</td>
<td>Bas Machines</td>
</tr>
<tr>
<td>Dusenberry</td>
<td>Slitter/Doctor Machines</td>
</tr>
<tr>
<td>Cerrutti</td>
<td>Gravure Presses</td>
</tr>
<tr>
<td>Esan</td>
<td>Extruders</td>
</tr>
<tr>
<td>Rotomec</td>
<td>Coaters and Laminators</td>
</tr>
</tbody>
</table>
Web Offset Printing is a process where an image is transferred from an image carrying plate to an intermediate rubber blanket, then to a continuous web of paper. The major advantage of offset printing is that the soft rubber surface of the blanket creates a clearer impression on a wide variety of paper surfaces with a minimum make-ready press work. Offset printing can be recognized by a smooth print, the lack of any impression in the paper, and the lack of a ring of ink or serrated edge, which is characteristic of letterpress printing methods. Web Offset is used for printing business forms, newspapers, long run books, and magazines.

Web Offset Printing Presses use rotary joints on the In-Feed Rolls, and the Ink Vibrator Rolls. Water is applied to the Ink Vibrator Roll to avoid the transfer of latent heat (heat that builds up as the press operates) to the Ink Fountain. Heat would affect the viscosity of the ink, making it soupy, and not allowing for uniform coverage to the rolls. There are sixteen rotary joints per unit and a press can have anywhere from two to 8 units. The most common is four units on a press. Heatset Printing utilizes a Dryer in the final process. The Chill Roll Stand comes after the Dryer and can have 6 to 8 rotary joints.

Newspaper printing presses do not use rotary joints.

Equipment used to print computer paper and business forms are not as sophisticated as a Web Offset Press, but rotary joints are found on Ink Vibrator Rolls and Chill Roll Stands in these printing processes too. Rolls of paper are fed into the press from a Turret Unwinder or Butler Splicer.

Flexographic Printing is a form of rotary web letterpress printing, using flexible rubber or photopolymer plates that are mounted to the printing cylinder. It is usually used in the food packaging and paper converting industries, and it is generally slower than offset printing. Flexographic Printing is done on film or foil because the inks cannot penetrate the medium. The medium must be dried between each application of color. Normally there is an Unwind Stand, controlled by clutches, a brake (air service) on the front end of the press, and a Rewinder on the delivery end. A Flexographic Press may have 2 to 6 units, with two Chill Rolls (water service) between each unit, and a final Chill Roll Stand.
Food Processing

Drying Overview

Food processing is the set of methods or techniques used to transform raw ingredients into food or to transform food into other forms for consumption.

<table>
<thead>
<tr>
<th>Industry Trends:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong> – reduction of fat content in final product and maintaining the natural taste of the product using less artificial sweeteners</td>
</tr>
<tr>
<td><strong>Hygiene</strong> – rigorous application of industry and government endorsed standards to minimize possible risk and hazards; US standard is HACCP</td>
</tr>
<tr>
<td><strong>Efficiency</strong> – rising energy costs lead to increasing usage of energy-saving technologies</td>
</tr>
</tbody>
</table>

Drying

Drying processes within the food industry vary depending on the final product. The primary goal of the drying process is moisture removal from the product. In some cases, drying can be used for sterilization, separation, or cooking. There are various types of rotary joints used with the majority of the joints being 4” and greater, used with steam service up to 10 bar, and rotational speeds less than 15 rpm. The process utilizes a large dryer with an internal screw or trunnion that moves the product through the dryer. Steam is injected into the screw and, in some cases, into holes drilled around the inner circumference of the dryer. Water, thermal oil, and air are also used in certain applications.

**Grain** - Grains such as wheat, soybeans, and corn products all have a certain moisture content. To be properly stored, grain must be dried to the proper moisture level to prevent spoilage and mold. While wheat and soybeans may dry to sage levels in the field, corn is typically harvested at about 25% moisture content and must be dried to about 15% moisture. Grain processors use steam tube dryers and dehydrators that use steam and water as media. Many animal feeds are processed from raw grains mixed with other minerals and products.

**Flakes/Powders/Films** - Drying is required to convert liquid material into products such as corn flakes, potato flakes, baby foods, and oatmeal, among others. The liquid material is dropped onto a hot cylinder surface and adheres itself onto the cylinder using the surface heat from steam (hot water or thermal oil may be used). In less than one single revolution, the liquid is dried and scraped off of the cylinder surface in the form of film, flakes, or powder using a doctor blade.

Scoop syphons are generally used to remove the condensate inside the dryers. In most cases, the rotary joints are 5” or larger. Smaller rotary joints are used when a dryer drum is located inside another drum to prevent the material from unsterile environments.
Food Processing

Drying Overview

**Fish** – Fishmeal is an animal food product used to feed mink, chicken, and other small animals. The fish is first pressed to remove oil, cooked, and then dried. The last two processes use steam heated dryers. In order to produce an easily digestible product, the fishmeal must be dried at low temperatures. The average steam pressure used is 5 bar and the fishmeal product must be 38°F/20°C - 58°F/30°C less than that of the dryers. The product is removed from the dryer after approximately two hours of drying. A different process using steam heated tubes in the dryer can reduce this drying time to 35 minutes.

**Tobacco** – Tobacco is grown in over 100 countries and comes in a number of varieties. After the tobacco is harvested, most varieties are subject to an on-farm heat curing process. Depending on the variety, tobacco may be cured by piped warm air, directly over an open, slow-burning fire, or in the sun. Dealers purchase this cured tobacco (still an agricultural raw product) from the farmers, and subject the tobacco to further drying and processing for periods varying from a few months to a two years to refine it before it can be used as an ingredient in other products such as cigarettes. During this time, moisture loss will reduce the weight of the tobacco by 8% - 12% and occasionally by as much as 40%.

The tobacco processing operation is delicate because the organic tobacco fibres are highly sensitive to disruptions in the process. Once the tobacco is conditioned, it is resold to tobacco manufacturers for transformation into such products as cigarettes, cigars, pipe tobacco, and fine-cut tobacco for roll-your-own cigarettes.

**Yeast** – Yeast drying is found in breweries, bakeries, and pastry manufacturers. Drum dryers are heated with steam and the yeast dries as it comes in contact with the drum’s outer surface. The drum immerses in the immersion trough filled with wet yeast. Part of this yeast will stick to the hot drum surface and will dry that way. After about one drum rotation, a hydraulically adjustable yeast knife cuts the yeast off the drum surface. Generally, scoop syphons remove the condensate from the dryer. Yeast typically starts with 75% to 85% moisture content and is processed down to 10% moisture content.
Rendering is a process that converts waste animal tissue such as fats, feathers, bones, and blood into value-added material. The majority of the waste comes from slaughterhouses, but can also come from restaurant grease, butcher shop scraps, expired grocery store meat, and carcasses from shelters, zoos, and veterinarians. Animal by-product and rendering processes use rotary dryers and cookers to separate the fat from the bone and protein. Many of the applications are similar to the rubber and plastic processes in that they mix, mill, calender, and finish the product. Rendering processes can be categorized into two categories, edible products and inedible products. The process for edible products is generally carried out in a continuous process at low temperatures with or without added steam. First, the liquid and fat mixture is separated from the solids and then the fat is further separated from the water. The solids and separated fat are then used in food products and if in surplus, the fat can be used in soap making.

In a continuous application, disc dryers are primarily used and two joints are generally found, one on each end of the machine. Disc dryers are made of discs that are welded to a central tube heated by steam from the inside. The product is continuously circulated in the rotating disk bundle and shovels transport the product axially through the disc bundle dryers. Scrapers fixed in between the disc ensure thorough mixing and prevents product from sticking to the discs. Rotary joints on these dryers handle steam, condensate, and air.

In a batch application, generally for inedible products, material is heated in a steam-jacketed vessel to drive off moisture and release fat from fat cells. Some edible products can be produced using a wet process or continuous application. The material is heated with added steam and then pressed to remove a water-fat mixture which is then separated into fat, water, and fine solids by stages of evaporation. The solids from the press are dried and then ground into meat and bone meal. Most independent renders process only inedible material.
Food Processing

Drying Overview

*Dryer OEMs* (see OEM Profiles for more information):

Atlas-Stord (HAARSLEV)
Davenport Dryer
Dupps
Idaho Steel Products
Baker Perkins
Bepex
Bufovak
GMF Gouda
Tremesa

*What and where to sell:*

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Service</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Tube Dryers</td>
<td>Steam</td>
<td>J, N, ELS, ELSN, LJ-PT, SX, flex hose, Liqui-mover pumps</td>
</tr>
<tr>
<td>Flaker Dryers</td>
<td>Steam</td>
<td>J, N, ELS, ELSN, LJ-PT, SX, flex hose, Liqui-mover pumps</td>
</tr>
<tr>
<td>Puffers</td>
<td>Steam</td>
<td>J, N, ELS, ELSN, SX, flex hose, Liqui-mover pumps</td>
</tr>
<tr>
<td>Unit Heaters</td>
<td>Steam</td>
<td>Liqui-mover pumps, vacuum breakers</td>
</tr>
<tr>
<td>Door Heaters</td>
<td>Steam</td>
<td>Liqui-mover pumps, vacuum breakers</td>
</tr>
<tr>
<td>Air Make-up Coils</td>
<td>Steam</td>
<td>Liqui-mover pumps, vacuum breakers</td>
</tr>
<tr>
<td>Shell &amp; Tube Water Heaters</td>
<td>Steam</td>
<td>Liqui-mover pumps, vacuum breaker</td>
</tr>
<tr>
<td>Plate &amp; Frame Water Heaters</td>
<td>Steam</td>
<td>Liqui-mover pumps, vacuum breakers</td>
</tr>
<tr>
<td>Steam &amp; Supply Headers</td>
<td>Steam</td>
<td>Thermocompressors, desuperheaters</td>
</tr>
</tbody>
</table>

*Problems to look for:*

*Steam or water leaks* can cause contamination or inconsistencies in heat/cooling control causing hot spots.

*Condensate carry over and flash loss.*

*Old technology* causing machine failures and increased downtime.
Food Processing

Drying Overview

Competition:

**DEUBLIN**

H Series Steam and Hot Oil Unions

Operating Data:
- Max. Pressure: 230 PSI (16 bar)
- Max. Speed: 1,000 RPM
- Max. Temperature: 250°F

F Series 5” Water Union

Steam Service Operating Data:
- Max. Pressure: 150 PSI (10 bar)
- Max. Speed: 350 RPM
- Max. Temperature: 365°F

Hot Oil Service Operating Data:
- Max. Pressure: 100 PSI (7 bar)
- Max. Speed: 180 RPM
- Max. Temperature: 450°F

Both series include the following features:

- Monoflow or duoflow designs
- Self-Supported rotating union
- Two widely-spaced graphite bearings
- Stainless steel rotor

**DUFF NORTON**

9000 Series

Operating Data:
- Max. Pressure: 250 PSI (17 bar)
- Max. Speed: 500 RPM
- Max. Temperature: 375°F
Features:
- Bellows-type seal for flexibility with equipment misalignment
- Integrated cartridge
- Ball bearings and graphite bearings available for higher speeds and temperature applications
- Up to size 5"

PEARL

Pearl is a Japan-based manufacturer of rotary joints. They produce large, self-supporting joints up through 16". They supply approximately 40 large rotary joints to dryer manufacturer TSK (Japan) annually. Pearl is primarily marketing in Southeast Asia. TSK markets its production Europe and Asia. Pearl is unable to provide a CE mark for its products.

MAIER

Series H and HW

Steam: H and HW; Water at low RPM; Hot oil: HW

Operating Data:
- Max. Pressure: 250 PSI (17 bar)
- Max. Speed: 500 RPM
- Max. Temperature: 375°F

Features:
- Two carbon guides
- Locked housing guide
- Nipple made of steel; sealing surface [is plated] chrome steel
- Cover and compression springs made of chrome steel
- HWA butting ring and adjustment ring made of chrome steel
- Seal ring is pressure-loaded
Atlas-Stord, part of the HAARSLEV a/s Group, is headquartered in Denmark with offices in Spain, Norway, Germany, and Peru. Atlas-Stord provides process solutions and equipment to the fish meal and oil, rendering, breweries and distillers, biomass, and industrial sludge industries.

The following products are all manufactured by Atlas-Stord:

**Hot Air Dryer, type HLT** – co-current convective drying system with a rotating drum for drying of various types of raw material. It consists of two separated circulation systems, which imply no contact between product and combustion gases. The gas system consists of combustion chamber with a gas or oil burner. Furthermore, a mixing chamber where the combustion gases are mixed with recycled exhaust gas, a heat exchanger for energy transfer to the drying air, and a gas circulation fan. This product is known in the industry as *Low Temperature fish meal drier system*.

**Rotary Universal Drum Drier, type RUDD** (image below) – engineered with an advanced single-pass free-flow system.

**Rotadisc Drier, type TST** (image below) – capable high capacity, gentle drying, and consistent product quality. This is the most popular product for Atlas-Stord in terms of products produced and widest distribution. The material to be dried is added at one end of the drier and while the moisture is evaporated the material is transported to the other end and taken out through a bottom outlet valve. This product is usually applied to fish meal and rendering plants, sludge treatment plants, breweries, distilleries, as well as chemical plants.
Food Processing (Drying)

OEM Profiles

**RotaChannel Drier, type RCD** (image below) – similar concept to the Rotadisc Drier, type TST. The heating plate design provides contact between the product and the heating surface, increasing the specific capacity and reducing power consumption and wear.

**Rotatube Drier, type RTD** (image below) – compact steam drier for drying of various protein-based feedstuff. It is built of a rotating drum with internal lifting shovels and a heating surface which is designed as tubes bundles heated by steam.

**Raw Material Sterilizer, type SBC (batch cooker)** – redesign of the conventional batch cooker.

**Meal Sterilizer, type RMS** (image below) – equipment developed for heat treatment of both raw materials and meal to enable end users to meet requirements of EU legislation (sterilization requirements). Ensures rendered products are treated at 133°C and a steam pressure of 3 bar for 20 minutes. This product treats meal coming from both the wet and dry rendering processes.
Preheater, type RPH (image below) – the Rotadisc preheater is an indirectly heated, continuously working device for gentle preheating of raw materials. Designed for steam as the standard heating medium, the preheater can also use hot water or thermal oil as alternative heating mediums.

Compact Coagulator, type WHCC (image below) – heat exchanger designed to coagulate (cook) proteins. The mass travels continuously through the serially connected cooking tubes where it is agitated by the rotating scrapers and heated to the required temperature. The end result is a homogenously cooked product with a very short exposure to high cooking temperatures.

Cooker, type SFC – applied in processes where high yield from raw material of variable quality and composition is required. Fish meal and high quality chicken or turkey meal are a few examples.

Fish Meal Plant, type TW (image below) – designed to meet the demand for small space saving and easily operated fish meal plants. Suited for operation on board trawlers, purse seiners, and floating factories. The end product is fish meal.
Davenport Dryer, headquartered in Rock Island, Illinois (USA), manufacture and supply steam tube dryers in the ethanol industry. Other steam tube dryer applications include corn germ, corn gluten, corn fiber feed, cellulosic process cake, soybean conditioning, canola seed conditioning, paper sludge, and various chemicals and minerals.

Davenport customers include: Blue Flint Ethanol, Red Trail Ethanol, Heron Lake Energy, BP Amoco Chemicals Corp., Johnson Controls, etc.

Kadant Johnson Products: EL Steal Joints
Dupps
www.dupps.com

Dupps, headquartered in Germantown, Ohio (USA), builds and installs high quality process equipment; including protein co-products rendering systems and rotary drum dryers. Dupps also provides maintenance, repair, and rebuild support.

The following machinery is manufactured by Dupps:

**QuadPass™ Four Zone Dryer** – used for agribusiness, forest products, municipal and industrial wastes, and animal protein recycling.

**Ring Dryer** – grinds, dries, conveys, and produces heat all in one system that handles any material that can be entrained. This dryer gives the manufacturer a cooler product with accurate moisture content and no wet spots.

**Dupps Airless Dryer** – uses superheated steam at atmospheric pressure as the drying medium.

Dupps customers include: Tyson Foods, Simmons Foods, Wilson Foods, Atlanta Processing, Central By-Products, Tribune, By-Products, Clapper Corp., Armour Fresh Meats, Sunland Beef Co., River Valley Animal Foods, etc.

Kadant Johnson Products: LN and SX Rotary Unions, Syphon Elbows, Vacuum Breakers
Idaho Steel Products
www.idahosteel.com

Idaho Steel Products is located in Idaho Falls, Idaho (USA). They produce the only stainless steel drum dryer in the food processing industry. In addition to the drum dryer, Idaho Steel Products also manufactures cookers, steam peelers, blanchers (preheaters), rotary formers, and custom products.

*The drum dryer ranges in sizes up to 7’ x 20’ and has a pressure rating up to 175 psi.

*Kadant Johnson Products: LJ Rotary Joints
Baker Perkins, headquartered in Peterborough (United Kingdom), also has a location in Grand Rapids, Michigan (USA). Baker Perkins manufactures equipment for the bakery, biscuit, confectionary, and snack and breakfast cereal sectors.

**Flaking Roll** – use of producing flakes through maintained roll surface temperature, gap control, and regulated infeed.

- Contra flow water cooling system distributes cooling evenly over roll surface
- Water chambers close to surface for maximum cooling effect
- Closed loop system controls water temperature to within a 0.2°C tolerance band
- Water temperature can be set as required by operator
- Cooling module uses distilled or demineralised water for longer operating life
- Standard roll widths of 450, 780 and 1120 mm are available

Kadant Johnson Products: SX and LJ Rotary Unions, Flexible Hose, and Syphon Elbows
Bepex
www.bepex.com

Bepex International LLC., headquartered in Minneapolis, Minnesota (USA), manufactures indirect drying and vacuum dryers to the food and chemical industries.

Solidaire – includes a jacketed cylinder with a high-speed paddle rotor that creates a highly agitated, dense, thin layer of material against the jacketed vessel wall. This thermal processor also processes heat-sensitive materials ranging from free-flowing solids to wet cakes and slurries. Applications for the Solidaire include:

- **Drying**
  - Coffee, ground
  - Corn meal
  - Corn starch
  - Fish protein
  - Wheat starch
- **Cooling**
  - Food Mixes
- **Heating and Reaction**
  - Pepper
  - Starch
  - Wheat & soybean concentrate

Torus Disk – heater/dryer/cooler provides batch or continuous indirect heating, drying, cooling, or reaction of solids, slurries, gels, filter cakes, powders, and viscous materials. This processor consists of a stationary horizontal vessel containing a tubular rotor with vertically mounted double-walled discs that provide 85% of the heating surface. During operation of this indirect heating and drying system, a high relative velocity between the rotating discs and the product contributes to a high heat transfer coefficient. Applications for this processor include:

- Distillery and Brewery waste products
- Hexane extracted soybean meal
- Soy protein dextrose
- Corn and soybean waster products
- Fish meal
- Meat by-products/Rendering processes
Food Processing (Drying)

OEM Profiles

**Continuator** - dryer with a jacketed trough that provides indirect heat transfer. By adding gas through specially designed nozzles in the bottom of the trough, this dryer maximizes gas contact with the product. This enhances mass transfer of volatile. Applications for this dryer include:

- **Mixing**
  - Corn Meal
  - Food Mixes
  - Spices
  - Soybean meal
- **Cooking, Reacting, Heating, and Cooling**
  - Cacao
  - Chicken skin
  - Filler materials
  - Wheat germ
  - Wheat meal

**Ribbon Blender** – primarily designed for use with dry material but can be used with gas and liquid streams. The blender is used for batch or continuous mixing and is available in sizes ranging from 2-1100 ft. working capacity. Applications for the blender include:

- Animal feed
- Bakery mix
- Cereal
- Cocoa
- Flavorings
- Flour
- Instant drink mixes
- Milk powder
- Pet food
- Salt and seasonings
Buflovak LLC., Buffalo, New York (USA), manufactures process equipment for the food, chemical, waste treatment, metal, and glass industries. It consists of three operating groups: Buflovak Rotating and Vacuum Thermal Process Equipment Group, Buflovak Separation Technology and Applied Equipment Group, and BKE and Heppenstall Group.

Buflovak Rotating and Vacuum Thermal Process Equipment Group manufactures single and double drum dryers, vacuum dryers, and cooling drum flakers.

**Single Drum Dryer** –
- Drum dryers convert viscous liquids and pastes into dry powders, flakes, or sheets
- Standard atmospheric model consists of single heated drum supported on trunnions that turn in journal or roller type bearings
- Feed materials are applied to drum with splash or dip devices, or with applicator rolls
- Heat conducted through drum wall evaporates moisture from wet product film during partial revolution of drum
- Single layer applications dry to a lacy sheet or flake
- Multiple layer applications dry to uniform thickness and density with minimum dusting tendencies

**Double Drum Dryer** –
- Used to dry food, chemicals, and pharmaceuticals
- Materials vary in density and viscosity such as dilute solutions, heavy liquids, or pasty materials
- Effective for heavy sludges that become saturated and deposit salts
- Movable drum permits complete control of product film thickness

**Cooling Drum Flaker** –
- Drum flaking is most efficient method for solidification and flaking of wide range of materials
- 100% of product is solidified, flaked, and recovered
- Flakers are built and equipped for continuous operation
- Suitable for food, chemical, and pharmaceutical industries
- Standard cooling flaker drum sizes range from 15.2 cm diameter x 20.3 cm long to 2.0 m diameter x 5.0 m long (6” x 8” to 78” x 198”)
- Special applications include single drum, double drum, twin drum, and custom flaker configurations

Kadant Johnson Products: LJ, SX and SN Rotary Unions, Flexible Hose, and Syphon Elbows
GMF Gouda BV  
www.gmfgouda.com

GMF Gouda, headquartered in Waddinxveen (Holland), supplies special machinery to the chemical and food industry for drying, solidification, peeling, and thermal treating. GMF Gouda also has locations in North America, China, Indonesia, Singapore, Germany, and France.

**Drum Dryer** – during a full-continuous process, the product being dried is applied in a thin film on the outside of the drum and begins to dry immediately. After one rotation, a knife scrapes the dried product off the drum as a film or as flakes. This specific brand is suited for sticky and viscous products.

**Paddle Dryer/Cooler** – used to heat treat powders, granulates, filter cakes, and pasty products in a full-continuous process. The processes vary from drying, cooling, crystallizing and calcinizing, to melting, evaporating, solvents, and sterilizing. This dryer has a heated trough containing rotating heated paddle shafts. The product is fed into the front of the machine and moves to the outlet as a result of gravity. The paddles are used only for heat transfer not transporting the product.
Tremesa, S.A.U., headquartered in Granollers (Barcelona), designs and manufactures equipment and plant for the rendering sector dealing with the processing of animal and fish by-products aimed at obtaining animal fats and animal-protein meals.

**Batch Cookers** – used for drying and sterilization processes for all types of animal by-products including feathers and blood. The available capacities of the batch cooker range from 1,500kg to 15,000Kg.

**Continuous Cooker** – allows the continuous drying of animal by-product excluding feathers and blood. This cooker is suited for large production capacities guaranteeing homogeneity in the final products. The inside of the body is U-shaped and contains a rotating steam-heated multi-tubular shaft that provides a large drying surface area.

**Disc Dryers** – thermal transfer machines for various drying applications including hydrolyzed feathers, coagulated blood, sludge and products in general with low fat content that need a large contact heating surface area for evaporation.
Industrial Dryers

- Food
- Corn/Soybean
- Chemicals
- Pharmaceuticals
- Rendering
Industrial Dryers

- Instant mash potatoes
- Cereal
- Instant beverage mix
- Gelatin
- Grits
- Apple sauce
- Fish & meat pastes

Industrial Dryers

- Dextrine type adhesives
- Polyacrylamide
- Resins
- PET-polyethylene terephthalate
- Soaps
- Protein products
Industrial Dryers

- Drum (flaker dryers)
- Screw or sisc
- Rotary vacuum
- Steam tube

Flaker Dryer
Flaker Dryer

- Liquid or paste feed
- Adjustable knife
- Solids come off in sheets or flakes depending on product characteristics
- Screw conveyor option
- Five (5) independently driven "satellite" applicator rolls
Cooling Drum Flaker

**PAN FEED**

Heated Feed Pan maintains product in molten state.

**APPLICATOR ROLL FEED**

Spray Pipe & Siphon Pipe water removal assures even cooling of drum surface.
Screw / Disc Dryers

- Holo-flite
- Torus disc
- Porcupine
Disc Dryers

Cutaway shows unitized design. Breaker bars enhance heat mixing and assure self-cleaning.

Disc Dryers

Cutaway shows unitized design. Breaker bars enhance heat mixing and assure self-cleaning.

Disc Dryers

Cutaway shows unitized design. Breaker bars enhance heat mixing and assure self-cleaning.
Rotary Vacuum Dryers

Rotary Vacuum Dryers

[Diagram of Rotary Vacuum Dryers]

[Diagram labeled with: steam, condensate, insulation, filter elements]
Rotary Steam Tube Dryers

- Corn - Soybean
- Chemicals
- Pressures to 435 PSI
- 2-20 RPM
- 2” to 12” Size Joints
Rotary Steam Tube Dryers

- Torus ring-stationary syphon pipe
- Steam chest-rotating syphon pipe
Torus Ring – Stationary Syphon

Steam Chest – Rotating Syphon
Rotary Steam Tube Dryers

Most use rod supported rotary joints

LJ Joint 5”, 6”, 7-1/2”, 8”

LN Joints 5”, 6”, 7-1/2”, 8”

Opportunities to Upgrade

• Trunion wear
• ELSN 4”, 5”, 6-1/2”, 8-3/4”, 10”, 12”
• SJS 4” to 8”
• SJN 7-1/2” and 8”
Machine Tool Industry

Johnson-Fluiten

- Established in 2003
- Global leader in depth and breadth of rotary joint and precision union products
- Sold and serviced in nearly 150 countries
- Based in Milano, Italy
Machine Tool Industry---What is it?

• Virtually any process that deals with material removal
  – Drilling
  – Taping
  – Milling
  – Grinding
  – Boring
  – Etc.

Machine Tool Coolant Unions

• Externally-mounted coolant pipes spray coolant onto drill bit

• Through-spindle-coolant design improved cooling, better chip removal and increased tool life (early 1980’s)

• Deublin has owned this business with their 1116, 1108, 1109 and various bearingless designs
Through-Spindle-Cooling

• Specially designed tools are supplied for drilling, boring, reaming and tapping

Spindles

• Spindles can be supplied as a complete assembly, including rotary union
• Some spindle designs require special unions to accommodate for the drawbar/tool ejection
**Sigma Spindle**

**Major Spindle OEMs**

- Fischer (Germany)
- GMN (Germany)
- Setco (USA)
- IBAG (Switzerland)
- Gamfior (Italy)
- Sigma (Italy)
- Pope (USA)
- Weiss (Germany)
- Fischer (Switzerland)
Competition

- Deublin
- Barco
- Manutec
- GAT
- OTT
- RIX (Rocky)
- Takeda

Machine Tool Market

- Transfer Lines
  - Automotive Industry
    - OEM’s
    - Engine Blocks
    - Heads
    - Powertrain
    - Crankshafts etc.
- CNC Machining Centers
  - General Industry
    - OEM’s
    - Job Shops
Transfer Lines

• Purpose-built to produce one design of engine
• Transfer line consists of a number ‘stations’ which perform specific machining functions (drilling, tapping, boring etc.)
• Not all stations require through-spindle-cooling
• No flexibility without re-tooling
• Typical operating parameters:
  – 3,000 rpm
  – Coolant or Air/Mist
  – Limited dry-run

Typical Transfer Line
Typical Transfer Line Station

Transfer Lines

• Tier 1 - Automotive Engine plants
  – Ford
  – General Motors
  – DaimlerChrysler

• Tier 2 - Other Engine Plants
  – Harley Davidson
  – Briggs and Stratton
  – Tecumseh
Major Transfer Line OEMs

• Cross Heuller (USA, Germany, UK)
• Comau (Italy)
• Ex-cell-o (Germany, USA)
• Lamb (USA, Germany, UK)
• Giddings & Lewis (USA, Germany, UK)
• Turmatic (Germany)
• Ingersol (USA)
• Grob (Germany)

CNC Machining Centers

• Horizontal or Vertical (HMC & VMC)
• Greater machining flexibility
• Not all CNC machines are supplied with through-spindle-cooling
• Wide range of operating parameters
  – Up to 50,000 rpm and increasing
  – With dry-run option
CNC Machining Centers

CNC Dry-Run Unions

• All CNC machines fitted with through-spindle-cooling should use dry-run unions
• Dependent on the material being machined they may or may not use coolant
• A recent trend has been for small dedicated machining plants specifically set up to sub-contract work from larger manufacturers
### Major CNC Machine OEMs

- Mazak (Japan)
- Cincinnati Machine (USA)
- Makino LeBlond (Japan)
- Haas (USA)
- Hardinge (USA)
- Witzig & Frank (Germany)
- Ex-Cell-o (Germany)
- Hurco (USA)
- Fadal USA)
- Giddings & Lewis (USA)

### Gun Drilling (Deep Hole Drilling)

- Gun Drilling Machines (deep hole drilling)
- OEM’s include - Ixion (Germany) and Mollart (UK)
Gun Drilling

Applications

Transferlines

CNC’s

Gun Drilling

Power Presses

Clutches
Haas Automation

Operating Data
- Coolant
- Dry-Run
- 10,000 rpm
- 1500 psi

Entrust Tool

Operating Data
- Coolant
- 16,500 rpm
- 3,000 psi
- Gun-Drilling Machine
- SKF Spindles
- 18 unions
Rock Tool & Machine

- Operating Data
  - Water
  - 500 rpm
  - 5,000 peak psi

- De-Burring machine
  - 150 machine sold
  - 5 unions / machine

Continental Teves

- Operating Data
  - Coolant
  - 3,500 rpm
  - 300 psi

- OEM
  - Honsberg Lamb
  - Dial machine
  - 500 unions on site
Many of the applications for rotary pressure joints and related equipment are similar in the rubber and plastic industries. In fact, several of the major machine manufacturers build identical equipment that serves both industries.

Processing of plastics begins at the mixing stage, where you may find enclosed mixers, pressurized mixers, or open batch mixers. The mixing batches are made up of various synthetic materials and chemical additives to produce the raw material.

After mixing, the product is fed into mills, dicers, or calenders that will further shape the mix into a consistency that can be refined.

Calenders produce various thicknesses of sheet goods that can be further shaped or molded into a finished product.

Extruders can also be used to convert the raw plastic material (often in the form of pellets) into a finished product.

In processing plastics, you will see high temperature heat transfer oils used as a medium, as well as high temperature, high pressure hot water applications. Oil temperatures can exceed 700°F and many hot water systems will be operating at pressures in excess of 300 PSIG and 450°F.
Plastic Industry Overview

It is not important that we become experts in Plastic Film, it is important that we understand the basics that allows us to apply our product successfully into sales opportunities.
U.S. Market Share

- Deublin: 51%
- Kadant Johnson: 21%
- Barco: 12%
- Duff Norton: 7%
- Other (Maier): 9%

Extruded Sheet Film

- 3081 – Plastic Sheet Film
- 3089 – Unsupported Sheet and Film
- Extruded sheet lines operate from 50 FPM to 200 FPM
- Extruded sheet is typically on products that are 10 ML and thicker
- Extruded sheet can be wound in a web or sheered and stacked
Extruder

- Extruders with screws from 1-1/2” to 12”
- Air or water cooled
- The rotary unions are designed in the back of the screw and the water-cooling is required to keep the plastic from sticking to the screw
Extruder Application Parameters

- 50 – 300 RPM’s
- 70 to 90 Degree Water / City Water
- 50 to 60 PSI
- Standard rotary union will be a ¾” dual flow union
  – customers will typically be buying a ¾ single flow union
- Promote RX™ rotary unions
Calendars – Roll Stacks Purpose

- The three roll vertical roll stands primary purpose is to:
  - Take the heat out of the sheet
  - Control the finish of the sheet with mirror finish on the roll faces
  - Gauge the thickness of the sheet.
Application Parameters - Water

- There are two mediums that are used with hot water to cool being the most common
- 100 – RPM
- 275 – Degrees
- 60 – PSI
- 250 - GPM

Application Parameters - Oil

- Oil is used to take heat out of the sheet at a slow rate to prevent warping on thicker product
- 450 – 475 Degrees
- 40 – PSI
- 100 RPM’s
- 125 to 250 GPM
2” to 4’ Typical Rotary Union Sizes

- The RX rotary union line is the union that has been promoted to this market
- The rotary union can handle both the water and oil applications
- Trend has been to go to a dual flow union in which they buy three versus older machines that have six single flow unions

Competition Offerings

- Deublin supplies the 6000 series as well as the 757 and 857 series
- Duff Norton supplies the 9000 series rotary unions
- Barco promotes the E75RS series rotary unions
- All rotary unions on roll stacks have a guard put over them at the OEM level
Thermoformer

• Many customers are able to go from the roll stacks to the Thermoformer

• The Thermoformer is designed to have a die that the sheet is pressed against with heat and the product is formed and also cut from the sheet into a finished product

Additional Process that use Rotary Unions

• Sheet Condition Units
• Embossing Units
• Cooling Idler Rolls
**Embossing Unit**

- Embossing units sole purpose are to put a pattern onto the product.
- The sheet is run a little hotter to emboss the desired pattern and keep the integrity of the sheet in tack.
- Typical 1” rotary unions are used and slow RPM and 100 Degree water with low pressure.

---

**Sheet Condition Units**

- A series of 10” rolls that water cooled to control the temperature of the sheet.
- Typically use a ¾” or 1” single flow rotary union designed for 100 degrees, 60 PSI and operates a 5’ FPM.
Cast Film

• Difference between extruded sheet film and cast film is the cast film is cast in smaller ML thickness between 1 and 3 ML
• The speeds of cast film range from 1000 FPM to 2500 in cast film
• Another difference is that the “Roll Stack” is horizontal instead of vertical

In most cases the roll diameters can range from 12” to 42” rolls.

Typical Rotary Union Application

• 275 – Degrees
• 60 PSI
• Up tp 200 RPM’s
• GPM’s from 300 to 800 GPM
Type and Size of Rotary Unions

- Most cast film lines the horizontal roll stacks require single flow rotary unions that range from 3” to 6”
- Promote large RX rotary union line
- Competes against the Deublin 6400 series and F127 models
- There are a few off the Duff Norton 9000 series rotary unions also

Machine Direction Orientor - MDO

- Flexible packaging industry is trying to use thinner ML plastic and stretch it while maintaining the integrity of the film
- The MDO machine takes the web in a transverse 90 degree direction and gets the material to stretch from 3” to 14”
- They can coat the plastic film or add the plastic to another substrate
- Example: Potato Chip Bag – it is coated on one side and printed on the other
Plastic Machinery - Markets

Source: Freedonia Group

Key OEM’s

<table>
<thead>
<tr>
<th>Battenfeld</th>
<th>Black Clawson-Fulton, NY</th>
<th>Davis-Standard-Pawcatuck, CT</th>
<th>Egan – Davis Standard, Somerville, NJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloucester - Clouchester, MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parkinson Technology, Woonsocket, RI</td>
<td>Wellex - Blue Bell, PA</td>
<td>PTI, Aurora, IL</td>
<td>HPM – Taylop Industrial - Mount Gilead, OH</td>
</tr>
</tbody>
</table>

THE PAPER MAKING PROCESS

(Highlighted terminology is defined at the end of the section.)

A paper machine can be divided into forming, pressing, and drying sections.

In the forming section of a paper machine, the fourdrinier receives diluted stock from the headbox and removes water from the fibers. It also generates the proper turbulence to ensure an even formation of the fibers throughout the sheet. As water is drained and vacuumed from the stock slurry, the fibers begin to overlap and bond together forming the sheet of paper. The fourdrinier uses an endless wire or fabric that moves over stationary rolls and drainage devices that drain the sheet.

It is important that water removal is maximized on the fourdrinier, because it is more economical to do it here than on the press and dryer sections.

The paper web is conveyed from the forming section to the pressing section, where two presses remove water and consolidate the web without harming or degrading the quality of the sheet. The paper leaves the fourdrinier machine at about 17-21% consistency. Consistency can be further increased to above 40% by mechanical compression of the web in the nip of the two presses in the press section.

One of the most important effects of pressing is an improvement in the quality of the product. Pressing increases the compressive strength, burst strength, tensile strength, and density of the product, and reduces its thickness and tear strength.

Water remaining in the wet sheet after pressing is removed by evaporation in the dryer section. Paper drying requires a large amount of energy and expensive equipment, so it is desirable to minimize the amount of water entering the dryer section.

Evaporation of moisture from the sheet in the dryer section is accomplished by passing the sheet over a series of steam-heated, hollow cast-iron cylinders, where heat from the steam is transferred through the cylinder walls to the sheet. As the sheet starts to dry in the dryer section, the remaining moisture becomes more difficult to remove. To increase sheet temperature and encourage evaporation as the sheet progresses through the dryers, the initial dryers are run at lower pressures, and the pressure is gradually increased in the subsequent dryer groups.

The condensed steam, or condensate, within the dryer shell is removed by a syphon that is either stationary or rotates with the dryer. The cylinder’s capacity to transfer heat depends mainly on the design and operation of the syphon.
KADANT JOHNSON PRODUCT APPLICATIONS IN THE PAPER MAKING INDUSTRY

<table>
<thead>
<tr>
<th>MACHINE</th>
<th>SERVICE</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Machine Head Box</td>
<td>Water</td>
<td>RX, SX</td>
</tr>
<tr>
<td>Dryer Section</td>
<td>Steam</td>
<td>ELS, LJ, LN, PTX, SX, syphons, Turbulator bars</td>
</tr>
<tr>
<td>Calender Rolls</td>
<td>Water, Oil, Steam</td>
<td>RX</td>
</tr>
<tr>
<td>Winders/Unwinders</td>
<td>Air</td>
<td>GA</td>
</tr>
<tr>
<td>Reel Drum</td>
<td>Water</td>
<td>Cooling Systems, RX</td>
</tr>
<tr>
<td>Press Rolls</td>
<td>Water</td>
<td>Cooling Systems, RX</td>
</tr>
<tr>
<td>Pressure Roll</td>
<td>Water</td>
<td>Cooling Systems, RX (Yankee)</td>
</tr>
</tbody>
</table>

DEFINITIONS

Air Dried
The artificial drying of paper by contact with air over skeleton dryers after the paper has been surface sized.

Apparent Density
The weight per unit volume of the sheet. It is commonly calculated by dividing the basis weight by the caliper, although it must be recognized that the numerical value thus obtained is dependent upon the definition of the ream.

Appearance
The effect upon the sense of sight resulting from observation of the color, finish, cleanliness, and formation of papers.

Ash
The mineral residue after burning a sample of paper to determine the percentage of filler it contains.

Baby Dryer
A single drying cylinder of small diameter.
Barking Drum
Large rotating cylinder in which pulpwood sticks are tumbled against one another to remove the bark.

Basis Weight
The weight in pounds of a ream (either 480 or 500 sheets) of paper cut to a given size. The standard size ream varies with different grades of paper according to trade practices.

Beater
A large mixer in which the pulp is combined with the other ingredients of paper.

Beater Sized
Paper for which the size has been added to the pulp in the beater before the pulp is dispersed to the paper machine for fabrication.

Bend
A mechanical distortion of paper, such as would be obtained by paper tightly wrapped around a small core.

Blackening
Crushing of the paper by excessive pressure in the calenders.

Bleach
A chemical used to whiten paper pulp; a solution of chlorine or similar chemicals.

Blister
(1) A defect arising in paper when dried too suddenly on the drying cylinder or when the felts are not in good condition, leaving air between the felt and the sheet.

(2) A blister may also occur between two plies of a cylinder board owing to lack of ply adhesion, also called air bells, blow, or bubbles.

(3) A defect in coated paper which results when it is subjected to a high temperature during the drying of ink on high-speed heat-set presses. This defect is generally caused by excessive moisture, use of excessive heat on the press, or coating through which moisture vapor will not readily pass.

(4) A rapid test for papers made from highly hydrated pulps, such as glassine or greaseproof. These papers develop blisters when exposed to the flame of a match or candle just enough to char the sheet very slightly.

Bonding Strength
The resistance of a coated or uncoated paper to picking or lifting of its surface fibers or
splitting of the paper while being printed.

**Breaks**

A term used to denote a tear in a roll of paper which occurs while the paper machine is running. Such breaks are generally spliced and marked by a protruding flag.

**Breast Roll**

A large diameter roll around which the fourdrinier wire passes at the machine headbox, just at or ahead of the point where the stock is admitted to the wire by the stock inlet. It is covered with corrosion-resistant metal or fiberglass, and is usually driven by the fourdrinier wire.

**Broke**

Paper trimmings or damaged paper from the Machine or Finishing Rooms, usually returned to beaters for re-processing into saleable paper.

**Bursting Strength**

Resistance of paper to rupture under pressure, as indicated in pounds per square inch on a Mullen or “pop” tester.

**Calender Blackening**

A term descriptive of darkening of the intended shade of paper by excessive calendering, or by calendering wet paper.

**Calender Cuts**

Defects caused by creasing or cutting of the web of paper during calendering due to wrinkles in the web.

**Calender Spots**

Marks on paper caused by material sticking to a calender roll.

**Calender Stack**

Steel rolls at the dry end of the paper machine which smooth and level the sheet of paper.

**Calender Streaks**

Dark lines in paper, parallel with the grain, caused by uneven pressing and drying before calendering.
Caliper
The thickness of a sheet measure under specified condition; it is usually expressed in thousands of an inch (points or mils).

Clothing
A term applied to paper-machine felts and fourdrinier wires.

Cloudy
A term indicating unevenness or irregular formation in look-through of paper; it is another term for wild formation.

Coarse Paper
A term applied to various grades of paper used for industrial purposes as opposed to grades used for cultural purposes. The coarse paper can be bleached or unbleached, usually ranges from a basis weight of 18 pounds or more (24 x 36-500), and frequently is colored, printed, or both. Includes; wrapping papers, bag papers, gummed tapes, building papers, heavy duty envelopes, and towels.

Coating Color
The coating mixture in suspension or slurry form which is applied to the surface of the paper or paperboard in the coating process. Includes pigments, adhesives, dyestuffs, modifiers, and the liquid medium (usually water) required to carry and apply the components to the paper.

Consistency
The percentage, by weight, of air-dry (or oven-dry) fibrous material in a stock or stock suspension; it can also be called density or concentration.

Corrugating Medium
A paperboard used by corrugating plants to form the corrugated or fluted member in making corrugated combined board, corrugated wrapping, etc. Usually made from wood pulps, straw, or reclaimed paper stock on cylinder or fourdrinier machines.

Couch Roll
Roll used to separate wet paper web from the “wire”.

Counter Rolls
Rolls of paper which may be used in dispensers on the counters of retail stores, generally 9” in diameter in various widths.
Creped
The process of crowding a sheet of paper on a roll by means of a doctor, thereby, producing an effect simulating crepe.

Cross Direction
The dimension on a piece of paper at right angles to the direction of the grain.

Crown
The difference in diameter between the middle and ends of a press roll or calender roll necessary to allow for deflection so that the nip pressure will be uniform over the full width of the press or calender. The increase in diameter of the middle over the ends expressed in thousandths of an inch is called the crown of the roll.

Curl
Tendency of a sheet of paper to coil or roll up at the edges, usually caused by changes in weather or faulty drying on the paper machine.

Cutter
A machine which cuts rolls of paper into predetermined sheet sizes. The sheets are then cut to final size on a guillotine trimmer.

Cylinder Machine
One type of paper making machine, characterized by the use of wire-covered cylinders or molds on which a web is formed. These cylinders are partially immersed and rotated in vats containing a dilute stock suspension. The pulp fibers are formed into a sheet on the mold as the water drains through and passes out at the ends of the cylinders.

Damp Streaks
Crushed or blackened streaks running in the machine direction. They are the result of crushing caused during pressing or calendering a sheet of paper having high moisture content in areas.

Dandy Roll
A skeleton cylinder covered with a woven wire cloth, or with an arrangement of fine longitudinal wires, crossed at close intervals by heavier circumferential wires. The former produces wove paper, the latter produces laid paper. When letters, figures, or other devices are worked in the wires on the surface of the roll, a watermark is produced. Presently, plain dandy rolls are used to level the surface and improve formation.
**Digester and Blow Digester**

Large pressure vessel in which wood chips are cooked to separate fibers from each other and from undesirable particles in the wood. To “blow the digester” means to release the pressure and empty contents of the digester.

**Dished**

A pile of paper which lies in a concave rather than a flat condition. Also applied to the appearance of the end of a roll which is not flat.

**Doctor**

A thin plate or scraper of wood, metal, or other hard substance plated along the entire length of a roll or cylinder to keep it free from paper, pulp, size, etc., and thus maintain a smooth clean surface.

**Doctor Dust**

Dust that accumulates on doctors. Usually consists of fuzz from the paper. It may be attracted to the paper and be pressed into it.

**Draw**

(1) In trimming paper, the displacement of the cut sheet by the thickness of the knife; this is a common cause of inaccurately cut paper.

(2) The tension applied to the paper between sections of a paper machine, such as the press section or dryer section.

**Dryer Hood**

A covering over the whole or part of the dryer section of the paper machine or coating unit which serves to collect the hot, moisture-laden air from the drying process and exhaust it through suitable fans and duct work. It is designed to control air flow for uniform and rapid drying.

**Dryers**

The steam-heated cylinders over which paper in the web is passed to be dried.

**Emulsification**

The process of dispersing one liquid in another when the two liquids normally do not mix.

**Equivalent Weights of Paper**

Indicates equivalent weights of paper of different sizes and different ream weights but of identical basis or substance weights, i.e., 25 x 38-50 is equivalent in substance to 32 x 44-74.
Expansion
A change in the dimensions, usually cross grain direction, of a sheet of paper due to absorption of moisture.

Felt
A woven cloth used to carry the web of paper between press and dryer rolls on the paper machine. Woolen felts are used for the wet web in the press section. Dryer felts of cotton or synthetic materials carry the paper web through the dryer section of the machine.

Felt Side
The side of a sheet of paper opposite to the wire side of the sheet; this is the top side of the sheet when it is formed on the wire.

Fill
The maximum width of paper that can be made on any given paper machine.

Finish
(1) To finish paper is a term used to describe the cutting, counting, sorting, trimming, and packing of paper.
(2) The finish of a sheet of paper refers to the condition of its surface.

Fish Eyes
Translucent spots caused by slime, under-fibered portions of stock, or foreign materials which become glazed when the sheet is calendered.

Fourdrinier Machine
The name given to the wet end of the type of paper machine invented by Louis Robert, financed by Messrs. Henry and Sealy Fourdrinier. It is usually applied to an entire modern paper machine, including the dry end, which was not a part of the first paper machines.

Fourdrinier Wire
An endless belt woven of wire suitable for used on the fourdrinier machine on which the fibers are felted into pulp, board, and paper.

Grain Direction
The direction taken by a majority of the fibers in any sheet of paper. Synonymous with “machine direction” and the opposite of “cross direction”.
Hard-Sized
Refers to a type of paper which has been treated with considerable size to resist moisture penetration; opposite of “slack sized.”

Headbox
(1) On fourdrinier machines: a large flow control chamber which receives the dilute paper stock from the stock preparation system and, by means of baffles and other flow evening devices, maintains sufficient agitation, spreads the flow evenly to the full width of the paper machine, and provides delivery of stock to the fourdrinier wire uniformly across its full width.
(2) On cylinder machines: a low-regulating device which controls the volume of stock flowing to the screens and mixing boxes before the vats.

Inverform
A papermaking device used to manufacture single or multi-ply grades of paper and paperboard. The stock flows from a headbox to a bottom wire, and is then joined by a top wire so that water removal is accomplished through the top wire as well as the bottom wire. In multi-ply operation, the bottom wire and formed web continue under subsequent headboxes where additional plies are laid down. Each headbox is followed by another top wire. Virtually all of the water removal is upward through the top wire for each additional ply that is laid down. The machine is capable of extremely high speeds of operation.

Jordan
A machine used to refine paper stock. It controls the length of paper fibers. Paper stock goes through the Jordan after it has left the beater and before it goes to the paper machine.

Lap Machine
Produce sheets or laps of pulp for storage.

Machine Direction
The direction of paper, parallel to its forward movement, on the paper machine. This is also called “with the grain.”

Machine Dried
The process of drying paper on the paper machine by passing the damp sheet or web over steam-heated cylinders or drums.

Nip
The point of contact between two rolls, as in a calender stack.
Paper Machine
The machine upon which the fibers and other components of paper are formed, pressed, dried, calendered, wound upon reels, slit into appropriate widths, and wound into rolls or cut into sheets.

Point
A term used for an expression of thickness of a sheet of paper in thousandths of an inch (.001”).

Pulp
Papermaking material existing in a disintegrated fibrous wet or dry state. Before it is dispersed onto the paper machine, it is mixed, beaten, and diluted to a consistency suitable for fabrication into paper.

Ream
A quantity of paper; 500 sheets for most papers, 480 sheets for some tissues.

Refining
A general term applied to several operations, all of which involve the mechanical treatment of pulp in a water suspension to develop the papermaking properties of Hydration and Fibrillation and to cut the fibers to the desired length distribution.

Rewinder
A machine which takes rolls from the winder and slits or rewinds them into smaller rolls.

Roll Coating
A process in which coating color is applied to either one or both sides of a paper web by transfer from a rubber applicator roll. This process may be carried out on or off the paper machine.

Size or Sizing
A water-resisting material which is added to paper. An example is starch made from corn.

Size Press
Section of the paper machine where surface treatments are applied to the sheet of paper to give it special qualities.

Slitter
A sharp disk which cuts paper into pre-determined widths.
Stuff or Stock
A term which describes the papermaking material when it is ready for the paper machine.

Substance Weight
The weight in pounds of a ream of paper cut to a given size.

Suction Box
A device at the wet end of the machine which removes water from the paper web. It is located under the wire and removes water by means of a vacuum pump.

Trim
Indicates the maximum width of finished paper which can be made on a particular machine.

Two-Sided
A term applied to paper having large differences in color or finish on the wire and felt sides of the same sheet.

Waviness
A warping effect occurring along the edges of paper, particularly across the grain of paper exposed to an excess of atmospheric moisture.

Web
The continuous sheet of paper forming or having been formed and finished on a paper machine. In the finished state a web is not necessarily the full, trimmed width of paper made; but may be any portion of the original web wound into a roll for coating, embossing or printing.

Wet End
The beginning of the paper machine; comprising the headbox, wire, and press sections.

White Water
A general term for all waters of a paper mill which have been separated from the stock or pulp suspension, either on the paper machine or accessory equipment.

Winder
Equipment located at the dry end of the paper machine to take the web from the reel, trim off the edges, wind it into firm rolls, and slit it into several rolls.
Wire
The continuous meshed wire which is the traveling surface upon which the web of paper is formed. It is also referred to as the “machine wire,” or “fourdrinier wire.”

Wire-Mark
The impression left in a web of paper by the wire of a Fourdrinier machine.

Wire-Side
The surface of a sheet of paper which was next to the wire when formed. Opposite of the felt side.

Wrinkles
Creases in paper caused during manufacture. A “wet wrinkle” occurs at the presses; a “dry wrinkle” occurs at the calenders.

Yankee Machine
A type of Fourdrinier paper machine employing a single dryer of large circumference with a highly polished surface. The side of the paper coming in contact with this surface takes a glazed finish.
Overview of Paper Drying

<table>
<thead>
<tr>
<th>Paper Grade</th>
<th>Type of Dryer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging grades:</td>
<td>Cylinder dryers</td>
</tr>
<tr>
<td>– Linerboard</td>
<td></td>
</tr>
<tr>
<td>– Corrugated medium</td>
<td></td>
</tr>
<tr>
<td>Paper grades:</td>
<td>Cylinder dryers</td>
</tr>
<tr>
<td>– Newsprint</td>
<td></td>
</tr>
<tr>
<td>– Copy paper</td>
<td></td>
</tr>
<tr>
<td>Tissue grades:</td>
<td>Yankee / MG dryer</td>
</tr>
<tr>
<td>– Facial tissue</td>
<td></td>
</tr>
<tr>
<td>– Towel</td>
<td></td>
</tr>
</tbody>
</table>
Paper Machine

Forming Section  Press Section  Size Press  Calender Stacks

Headbox  Main Dryer Section  After-Size Dryers  Reel

Dryer Section
Dryer Cylinder

Cast Iron Shell

Steam

Paper Drying

Wet Paper Web
Rotary Joint Overview

- Mechanical seal between the stationary piping and the rotating dryer cylinder

Rotary Joint Overview

Single Flow

Dual Flow
Flow-Through System

Mounting Configurations

- Self-supported joints:
  - Carbon bearings
  - Ball bearings

- Externally supported joints:
  - Support rods
  - Mounting brackets
  - Circular ring brackets
Self-Supported Rotary Joint

Carbon Bearings

Ball Bearings
Self-Supported Rotary Joint

- Open gear machines

Self-Supported Rotary Joint

- Trunnion mounted dryers
Externally Supported Rotary Joint

Rod Supported
Bracket Mounted
Ring Bracket

Rotary Joint Summary

• Many rotary joint configurations
• Pressure-tight steam seal
• Carbon graphite seal ring
• Proper rotary joint
  + Good installation
  + Proper maintenance
  = Long seal life
Dryer Configurations

Two-Tier Dryer Section
Dryer Windage

Uno-Run Dryer Section
Air flows through the fabric

Sheet tends to follow the dryer

CD air flows cause edge flutter

Air between paper and fabric causes blowing

Centrifugal forces acting on the sheet

---

Single-Tier Dryer Section
Vacuum Transfer Rolls

Alternating Single-Tier
All-Top Single-Tier Dryer Section

Dryer Drive Systems
Open Gear Drive

Enclosed Gear Drive
Dryer Gearcases

Dryers Driven Through Fabrics
Felt Roll Driven Dryer Section

Dryer Ventilation
Two-Tier Dryer Section

Closed dryer pockets

Edge Duct Ventilation

VAPOR POCKETS
Pocket Ventilator – Offset Rolls

Dryer Hood

Exhaust
Supply

Makeup

PV

PV
Dryer Threading Systems

Rope Transfer

Wire Side

Top Side
Tail Cutter – Knife Type

Tail Cutter – Saw Type
Tail Cutter – Water Jet

Tissue Drying
Tissue Creping Action

Doctor Blade

Yankee Dryer

Paper Web

Creped Tissue

Ribbed Yankee Dryer
Yankee Condensate Removal

Yankee Air Cap
Air Cap Drying System

Furnace

DRY-END

WET-END

Shower Water

Shower Water
Rubber is compounded on big mixing machines called Banbury Mixers. A Banbury has two or three large rolls through which the rubber is kneaded. These rolls are cooled so the rubber will not cure during processing.

Rubber is extruded to form rubber tubing or hosing. The rubber extrusion process is the same as plastic extrusion; however, heavier machines are used because rubber has greater resistance. The extruder screw in the rubber extruding machine is cooled to prevent the rubber from curing during processing. Tubers are connected to the extruder heads to form the rubber tube or hose. The tuber die is water cooled to prevent vulcanizing of the rubber to the metal.

Rubber is also calendered to make sheet rubber for the tire industry. Rubber tire plants use Banbury mixers, extruders, calender train cooling stacks, and slashers to make tire cord.

**KADANT JOHNSON PRODUCT APPLICATIONS IN THE RUBBER INDUSTRY**

<table>
<thead>
<tr>
<th>MACHINE</th>
<th>SERVICE</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extruders</td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Slashers</td>
<td>Steam</td>
<td>ELS, SX rotary joints</td>
</tr>
<tr>
<td>Warming/Feed Mills</td>
<td>Water, Steam</td>
<td>RX, SX, rotary joints</td>
</tr>
<tr>
<td>Sizing Mill/Sheeter</td>
<td>Water</td>
<td>RX rotary joints</td>
</tr>
<tr>
<td>Tubers</td>
<td>Water</td>
<td>RX, rotary joints</td>
</tr>
</tbody>
</table>

Other products used in the Rubber Industry include Liqui-Mover pumps, sight flow indicators, flexible hose, and syphon elbows.
Rubber Industry
Market Sectors

- Tire Plants
- Hose Plants
- Belt Plants

Kadant Johnson Products

- RX rotary unions
- SX rotary joints
Applications

• Extruders
• Calenders
• Mixers (Banbury)
• Chill rolls/stacks

Misconceptions

• Old industry
• Old equipment
• Industry observations
  • Machines run relatively slow
  • ‘Simple’ application
  • “If it works, leave it alone”
  • Replace ‘like with like’
  • “We use what came with the machine”
Reality

• Old industry?
  • Less facilities but more modern
• Old equipment?
  • Investment in latest technology
• Industry observations?
  • Need to be re-educated
  • Success at the OEM level leads to more business
  • Replace older ‘pressure’ joints with ‘mechanical seal’ joints

Process / Machinery

• Compounding
  • Mixers
  • Mills
• Calendering
  • Calenders
  • Cooling Stacks
• Extruding
  • Extruders
    • Single
    • Twin
Steel

Industry Overview

The steel industry offers a variety of rotary union sales opportunities for Kadant Johnson. These opportunities will be found in both integrated steel mills and mini steel mills.

There is also potential in the steam sections of large integrated steel mills for Liqui-Mover® pumps, Thermocompressors, and Desuperheaters.

Quick Industry Facts:

- Steel is the backbone of bridges, skyscrapers, railroads, automobiles, and appliances. Most grades of steel are high strength steels that are lighter and more versatile.
- Steel is the most recycled material in the U.S.
- $50 billion market in the U.S., employing 154,000 people nationwide. 20 of the 1,200 firms operating in the U.S. are integrated steel mills.
- One of the largest energy consumers in the manufacturing sector, accounting for 2-3% of total U.S. energy consumption.
- Ohio, Indiana, Pennsylvania, Illinois, and Michigan have the highest steel production.

The Integrated Steel Mill:

An integrated steel mill performs all functions for primary steel making:

- Iron making – taking iron ore and smelting with coke and limestone in a basic oxygen furnace (BOF) to produce molten iron (conversion of ore to liquid iron)
- Steel making – removing impurities such as sulfur, phosphorus and excess carbon and adding alloy elements such as nickel, chromium, and manganese (conversion of pig iron to liquid steel).
- Casting – turning liquid (molten) steel into slabs, blooms, billets, and rounds.

Integrated steel mills are large facilities with annual production capacities of up to 3 million tons per year. Large and thick slabs are produced at integrated steel mills using multi-strand casters. The end products from integrated mills are generally large structural components such as heavy plate, coils, wire, rods, and beams. Secondary processes applied to coils and wire add galvanized coatings before being shipped into the market place. There are approximately 20 integrated mills in the U.S. that produce steel using basic oxygen furnaces.
The Mini Steel Mill:

The mini-mill is most often described as secondary steel producers who obtain most of their iron from scrap steel, recycled from used automobiles, machinery, and by-products of manufacturing. Sometimes direct reduced iron (DRI) is used with scrap steel to help maintain the desired chemistry of the steel. Typically, a mini-mill will have an electric arc furnace for scrap melting and a ladle furnace or vacuum furnace for controlling the chemistry. Thin slab, billet and strip casters are commonly found in this type of steel mill and usually are focused on a single product within a specific mini-mill.

Another key feature of a mini-mill is the electric arc furnace which can be started and stopped on a regular basis to follow market demand, which is not cost-feasible using a BOF due to the BOF requiring large amounts of energy and time to start up after being stopped.

Equipment and Processes

The production of molten steel mainly involves process heating operations that consume large amounts of fossil fuels and electricity. Process heating accounts for more than 80% of the industry’s total energy use.

Process heating drives chemical reactions, melts scrap, and reheats steel prior to processing. The major technologies that are involved in this operation are coke making, blast furnace iron making, BOF steelmaking, EAF steelmaking, reheating, and argon oxygen decarburization.

The forming process shapes steel into forms and semi-finished products. The processes used in forming are casting, hot and cold rolling, extrusion, drawing, finishing, and cutting.

Continuous Slab Casters – Also known as CCMs (continuous casting machines). This equipment offers the greatest sales opportunity for rotary unions compared to other equipment in a steel mill. CCMs are machinery which processes molten steel into hard slabs which range in size, but are typically 6" X 40" X 25'. The process begins when the molten steel is delivered to the Caster (from the BOF). The molten steel is contained in a large vessel called the Ladle. The Ladle is placed over the Caster by an overhead crane and releases the molten steel through a gate at the bottom of the Ladle into a smaller vessel, referred to as the Tundish. The Tundish then opens and allows the molten steel to enter into the mold, which establishes the size and shape of the slab.

As the new slab leaves the mold, a thin skin has formed to retain the shape of the mold. This shape must be contained and controlled or the slab can tear, which will release molten steel on to the casting machine. The newly formed slab is directed through a series of vertical and horizontal casting segments. Segments are usually 12 to 20 rolls, split equally with top and bottom rolls. The slab is moved through the vertical segments by gravity until reaching the horizontal segments, where drive rolls within a given segment pull the slab along.

As the slab moves through the horizontal segments, the skin of the slab becomes thicker, turning into a solid slab. Once the solid slab leaves the last horizontal segment, it moves onto the run-out table where it is torch cut into a pre-determined length. The slab is then removed by a large crane as the next slab is cut to length. This process can continue for several days without interruption.

With respect to the application of rotary unions, each roll of a segment requires water cooling. The water cooling prevents heat transfer damage to both the rolls and roll bearings. Casting machines have a varying number of segments (8-14) per casting line. Also, for each segment in operation (on-line), there is a spare segment off-line. In addition to the segments, there are many spare rolls that are waiting to be installed into a segment when a segment is removed for repair. All segments and spare rolls are outfitted with rotary unions.
Steel

Industry Overview

The combination of on-line and off-line equipment provides an installation base of over 500 rotary unions for a single continuous slab caster. There can be 2-4 slab casters at a large integrated steel mill facility.

Finished slabs are sent on to Blooming or Reduction mills, where they are reduced in size and thickness to the customer’s specifications.

Slabs of steel cool down rapidly after the primary series of reductions. The steel must be reheated in annealing and heat treating furnaces to make it pliable again for further sizing. Inside these furnaces, the steel is transported on a series of rolls which are internally water cooled.

In tin plate mills and stainless steel mills, scrubbers are used to clean the steel. Rotating nylon brushes are mounted on a hollow core through which water is fed to cool and prolong the life of the brushes.

**Thin Slab Casters** – Thin slab machines are very similar to the large continuous casting machines, except they are smaller in width and height with fewer segments. Slab size can vary from caster to caster, but is generally 2” X 36” X 20’.

A thin slab caster is supplied molten steel from the electric arc furnace, which typically melts down scrap and recyclable steel from automobiles, appliances, and other products. This caster also has water cooled rolls, which assist in preventing damage from the slab heat transfer condition. Due to the fewer number of segments, there are significantly fewer rotary unions installed. The installed base of rotary unions is estimated at 200 –250 pieces, including spares.
**Tunnel Furnaces** – A Tunnel Furnace is an extension of a Thin Slab Caster. When the thin slab leaves the caster and is cut to length, it is immediately transferred into the tunnel furnace before the slab is allowed to cool. The tunnel furnace is completely enclosed to retain heat as the slab is moved toward the rolling mill which is also connected to the caster/furnace line. Rotary unions are installed on the transfer rolls of the furnace. The furnace rolls are positioned approximately 36 inches apart over the length of the furnace. Most Tunnel Furnaces have 180 - 200 rolls which require a 1 ½” dual-flow rotary union on each roll. Unlike the caster rotary unions, ball bearing rotary unions are typically used on this application. Roll cooling and bearing cooling drive the need to use rotary unions on a tunnel furnace. Tunnel furnaces are only found in mini steel mills where thin slab casters are installed.

**Billet Casters** – This type of caster has similarities to both slab and thin slab machines. While the mentioned machinery is segmented (for purposes of removing one section at a time), billet casters are designed with independent rolls that are attached to a single main frame.

Billet casters use water cooled rolls to guide the small round or square shape through the caster until it can be cut to a specific length. While the number of water cooled rolls is less than what is found on thin slab machines, there are usually multiple casting lines on a billet caster. The installed base of water unions is between 50 and 150 depending on the number lines.

**Walking Beam Furnaces** – The walking beam furnace can receive slab steel from the slab yard or hot steel from the caster. The term walking beam describes a series of walking cycles to move the slab steel – lift, traverse, lower, and return. Once again, rotary unions are used to water cool the rolls and roll bearings of the furnace. The size of the ball bearing rotary unions is usually 1½” or 2”. Depending on the design of the furnace, 10 – 20 dual-flow rotary unions are installed.

**Reheat Furnaces** – A reheat furnace is a generic term that describes pusher and waking beam furnaces. Like the traditional walking beam furnace, a reheat furnace provide the function of reheating steel slabs...
which have become cool, to be further processed into a coil of steel. The rolls of reheat furnaces are sometimes referred to as charge and discharge rolls. Ball bearing rotary unions are installed on these rolls, in 1 ½” and 2” sizes.

**Coilers and Uncoilers** – This equipment can provide opportunities to sell double-passage hydraulic rotary unions. Hydraulic fluid is required on coiling equipment to expand the mandrel of the rotating hydraulic cylinder to grip the inside diameter of the coil. Coiling equipment can be found in several areas of a large integrated steel mill and in smaller mini steel mills. Applications vary from rolling cold product to rolling steel strip which has been galvanized. All rotary union applications for this product need to be channeled through engineering, as non-standard products are required.

*First image is an example of a coiler and the second image is a multiple passage union that would be commonly used on a coiler.*

**Galvanizing, Annealing, and Pickling Lines** – These (3) are considered finishing operations. There are a variety of water cooled rolls that are present in these processes. The OEMs that provide the machinery for galvanizing, annealing, and pickling do not follow each other when applying rotary unions. Sizes of rotary unions vary from small ¾” to larger 3” products. The hot dip galvanizing process offers the greatest potential. Some galvanizing lines may have up to (25) 3” rotary unions. Also, coilers and uncoilers are found in all three areas.

**Steel OEMs** (see OEM Profiles for more information):

<table>
<thead>
<tr>
<th>Most Recognizable OEMs:</th>
<th>Others:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS Group</td>
<td>Corus</td>
</tr>
<tr>
<td>§ SMS Demag</td>
<td>Fata Hunter</td>
</tr>
<tr>
<td>§ Mannesmann Demag</td>
<td>Herr-Voss</td>
</tr>
<tr>
<td>§ Concast</td>
<td>Hitachi Zosen</td>
</tr>
<tr>
<td>§ SMS Millcraft</td>
<td>LOI Furnace</td>
</tr>
<tr>
<td>Danielli</td>
<td>§ Salem Furnace</td>
</tr>
<tr>
<td>§ Davy Distington</td>
<td>Mitsubishi Heavy</td>
</tr>
<tr>
<td>§ Wean United</td>
<td>Stein Heurtey</td>
</tr>
<tr>
<td>Bricmont</td>
<td>Sumitomo</td>
</tr>
<tr>
<td>Siemens VAI</td>
<td>Surface Combustion</td>
</tr>
<tr>
<td>§ Voest-Alpine</td>
<td>Tenova (Core Furnace)</td>
</tr>
<tr>
<td>§ Rokop</td>
<td>§ Italiampianti</td>
</tr>
</tbody>
</table>

What and where to sell:

<table>
<thead>
<tr>
<th>Equipment:</th>
<th>Service:</th>
<th>Product:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Casters</td>
<td>Water</td>
<td>CJI, BCI, CJE</td>
</tr>
<tr>
<td>Thin Slab Casters</td>
<td>Water</td>
<td>CJI, BCI, CJE</td>
</tr>
<tr>
<td>Billet Casters</td>
<td>Water</td>
<td>CJI, BCI, RX, CJE</td>
</tr>
</tbody>
</table>
Steel

Industry Overview

<table>
<thead>
<tr>
<th>Scrubbers</th>
<th>Water RX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnaces/Ovens</td>
<td>Water RX</td>
</tr>
<tr>
<td>Trunnions of BOF</td>
<td>Water Custom unions</td>
</tr>
<tr>
<td>Run-out tables</td>
<td>Water CJE</td>
</tr>
<tr>
<td>Uncoilers/Coilers</td>
<td>Hydraulic Fluid Contact Engineering</td>
</tr>
<tr>
<td>Galvanizing Lines</td>
<td>Water RX</td>
</tr>
<tr>
<td>Levelers</td>
<td>Water RX</td>
</tr>
</tbody>
</table>

Industry Terminology:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakout</td>
<td>A condition when the slab steel breaks opens and allows molten steel to escape.</td>
</tr>
<tr>
<td>Strand</td>
<td>Designates a single section where a slab is formed on a slab caster.</td>
</tr>
<tr>
<td>CCM</td>
<td>Continuous Casting Machine.</td>
</tr>
<tr>
<td>Segment</td>
<td>A multi-roll section of a slab caster, a single frame.</td>
</tr>
<tr>
<td>Roller Apron</td>
<td>The section of the slab caster where the finished slab rolls out.</td>
</tr>
<tr>
<td>Drive Roll</td>
<td>A segment roll that is mechanically driven.</td>
</tr>
<tr>
<td>Idle Roll</td>
<td>A segment roll that is not mechanically driven.</td>
</tr>
<tr>
<td>Split Roll</td>
<td>A segment roll that consists of one short and one long roll combined to form a “single” roll.</td>
</tr>
<tr>
<td>Withdraw Section</td>
<td>The section of the CCM that extracts the slab steel.</td>
</tr>
<tr>
<td>Tundish</td>
<td>A vessel that accepts molten steel from the ladle</td>
</tr>
<tr>
<td>Ladle</td>
<td>A large vessel that molten steel is poured into from the BOF.</td>
</tr>
<tr>
<td>Heat</td>
<td>The amount of molten steel produced in a ladle and successfully made into slabs.</td>
</tr>
<tr>
<td>Galvanizing</td>
<td>The area in a steel mill that applies galvanized (zinc) to strip steel.</td>
</tr>
<tr>
<td>Hot Strip mill</td>
<td>The steel mill area that takes hot slabs and reduces them to plate or coils.</td>
</tr>
<tr>
<td>Leveler</td>
<td>Equipment that straightens out strip steel.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Steam Hammer</td>
<td>A condition where water turns to steam causing a violent reaction in a piping system.</td>
</tr>
<tr>
<td>Water Hammer</td>
<td>A condition where steam pushes water at high velocities through a piping system.</td>
</tr>
<tr>
<td>Frame</td>
<td>The supporting structure of a segment.</td>
</tr>
<tr>
<td>Round</td>
<td>A round shape cast on a billet caster.</td>
</tr>
<tr>
<td>Bloom</td>
<td>A square shape cast on a bloom caster (larger than a billet).</td>
</tr>
<tr>
<td>Billet</td>
<td>A square shape cast on a billet caster between 7” and 15”.</td>
</tr>
<tr>
<td>Core Buster</td>
<td>The water supply pipe inside a tunnel furnace roll.</td>
</tr>
<tr>
<td>Bore Mounted Rotary Union</td>
<td>A rotary union that is fitted inside the roll journal.</td>
</tr>
<tr>
<td>Journal Inserted Rotary Union</td>
<td>A rotary union that is fitted inside the roll journal.</td>
</tr>
<tr>
<td>BCI Rotary Union</td>
<td>Kadant Johnson Bearing Cover Inserted Rotary Union (quad seal).</td>
</tr>
<tr>
<td>BCIM Rotary Union</td>
<td>Johnson-Fluiten Bearing Cover Inserted Rotary Union (mechanical seal).</td>
</tr>
<tr>
<td>CJID Rotary Union</td>
<td>Dual-flow C-Cast union mounted inside the roll journal</td>
</tr>
<tr>
<td>CJIA Rotary Union</td>
<td>Single-flow C-Cast union mounted inside the roll journal.</td>
</tr>
<tr>
<td>CJED Rotary Union</td>
<td>Dual-flow C-Cast union attached to the roll externally using a Q-nipple or thread</td>
</tr>
<tr>
<td>CJEA Rotary Union</td>
<td>Single Flow C-Cast union that attaches to the roll externally by a Q-nipple or thread</td>
</tr>
<tr>
<td>Horizontal Pipe</td>
<td>The water supply pipe that attaches to the rotary union.</td>
</tr>
<tr>
<td>Caster</td>
<td>A Continuous Casting Machine.</td>
</tr>
<tr>
<td>BOF</td>
<td>Basic Oxygen Furnace that produces molten steel.</td>
</tr>
<tr>
<td>Mold</td>
<td>The first section of a caster below the tundish.</td>
</tr>
<tr>
<td>Slab</td>
<td>The product of a steel casting machine.</td>
</tr>
<tr>
<td>Secondary Cooling</td>
<td>The process of water cooling rolls on a casting machine.</td>
</tr>
<tr>
<td>Primary Cooling</td>
<td>The process of externally spraying a slab, bloom, or billet to cool the product.</td>
</tr>
</tbody>
</table>
Steel

Industry Overview

Dummy Bar  The bar or chain that the molten steel attaches to within the mold to guide the shape.

Slag  The byproduct of molten steel that falls off the slab or billet during production.

Competition:

**Deublin** – Deublin’s 2400 series and 57 series are found throughout the steel industry on furnaces and continuous casting machinery.

<table>
<thead>
<tr>
<th><strong>Kadant Johnson CJI</strong></th>
<th><strong>vs.</strong></th>
<th><strong>Deublin 2400</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Double quad ring seals</td>
<td>Mechanical seal type</td>
<td></td>
</tr>
<tr>
<td>Thrust bearings</td>
<td>No secondary seal</td>
<td></td>
</tr>
<tr>
<td>Deep grease galleys</td>
<td>Composite bearing in body</td>
<td></td>
</tr>
<tr>
<td>Flanged body with bolt holes</td>
<td>Flanged body (no bolt holes)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Kadant Johnson RX</strong></th>
<th><strong>vs.</strong></th>
<th><strong>Deublin 57 (1/2” – 1 ½”)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Seal Type – Tungsten Carbide against Carbon Graphite Seals</td>
<td>Mechanical Seal Type – Silicon Carbide against Carbon Graphite Seals</td>
<td></td>
</tr>
<tr>
<td>Springs located outside the flow area</td>
<td>Large spring located inside flow area</td>
<td></td>
</tr>
<tr>
<td>Two piece housing, on machine seal replacement</td>
<td>Single piece body, requires removal of all parts for repair</td>
<td></td>
</tr>
</tbody>
</table>
Steel

Industry Overview

Barco (USA) - E-75 RS for cooling water applications on furnace rolls and billet casters.

Duff Norton (USA) – 5000 series and 9000 series for cooling water applications on furnaces and billet casters. 1500 series for water cooling on continuous casting machinery.

Rocky (Japan) – wide range of rotary unions for continuous casters and furnaces. Not many found in the USA, but strong presence in Japan and Latin America.

Dynamic Sealing Technologies (USA) – found on special steel mill applications requiring high pressure or multi-passage rotary unions.

Rotary Systems (USA) - found on special steel mill applications requiring high pressure or multi-passage rotary unions.

GAT (Germany) - mostly found on special steel mill applications requiring high pressure or multi-passage rotary unions.

Filton (UK) – manufactures water and steam rotary unions. European focused.

Maier (Germany) – not usually found in steel mills in North America.

Springmann (Germany) – found on continuous casting machines around the world.
SMS Group is a group of companies in plant construction and mechanical engineering for the industrial processing of steel, aluminum, and nonferrous metals. SMS Group is divided into two business areas, SMS Demag and SMS Meer.

SMS Demag is then further organized into divisions including steelmaking/continuous casting technology, hot rolling mills/cold rolling mills, strip processing lines, and minimills for long products.

SMS Meer is organized into three divisions including tube, long products and copper plants, press and forging technology, and induction technology.

Below are profiles of the divisions that are relevant to Kadant Johnson products and services.

**SMS Demag LLC (SMS Group)**
www.sms-demag.us

SMS Demag, headquartered in Germany, has locations worldwide including Germany, Europe, North and South America, Asia, Africa, and Australia.

SMS Demag develops, designs, and builds machinery for the steel and aluminum industries. Their products range covers the entire process chain including steelworks, continuous casters, and roll milling technology.

**Continuous Casting** – SMS Demag’s patented CSP funnel mold provides the prerequisites for casting 45 - 70 mm thick slabs at high casting speeds (over 5 m/minute) with excellent surface and internal quality and a high productivity rate. They offer CSP casting plants built as single or twin lines.

SMS Demag’s casting machines are used to produce rail and spring steels, SBQ steels, ball bearing and valve steels along with other special types of steel. They also cast the largest octagonal, round and beam blank shapes.

Kadant Johnson Products: BCI and C-Cast
SMS Millcraft (SMS Group)
www.sms-millcraft.us

SMS Millcraft LLC, located in Pittsburgh, Pennsylvania, USA, is a supplier of off-line maintenance for metals producers in the US.

SMS Millcraft provides technology-based maintenance on the following equipment:

- Continuous slab, billet and bloom casters
- Molds and copper mold plates
- Rolls
- Spindles, chocks, reels and mandrels
- Long-products rolling mills
- Couplings
- Material handling equipment

SMS Millcraft has ten plants across the U.S. to meet its customers’ maintenance and equipment needs.

- Columbus, Mississippi
- East Palestine, Ohio
- East Pittsburgh, Pennsylvania
- Gary, Indiana
- Mobile, Alabama
- Mokena, Illinois
- Muscatine, Iowa
- Oil City, Pennsylvania
- Taylor, Michigan
- Washington, Pennsylvania

Kadant Johnson Products: BCI and C-Cast
Concast, located in Pittsburgh, Pennsylvania (USA), focuses on processes and technologies for the long product steel making sector.

The design and supply of the following technological key-equipments are a part of Concast’s scope:

- Electrical Arc Furnaces AC/DC
- Vacuum Degassing Plants VD/VOD
- Ladle Furnaces
- Continuous Casting Machines for blooms, beam-blanks, rounds and billets
- Minimills
Danieli, headquartered in Buttrio, Italy, is a supplier of equipment and plants to metals industry, worldwide. Danieli has facilities located in Germany, Spain, the Netherlands, USA, United Kingdom, Sweden, and France. Over the years Danieli has acquired several other well known names such as Davy Distington and Wean United.

Danieli manufactures slab and bloom casters, thin slab casters, galvanizing lines, pickling lines, and furnaces.
Siemens VAI, headquartered in Linz (Australia), has locations in Germany, United Kingdom, France, Spain, Italy, and USA. Siemens is an engineering and plant-building company for the iron and steel industry, for the flat-rolling sector of the aluminum industry, and for open-cast mining. Voest-Alpine and Rokop are two other steel OEMs that have been acquired by Siemens.

Siemens advises and implements optimum casting solutions for its customers. This covers both new and used slab, bloom/beam-blank, and billet caster installations.

Supplies and Services:

- Slab casters
- Combi-casters (single, twin and triple)
- Medium/thin-slab casters
- Casting and direct rolling (ESP)
- Bloom casters
- Beam-blank casters
- Billet casters
- Plant replacements
- Modernizations
- Special casters (e.g., vertical casters)

*Examples of Siemens VAI technological packages for improved casting performance.

Kadant Johnson Products: C-Cast
Bricmont, headquartered in Canonsburg, Pennsylvania (USA), covers all aspects of designing and building industrial equipment for the steel industry.

Bricmont lines represent equipment for heating and cooling strip for galvanizing. An induction heater may provide heat to the strip shortening the overall length of the line plus providing greater yield due to product transitions. Typical furnace types from Bricmont include, walking beam furnaces, roller hearth furnaces, walking hearth furnaces, pusher furnaces, and batch furnaces.

Kadant Johnson Products: RX and SX Rotary Unions
Tenova Group, headquartered in Italy, designs and supplies furnaces to the ferrous and nonferrous industries. They serve the metal producing industries in the United States, Canada, and Mexico. Tenova Group has acquired several furnace companies including LOI, Italimpianti (now called LOI Italimpianti), and Core Furnace.

Core Furnace Systems designs and supplies walking beam and walking hearth furnaces for the reheating of billets, blooms, slabs, thin slabs, beam blanks, and pipes, for materials such as copper, carbon steel, stainless steel oriented grain steel, titanium, and special alloys.

Core also provides tunnel furnaces to reheat thin slabs 40 – 90 mm thick as well as roller hearth furnaces for endless rolling plants with bar lengths up to 1,000 feet.

Other furnaces include rotary hearth furnaces, pusher furnaces, burners, and walking hearth furnaces.

LOI Italimpianti manufactures reheating and heat treatment plants for steel, aluminum, and automobile industries. It has locations in Europe, China, India, USA, Poland, and Russia.

The furnaces it manufactures include walking beam, walking hearth, roller hearth, and rotary hearth furnaces. LOI Italimpianti also manufactures a range of annealing and galvanizing furnaces for steel strip.

Kadant Johnson Products: C-Cast and RX Rotary Unions
Natural and synthetic fibers go through many processes before they become cloth.

**Synthetic fibers** are extruded, like many plastics. The extruded fiber strands are then kinked so that they are flexible enough for knitting or weaving operations. This is done by passing the strands over heated breaker rolls and striking them with a breaker bar. The applied kinks in the fiber are very close together, removing stiffness and making the fiber more supple.

Man-made fibers like **slit film and monofilament fibers** are produced on roll stands and draw stands. Both have heated and cooled rolls.

**Natural fibers** are ran through sizing (starch) and then through a slasher, which has heated rolls to dry the starch.

Once the fabric is woven or knitted, it is ready to be bleached or dyed. This is done on a continuous web basis. After bleaching or dyeing, the fiber goes to the dry can range where it passes over a series of steam heated cans or cylinders to dry or evaporate the remaining moisture. Even a small textile mill can have hundreds of joints on the dry cans.

A singer machine is used to burn the lint from woven fabric. Water cooled rolls are used to reduce the temperature of the fabric as it passes the flame bars of the Singer.

**KADANT JOHNSON PRODUCT APPLICATIONS IN THE TEXTILE INDUSTRY**

<table>
<thead>
<tr>
<th>MACHINE</th>
<th>SERVICE</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breaker Rolls</td>
<td>Steam</td>
<td>SX rotary joints</td>
</tr>
<tr>
<td>Slashers</td>
<td>Steam</td>
<td>LJ, SX, rotary joints</td>
</tr>
<tr>
<td>Draw Strands/Roll Strands</td>
<td>Steam</td>
<td>SX rotary joints</td>
</tr>
<tr>
<td></td>
<td>Hot Oil</td>
<td></td>
</tr>
<tr>
<td>Dryer Cans</td>
<td>Steam</td>
<td>SX rotary joints</td>
</tr>
<tr>
<td>Singers</td>
<td>Water</td>
<td>SX rotary joints</td>
</tr>
<tr>
<td>Synthetic Fibers</td>
<td>Steam</td>
<td>IC, LJ-PT, SX rotary joints</td>
</tr>
</tbody>
</table>

Other products used in the Textile Industry include Liqui-Mover pumps, sight flow indicators, and flexible hose.
The Textile and Fiber Industry

What can you do with textile?

- Bleaching
- Dyeing
- Printing
- Calendering
Drying Cylinders

Draw Stand

1. Inlet protection
2. Housing with seven water-heated godets
3. Hot water - feed pipe
4. Hot water - discharge
5. Rotary sealing heads
6. Drive journal
7. Mounting plate (gear) with inspection window
8. Lubrication oil station on separate socket
9. Nip / squeeze roll
Thermo-Laminating Calender

- Thermo-Laminating Calender
- Two or more fabric webs are bonded by temperature and pressure together

Man-Made Fiber (Synthetic)

- Nylon
- Polyester
- Polypropylene
- Rayon
- Carbon Fiber
- Glass Fiber
- Tyvek (registered trademark of Dupont)
- Other Proprietary Fibers
Synthetic Fibers

- Manufacturing equipment is more closely associated with Plastics OEM’s
- Market segment is largely controlled by Maier and Deublin
- Synthetic fibers and plastics are likely the most active capital investment segment of the North American
- European OEM’s dominate foreign imports into North America

Synthetic Fiber Types

- Extrusion
  - Monofilament
    - No Joints Used
    - Fishing line
  - Multifilament
    - Steam Joints
    - Hot oil Joints
    - Toothbrush bristles
  - Slit Tape (Flat Fiber)
    - Hot Oil Joints
    - ie. Nylon Backing, Goretex, Tyvek, etc.
Synthetic Fiber Processing

- Extrusion
  (Typically, Joints aren’t always utilized)
  - Draw Stands
    Thread Diameter
    Hot Oil or Steam Joints
    Water Joints
  - Annealing Stands
    Thread Density
    Hot Oil Joints
    Water Joints
  - Weaving
  - Calendering
    Hot Oil
  - Mechanical Non Wovens
    "Calendering"
    Hot Oil Joints
  - Chemical Non Wovens
    "Calendering"
    Hot Oil Joints
  - Relaxation Stands
    Hot Oil Joints
    Water Joints
  - Weaving

BCF Plant

Spinning and texturizing machines for the production of synthetic continuous yarns from polyester or polypropylene for the carpet industry
Staple Fiber plants

Spinning and drawing lines for the production of synthetic staple fibers mainly from polyester and polypropylene for the clothing industry.

Parts of a Fiber Line
Guide stand

Draw Stand
Calender dryer

Fiber Draw Line
Fluid Flow Basics

Fluid Rotary Joint Applications

- Small roll ID
- No siphon
- No air inside roll
Fluid Flow Characteristics

- Two fundamental differences between steam flow and fluid flow
  - Fluids are incompressible, steam is compressible
    - Incompressible = a Newtonian fluid
    - Compressible = a non-Newtonian fluid
  - Steam typically experiences a phase change in the heat transfer process, fluids typically do not

Compressible vs. Incompressible

- Why is this important?
  - Water:
    - 1 gal. of water weighs 8.3 lb at 14.7 psia or 100 psia or 500 psia
  - Steam:
    - 1 gal. of steam weighs .005 lb at 14.7 psia
    - 1 gal. of steam weighs .03 lb at 100 psia
    - 1 gal. of steam weighs .14 lb at 500 psia
  - Conclusions:
    - Pressure does not affect the volume of fluid
    - Fluids are much more dense than gases
Phase Changes

• Steam applications
  – Steam gives up large quantities of heat during the phase change back to water
  – The water (condensate) has much higher density than the steam so the volume that 1 lb of water occupies is much less than the volume that 1 lb of steam occupies
  – Conclusion:
    • Steam joints have a much larger inlet flow area than the outlet flow area

• Fluid applications
  – The fluid enters roll and gives up heat in direct proportion to temperature difference
  – No phase change will occur unless fluid is heated beyond its boiling point
  – Phase changes should never occur in fluid heating or cooling applications
  – Conclusion:
    • Inlet flow area should be equal to outlet flow area for fluid applications
## Design Criteria

- Fluid applications are governed by three primary considerations
  - Maximum fluid temperature
  - Minimum fluid pressure
  - Required flow rate

### Maximum fluid temperature
- Typically specified by customer based on pump capabilities, cooling system design and other factors not related to the rotary joint.

### Minimum fluid pressure
- Typically specified by customer based on the same factors outlined above.

### Verify that the fluid does not change to a gas at the maximum temperature and minimum pressure
- Refer to the steam tables for water (Crane technical paper number 410) or contact Kadant Johnson
- Refer to the manufacturers specifications for thermal oil properties
Design Criteria

- **Flow rate**
  - Specified by customer or recommended by Kadant Johnson
  - Flow rate determines the rotary joint size
    - Higher flow rate does not necessarily result in more heat transfer

- **Rotary joint flow capacity**
  - Flow velocity is limited to 20 ft/sec for water applications
  - Flow velocity is limited to 20 ft/sec for oil applications

Physics

- **Flow rate** is the amount of fluid passing through the rotary joint per unit of time
  - Typical units are: gal/min, lb/hr, kg/min, liters/min

- **Flow velocity** is the average distance the fluid travels per unit of time
  - Typical units are: ft/min, ft/sec, m/min, m/sec

- **Flow area** is the cross sectional area that the fluid flows through inside the rotary joint
  - Typical units are: in², m², cm², mm²
Physics

- Flow Velocity = Flow Rate/Flow Area

Example:
- A customer has a single flow water application requiring 15 gal/min flow rate. What size rotary joint do we specify?

Example

- To start the analysis we will guess that a \( \frac{3}{4} '' \) rotary joint is appropriate for this application and then perform the calculation to verify the result

\[
V = \frac{Q}{A}
\]

where:

\[
Q = 15 \text{ gal/min} \times 231 \text{ in}^3/\text{gal} \times 1 \text{ min/60 sec} = 57.75 \text{ in}^3/\text{sec}
\]

\[
A = \pi \times r^2 = 3.14 \times (.75/2)^2 = .442 \text{ in}^2
\]

\[
V = \left( \frac{57.75 \text{ in}^3/\text{sec}}{.442 \text{ in}^2} \right) \times 1 \text{ ft}/12 \text{ in} = 10.9 \text{ ft/sec}
\]
Example

• A dual flow application is similar
  – Dual flow calculations require flow velocity calculations for the inlet area as well as the outlet area
  – Cooling water applications are usually “reverse flow” arrangements
    • The water flows into the roll through the horizontal pipe, or supply pipe as it is normally referred to in this type of application
    • This arrangement prevents air or steam from being trapped inside the roll and provides much more consistent cooling capabilities

Pressure

• Pressure measurement scales
  – Absolute
    • Bar, kpa, Mpa, psia
  – Gauge
    • Bar gauge, kpa gauge, Mpa gauge, psig
  – Vacuum
    • Inches, centimeters or millimeters of mercury (Hg)
    • Feet, inches, meters, centimeters or millimeters of water
Pressure

Absolute Pressure Scale
- 0 psia
- 14.7 psia
- 1 atm.
- 114.7 psia

Gauge Pressure Scale
- -14.7 psig
- 0 psig
- 1 atm.
- 100 psig

Vacuum Pressure Scale
- 29.9" Hg
- 33.9 ft H2O
- 760 mm Hg
- 10.332 mm Hg

Mercury or water levels are typically not used to measure pressure above atmospheric.
The Basic Concepts of Steam

Kadant Johnson

Steam

An invisible gas generated by adding energy to liquid water causing it to change into a vapor.
Energy States of Water

- High – Steam vapor
- Medium – Water liquid
- Low – Ice solid

Qualities of Steam

- Produced from water
- Clean, odorless, and tasteless
- Heat can be used over and over – flash
- High usable heat content
- Gives up its heat at constant temperature
- Easily distributed and controlled
- Well-known characteristics
  - Pressure, temperature, volume
British Thermal Unit (BTU)

BTU = Amount of heat needed to raise one pound of liquid water one degree Fahrenheit (°F)

Sensible Heat of the Liquid

• Energy in the water before it boils
• Can be measured by a thermometer
• Water has 180 BTUs at the boiling point (212°F)
Latent Heat

- Additional energy necessary to convert liquid water to steam vapor

- During the conversion to steam, the volume of the water increases dramatically

Heat Required to Generate One Pound of Steam

- 1 lb water at 32°F
- 1 lb water at 212°F
- 1 lb steam at 212°F

0 psig

+ 180 BTU =
+ 970 BTU =
Heat Required to Generate One Pound of Steam

100 psig

1 lb water at 32°F + 309 BTU =

1 lb water at 328°F + 880 BTU =

1 lb steam at 328°F

Types of Steam

- **Saturated Steam** – Steam in immediate contact and at the temperature of the water from which it was formed (also known as wet steam)

- **Superheated Steam** – Steam to which energy has been added to raise its temperature above its boiling point (also known as dry steam)
Flash Steam

• Reduce the pressure of condensate
• Condensate re-evaporates
• Flash steam is created
• Amount of flash steam can be calculated

Flash steam % = \[ \frac{H_{S1} - H_{S2}}{H_{L2}} \times 100\% \]

Calculating Flash Steam

Flash steam % = \[ \frac{H_{S1} - H_{S2}}{H_{L2}} \times 100\% \]

\( H_{S1} \) = sensible heat of higher pressure
\( H_{S2} \) = sensible heat of lower pressure
\( H_{L2} \) = latent heat of lower pressure
Calculating Flash Steam

Flash steam % = \( \frac{H_{s1} - H_{s2}}{H_{L2}} \times 100\% \)

\[
\begin{align*}
309 - 180 & \quad \times 100\% = 13\%
\end{align*}
\]

For 100 psig condensate flashing to 0 psig:

\[
\begin{align*}
H_{s1} &= 309 \text{ Btu/lb} \\
H_{s2} &= 180 \text{ Btu/lb} \\
H_{L2} &= 970 \text{ Btu/lb}
\end{align*}
\]

Steam Properties

<table>
<thead>
<tr>
<th>Pressure (psig)</th>
<th>Temp (° F)</th>
<th>Heat of Liquid (BTU)</th>
<th>Latent Heat (BTU)</th>
<th>Total Heat (BTU)</th>
<th>Specific Volume (ft³/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>212</td>
<td>180</td>
<td>970</td>
<td>1150</td>
<td>26.8</td>
</tr>
<tr>
<td>50</td>
<td>298</td>
<td>267</td>
<td>912</td>
<td>1179</td>
<td>6.7</td>
</tr>
<tr>
<td>100</td>
<td>338</td>
<td>309</td>
<td>880</td>
<td>1189</td>
<td>3.9</td>
</tr>
</tbody>
</table>
Specific Volume

- Amount of space occupied by one pound of steam at a given pressure
- Inverse relationship between steam pressure and volume (pressure goes up, volume goes down)
- The higher the steam pressure, the less space required

<table>
<thead>
<tr>
<th>Pressure (psig)</th>
<th>Water (ft³/lb)</th>
<th>Steam (ft³/lb)</th>
<th>Steam/Water (ft³/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0167</td>
<td>26.8</td>
<td>1600</td>
</tr>
<tr>
<td>50</td>
<td>0.0175</td>
<td>6.7</td>
<td>380</td>
</tr>
<tr>
<td>100</td>
<td>0.0179</td>
<td>3.9</td>
<td>216</td>
</tr>
</tbody>
</table>
Specific Volume

- The steam volume decreases with pressure
- This results in reduced:
  - Pipe erosion due to high velocity
  - Pressure losses in the system
  - Noise generation

Pipe Line Velocity Guidelines

- Steam flow < 6000 fpm
- Condensate flow < 4000 fpm
  - This is by-phase flow
- Liquid Flow < 420 fpm
  - 6-8 fps
Calculating Pipe Line Velocity

\[ S_v = \frac{F \times V \times 2.4}{A} \]

\[ V = \frac{F \times V \times 2.4}{A} \]

- Steam flow rate is 1,000 lb/hr
- Steam pressure is 75 psig (V = 4.89 ft³/lb)
- Pipe size is 2.5” (internal area = 2.469 in²)
Calculating Pipe Line Velocity

\[ V = \frac{F \times V \times 2.4}{A} \]

\[ V = \frac{1000 \times 13.74 \times 2.4}{2.469} = 13,356 \text{ fpm} \]

- Steam flow rate is 1,000 lb/hr
- Steam pressure is 15 psig (V = 13.74 ft3/lb)
- Pipe size is 2.5” (internal area = 2.469 in2)

Pipe Line Losses

<table>
<thead>
<tr>
<th>Pipe Size (Sch 40)</th>
<th>Velocity (fpm)</th>
<th>Velocity (mph)</th>
<th>ΔP/100 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾”</td>
<td>17,580</td>
<td>200</td>
<td>87</td>
</tr>
<tr>
<td>1”</td>
<td>10,830</td>
<td>120</td>
<td>25</td>
</tr>
<tr>
<td>1 ¼”</td>
<td>6,250</td>
<td>70</td>
<td>6</td>
</tr>
<tr>
<td>1 ½”</td>
<td>4,600</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>2”</td>
<td>2,780</td>
<td>30</td>
<td>1</td>
</tr>
</tbody>
</table>
What size pipe is needed?

**1000 lb/hr flow rate at 6000 fpm**

- Water: 1/8"
- 100 psig steam: 1-1/4"
- 50 psig steam: 2"
- 0 psig steam: 3-1/2"

A 3” pipe has 8.6 times the area of a 1” pipe!
Interchanging Competitors’ Rotary Joints

• To make sure you are offering the best product for the application capture the following:
  – Medium
  – Temperature
  – RPM
  – Pressure
  – Competitive part numbers are useful if available
Beware!

- Rotary joints and unions are consistently misapplied
- Is the customer trying to get a lower price or the best possible solution?
- Sometimes knowing the application is better than knowing the competitors’ part number
- We always want to try and put on a standard Kadant Johnson rotary joint versus creating a special
- You get one chance to show the customer that you and your product are the best option for their application

Competition

- Deublin
- Barco
- Duff-Norton
- Christian Maier
Deublin

- 55 and 57 Series
- 6000 Series
- H Series
- 9000 Series
- HPS Series

Deublin Target Markets

- Printing
- Plastics
- Rubber
- Machine tool
- Steel
- Corrugating
- Textile
- Converting
- Alternative Energy
Nomenclature

557—000-395-144

557 = 1-1/2
Seal Package – Carbon Graphite to Silicon Carbide

2”-12 UN RH Thread

Syphon Pipe

Deublin 57 Series Rotary Union

• Identical to the 55 series dimensionally
• They have silicon carbide to carbon graphite
• Is applied to tougher water applications
Kadant RX Rotary Union vs. Deublin 55 & 57 Series

- Spring
- Bearing Protection
- ‘O’ Rings
- Counterseat retention
- Repairs

Commercial Issues

- RX rotary unions interchangeable with 55 & 57 series
  - ‘Fit-Form-Function’
  - No piping issues
- Deublin Deliveries
- Pricing
  - Standard configurations are competitively priced
- Product Flexibility
  - RX rotary union operates at higher temperatures than Deublin
- Possible to reuse Deublin duo-flow assemblies
Kadant RX Rotary Unions vs. Deublin Large 6000 & F Series

- Bearing Protection
- 2 x large bearings
- Counterseat not on 'pins'
- Media (Deublin Water only)
- Drain Holes not slots

Commercial Issues

- RX rotary unions interchangeable with 6000 series
  - ‘Fit-Form-Function’
  - No piping issues
- Deublin Deliveries
- Pricing
  - Standard configurations are competitively priced
- Product Flexibility
  - We can offer RX rotary unions on higher temperatures and speed applications than Deublin
Kadant SXBPQ Rotary Joint vs. Deublin HPS (1-1/2"

- Split wedge syphon support
- Vertical syphon adjustment
- ½” or ¾” syphon option
- Pressure rating: 300 psig
- Speed rating: 550 RPM

- Bushing type syphon support
- Angular syphon adjustment
- ½” syphon option
- Pressure rating: 250 psig
- Speed rating: 400 RPM

SXBPOQ Rotary Joint Selling Points

- Convex seal ring under compression
- Split wedge syphon support
- 2 antimony carbon guides
- Vertical adjustable syphon
- ½ and ¾ Syphon compatible
- 2 guides
Kadant CJID vs. Deublin 2400 (Steel)

- Double Quad Ring Seals
- Thrust Bearings (Seal)
- Grease galleys (Body)
- Flanged body w/ bolt holes
- Mechanical Seal Type
- No Secondary seal
- Composite bearing in body
- Flanged body (no bolt holes)

CJID Selling Points – Continuous Casters

- Primary seals – Nitrile (Buna) quad rings
- PTFE (Teflon) thrust bearings act as secondary seal
- Flanged body – includes journal matched bolt hole pattern
- Cannot fail catastrophically
- Expected service life 2 years
- Simple to repair
- Competitive Price
CJID Applications – Steel Industry

• Continuous Casting Machines
• Thin Slab Casting machines

Barco

• E75-RS
• Type C
• Super G
• SFL
• Type E
Barco Target Markets

- Rubber
- Textile
- Plastics
- Printing
- Steel

Nomenclature

BC54000-40-51

- Barco Type C
  - 54000 - Ferrous
  - 54065 - Bronze
  - Dual Flow
- 51 - Left Hand Thread
- 40 - 2-1/2” Rotary Joint
Kadant RX Rotary Union vs. Barco E75-RS

- Springs
- Bearing Protection
- ‘O’ Rings
- Bearings sealed for life
- Repairs

Commercial Issues

- Sales/Service
  - Primarily through Motion Industries
- Price
  - Word is that Barco pricing has increased
Kadant RX Rotary Union Conversion from Barco CF (3”)

- Barco CF
- RX Q Nipple Interchange
- Pressure Joint
- Carbon Bearings
- High Torque
- Not designed for Water

Duff Norton

- 5000 Series
- 9000 Series
- 9000 Series HT
Duff Norton Target Markets

- Rubber
- Textile
- Plastics
- Synthetic Fiber

Kadant RX Rotary Union vs. Duff Norton 5000

- Bearing Protection
- Drain holes restricted
- STD seal package C vs. CR coated steel
- Repairs
- Bearings sealed for life
Commercial Issues

• Deliveries
  – Duff deliveries are long

• Price
  – Generally prices are higher

Kadant RX Rotary Union vs. Duff Norton 9000

• Tungsten Carbide / Carbon Graphite Seals
• Carbon Graphite / Hardened Steel Seals

• 2 Piece Housing – Easy to Repair on site
• Single Piece Housing – Must send to factory for repair
Maier

- DX Series
- DP Series
- H Series
- M Series

Maier Target Markets

- Rubber
- Textile
- Plastics
- Converting
Kadant RX Rotary Union vs. Maier DX & DP

- Spring
- Bearing Protection
- STD seal package C vs. Steel
- Repairs

Commercial Issues

- Delivery
  - Maier deliveries are long
- Maier ‘Q’ nipples different to Kadant Johnson
  - Kadant Johnson adaptor flanges available
- Maier DX has a tapered sealing face on rotor.
  - Kadant Johnson STD rotors interchange OK
- Watch for strange ‘M’ and ‘P’ connection sizes on Maier
- STD Maier nipples are BSPP unless a special part number
- Maier has BSP entries
## Competitive Summary

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kadant Johnson</td>
<td>RX</td>
<td>SX, ELS</td>
</tr>
<tr>
<td>Deublin</td>
<td>55, 57 &amp; 6000 Series</td>
<td>9000 series, H</td>
</tr>
<tr>
<td>Barco</td>
<td>E75-RS</td>
<td>Type C, Super G, GR</td>
</tr>
<tr>
<td>Duff Norton</td>
<td>5000, 9000 series</td>
<td>9000, 8000 series</td>
</tr>
<tr>
<td>Christian Maier</td>
<td>DX, DP, M</td>
<td>H</td>
</tr>
</tbody>
</table>
Field Identification Guide

Guide to Joint Part Identification ................................................................. 2
Type LN, LJ and Lug support internally compensated joints ................... 4
Type ELS and ELSN Rotary Joints ............................................................... 9
Shelf Bracket Mounted Joints ................................................................. 10
PT/PTX Joints ......................................................................................... 12
Type RX Rotary Joints ................................................................. 13
Type W Rotary joints ................................................................. 14
Type WR ................................................................. 14
Guide to Joint Part Identification

The field identification of rotary joints is required to insure we provide the appropriate spare parts. Please call Three Rivers to help identify field equipment based on sales history and casting numbers. Equipment supplied to a facility by an OEM (Original Equipment Manufacture) or a distributor (Motion Industry, Fergusson, etc.) may not be in customer history and may require field identification.

This guide is for common rotary joints. This guide does not cover special and custom joints.

All parts and assemblies have a Part ID and a Symbol Number. The Part ID includes all the information to supply the component. The Part ID is an eight (8) digit code. For parts, the Part ID is a string of eight numbers. For example 16078500.

For assemblies the Part ID is a combination of numbers and alpha characters. The Part ID starts with two (2) numbers, followed by one (1) alpha character and five (5) more numbers. For example 16B45300.

The “Symbol Number”, which is shown on the drawings, also describes the part. We typically required additional information with the “Symbol Number” to completely describe the part.

Complete rotary joints supplied since 2000, are tagged with a nameplate that includes the Part ID and Order Number. (See Photo #1) The Part ID is the easiest way to identify the joint. The Order Number can help identify other equipment that was supplied with the joint, such as journal flanges and syphon equipment.
We do not tag individual parts with the joint assembly numbers. Since most customers rebuild their rotary joints, it is common to find rotary joints without tags.

The following guidelines are intended to help identify what information is required for part identification and where it can be gathered. The guide is organized by joint type. The process of identifying a rotary joint without tags involves gathering casting numbers and part dimensions.

Typical repair parts for rotary joints include the carbons, gaskets and O-rings used in each joint assembly. These parts can be identified based on the body and head casting numbers.

If the customer needs to replace the metal parts, the following information is needed for each part. The easiest place to obtain this information is the storeroom. Most parts are wrapped in paper and labeled before they are shipped. If the label has been removed, the following information will have to be gathered. If the storeroom does not stock these parts, it will be necessary to disassemble the rotary joint to obtain the required measurements.

<table>
<thead>
<tr>
<th>Part</th>
<th>BOM #</th>
<th>Information Required</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body Type L</strong></td>
<td>1</td>
<td>-Lug hole spacing (the “N” dimension on the drawings)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Hole size (the “O” dimension on the drawings), typically 1/16” larger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>than the support rods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Steam inlet connection size (the “M” dimension on the drawings)</td>
</tr>
<tr>
<td><strong>Body Shelf Style</strong></td>
<td>1</td>
<td>-Body drilling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Steam Inlet connection size (the “M” dimension on the drawings) and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pressure rating</td>
</tr>
<tr>
<td><strong>Head</strong></td>
<td>2</td>
<td>-Number of bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Condensate connection size (the “P” dimension on the drawings)</td>
</tr>
<tr>
<td><strong>Thrust Collar</strong></td>
<td>3</td>
<td>Syphon size for rotary syphons (not required for stationary syphons)</td>
</tr>
<tr>
<td><strong>Nipple</strong></td>
<td>4</td>
<td>-Overall Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Thread type and hand (if applicable)</td>
</tr>
<tr>
<td><strong>Packing Gland</strong></td>
<td>10</td>
<td>Horizontal pipe size</td>
</tr>
</tbody>
</table>
Type LN, LJ and Lug Style Internally Compensated Joints

Type LN, LJ and Lug supported internally compensated joints (LN-IC), are most easily identified by the cast lugs that are used to support the rotary joint. The LN joint is also described as a rod supported joint. The support rods can be mounted to the bearing cover or used with stands. The rods pass through the lugs and support the joint. These joints share many common parts.

The main difference between the LN and LJ rotary joint is the syphon. Type LN’s are for a rotating syphon. Type LJ's are for a stationary syphon.

The internally compensated joint can use either style of syphon. The difference is the nipple. The IC joint uses a three-piece nipple arrangement, instead of a one piece nipple. Drawings AB8248, AB1952, and AB3110 show typical arrangements for 3” versions of these joints.

The body casting (BOM #1) number can be found 180 degrees from the steam inlet port. A typical casting number will be similar to J2701L or J2701LR. Based on the size of the lugs, the L may be followed by an additional digit for example J2701L4. If the body has an integrally cast flange connection, the casting number will also include the letter “F” - J2701LF. See photo #2 for a typical casting number.

Photo 2 – 2600LN/LJ Body
The head casting number can be found on the exposed face of the head. The casting number will be 6 to 8 digits long similar to J2702NA or J2702A. This casting number will allow us to distinguish between an LN and LJ rotary joint. (See photo 3)

**Photo 3- 2550LN Head**

If the customer wants to replace the wear plate or wear plate gasket, the number of bolts (BOM#16A) used with the wear plate (BOM #16) will be required. Most sizes of lug supported joints are supplied with 6 or 8 bolt pattern configurations.
Only viewing the outside of the rotary joint cannot identify internally compensated joints. It is necessary to examine the nipple to determine if it is a compensated or non-compensated rotary joint. The nipple for an internally compensated joint is made of 3 parts, a nipple tube, nipple body and Teflon O-ring. See photo #4

**Photo 4 – IC Nipple Parts and Assembly**
Type S and SX

The SX rotary joint was designed to replace the Type S rotary joint. Drawing AB6868 and AB9781 show typical SX and S assemblies. The S and SX joints are interchangeable. Both joints are available in standard and heavy (high pressure) bolting patterns. The head (BOM #2) is interchangeable between S and SX joints.

In the SX joint line, the standard and heavy bolt patterns are machined from the same casting. In order to determine if a SX joint has a standard or heavy bolt pattern, it is necessary to look at the casting number on the head. Type S heads with heavy bolt patterns have the letter “H” in the casting number.

The standard and heavy bodies for the Type S line are made from different castings. This is because the original cast iron Type S bodies required a thicker wall to obtain the higher-pressure rating for use on corrugators. The standard and heavy parts will not bolt together. The two versions of the head and body remain common in the field. The standard body has sufficient pressure ratings for most new applications.

The body casting (BOM #1) number can be found 180 degrees from anti-torque lug. A typical casting number will be similar to S2701H or SX3701. See photo #5 for a typical casting number.

Photo 5- 3600SX Body
The head casting number can be found on the exposed face of the head. The casting number will similar to S3702A or S3702BH.

Photo 6- 3550SB Head

The SB head is occasionally modified to work with a rotary syphon. The rotating horizontal pipe is supported by a bronze bushing in the joint head. This arrangement is only used for water and hot oil applications. It is never used with steam.
Type ELS and ELSN Rotary Joints

The body casting numbers most easily identifies the ELS and ELSN. For sizes 2 inch and smaller, the ELS body casting start with the letters SR and the body and head are cast as a single piece, see drawing A24190.

For sizes 2.5” and larger the ELSN and ELS rotary joints use the same body casting. The body casting numbers that start with the letters SNR

The main difference between the ELSN and ELS rotary joint is the syphon type. The ELSN is designed for an internal syphon pipe that is rotary. The ELS is design for a stationary syphon. Drawings AB5257, and AB5356 show typical arrangements for 3” versions of these joints.

The body casting (BOM #1) number can be found 180 degrees from the steam inlet port. A typical casting number will be similar to SNR2701 or SR3551. If the body has integrally cast flanged connections, the casting number will also include the letter “F” i.e. SNR2701NF. See photo 7 for a typical casting number.

Photo 7- 2550ELSN Body

The head casting number can be found on the exposed face of the head. The larger ELS joints often use Type L heads along with Type EL heads. The casting number will be 6 to 8 digits long similar to J2702NA, J2702NAF or SNR2702A.
Shelf Bracket Mounted Joints

Three different styles of rotary joints can be adapted to mount on shelf style brackets. Those styles are the NAW, BAF and PT rotary joint.

The BAF rotary joint is the easiest of the styles to identify. The bodies tend to be rounded and have a shroud that extends from the joint body to the journal flange. See drawing AB5383. Most of these joints have been removed from service.

The PT rotary joint is easily identified by the exposed springs between the rotary joint endcap and piston. See drawing AB8911. Identification of parts for the PT joint is covered in the PT/PTX joint section.

The 6000 series Type NAW rotary joint is a very common rotary joint. It is most often found on Beloit paper machines with shelf style mounting brackets. The joints are most easily identified by their flat-bottomed bodies. See Drawing AB2445. In dual flow applications the condensate is discharged through the head and the steam inlet can be on the right, left or top/bottom of the joint.

The body casting (BOM #1) number can be found 180 degrees from the steam inlet port. A typical casting number will be similar to J6801E-1R. See photo 8 for a typical casting number.

Photo 8- 6750NAW Body
The NAW rotary joint uses LN heads with integrally cast flanges. The head casting number is cast into the side of this style head. The casting number will be 6 to 8 digits long similar to J2702NA or J2702NAF. (See photo 9)

**Photo 9- 2750LN Integral Flanged head**

In most applications the bodies and heads are machined per ASME 150 lb or 300 lb flange drilling standards. The same casting is used for both pressure ratings. The flange pressure rating should be confirmed with the customer.

Due to the variety of brackets manufactured by Beloit and other paper machine OEMs. A large number of body machining patterns and nipple lengths have been developed. Body drilling and nipple lengths are critical dimensions for this joint series.

You will want to make sure to record the orientation of the connections. For example: The joint **sits on** the support bracket and the steam inlet is on the **right hand** side as you are looking towards the machine. Or the joint **hangs from** the support bracket and the steam inlet is on the **right hand** side as you are looking towards the machine. This orientation information is required for properly assembling a replacement joint.
PT/PTX Joints

The PT (Piston Type) and PTX style rotary joints are easily identifiable by the exposed springs. The PT seal package can be used in shelf bracket supported (AB6413); Lug supported (AB5829) and ring bracket supported joint bodies (AB7881).

The PTX joint is a lighter version of the PT joint. It is available only in 3.5” and 4” sizes. It was originally designed to use with cantilever stationary syphons. It can be identified by the stainless steel sleeve in which the “Piston” rides.

With the exception of the 3.5” and 4” specifically designed for cantilevers, most PT joints are used for single flow applications. The casting number off the body is required for identifying the joint size.

For most joint sizes, the PT joint is available with either O-ring seals on the piston or an energized cup seal. It is necessary to look at a Piston (BOM #4) and endcap (BOM #32) to determine which style seal is being used. The cup seal design has a single groove and the O-ring design has two grooves. The groove(s) in joints 3” and smaller are found in the endcap and on the piston on larger sizes.

The recommended spare parts for the PT joint are sold in repair kits. They are referred to as “hard” and “soft” repair kits. The hard kits (see A45975) are complete endcap assemblies. The soft kits (see A45329) contain the carbon seal ring (BOM#6), piston seal (BOM #25) and the necessary gaskets and O-rings to change the parts. The exact make up of the repair kit varies with the joint style and support configuration.
Type RX Rotary Joints

The RX rotary joint was introduced in 2001. All RX assemblies should be tagged with Part IDs and customer order numbers.

The RX joint line is built on a cartridge system. The product line uses many of the same external parts from cartridge to cartridge with the differences between the cartridges being type of bearing, type of grease, seal material, counter seat material and the addition of secondary seals. See the drawings AB9104, AB9105, AB9106 and AB9107 for a 3" RXA in each cartridge configuration.

The recommended spare parts for the RX line are sold in repair kits. Each cartridge level has two (2) repair kits. One repair kit provides all the parts necessary to change the seals. These seal repair kits have a symbol number similar to RK4300RX-SR. The second repair kit contains all the parts necessary to replace the seals and the bearings. It has a symbol number similar to RK4300RX-BK.

If an RX joint does not have a product identification tag, the body casting number and operating conditions will be required to determine the proper cartridge. The following information will be required:

Fluid type
Fluid temperature
Fluid flow rate (gpm)
Flow type (single, dual w/stationary pipe, dual w/rotary pipe)
Roll diameter and speed or rpm
Journal mounting arrangement (threaded, "Q"uick release, flanged)
**Type W Rotary joints**

Sales of new complete Type W rotary joints ended in 2008. They are still commonly found in the field. They are typically found on press rolls and other cooling applications. The key to identifying a Type W joint is the body casting number. The casting number will begin with a “W” such as W3701.

Type W joints need to be converted to an RX rotary joint. The following information will be needed to start the conversion process:

- Fluid type
- Fluid temperature
- Fluid flow rate (gpm)
- Flow type (single, dual w/stationary pipe, dual w/rotary pipe)
- Roll diameter and speed or rpm
- Journal mounting arrangement (threaded, “Q”uick release, flanged)

**Type WR**

The WR rotary joint is available in sizes up to 3 inches. The line has been provided with both brass and ductile iron bodies. The WR product line was custom engineered for many applications. Custom seal materials, o-ring materials, grease specifications and custom nipple designs, make field identification difficult.

If a WR joint is found in the field that does not have a product identification tag, the body costing number and operating conditions will be required for the applications group to make a RX replacement recommendation. The following information will be required:

- Fluid type
- Fluid temperature
- Fluid flow rate (gpm)
- Flow type (single, dual w/stationary pipe, dual w/rotary pipe)
- Roll diameter and speed or rpm
- Journal mounting arrangement (threaded, “Q”uick release, flanged)
Hot Oil Rotary Unions

SX™ Rotary Union

- Up to 150 psig
- Up to 650 °F
- Up to 550 RPM – depending on size
- Sizes ¾” – 3”
ELS™ Rotary Union

- Up to 510 psig
- Up to 650°F
- Up to 200 RPM
- Sizes 1-1/4” to 12”

RX™ Rotary Union

- 150 psig
- Up to 482°F
- 1000 RPM
- Sizes 2”, 2-1/2” & 3”
RX™ Rotary Union

- 150 psig
- Up to 482 F
- 750 RPM
- Sizes 4”, 5” & 6”

BAF-SB Bracket Mounted Rotary Union

- Up to 150 psig
- Up to 650 F
- 1000 RPM
- Sizes 5” and 6”
Bellow Seal

The 9000 Series Rotary Union incorporates a special Bellow Seal package

Lapping Process

The spherical face of the nipple is lapped to the seal ring by turning it in a lathe at 60 RPM
Once lapped, the surfaces are flat within three to four light bands.

In House Testing

Dow Therm G test oil
### Filtration

- Recommended to remove particles 40 – 60 microns (0.0016” - 0.0024”) or smaller
- Average thickness of a strand of human hair is 0.0015”
- Thickness of a sheet of paper is 0.0030”

### Typical Applications

- Coal Dryers
- Hollow Flight Dryers
- Textile Dryers
- Calender Rolls
Application of Stationary and Rotating Syphons

Inside the Dryer

- Condensate Behavior
- Syphon Design and Selection
- Turbulator® Tube™ Bars
- Syphon Applications
Condensate Behavior

- Condensate behavior is dependent on rotational speed and load
- Three stages of condensate
  - Puddling
  - Cascading
  - Rimming

Condensate Behavior Puddling Stage

- Speeds below 300 fpm
- Heat transfer is good
Condensate Behavior Cascading Stage

- Speeds between 300 and 900 fpm
- Heat transfer is at its highest point
- Extreme turbulence
- Drive load is very high

Condensate Behavior Rimming Stage

- Speeds above 900 fpm
- Heat transfer is reduced
- Rim thickness is dependent on syphon clearance
- A solid film of water creates high resistance to heat transfer
Condensate Behavior Rimming Stage

- As speed increases, a gradient forms
- The shell temperature decreases further from the syphon tip
- Turbulator bars are required to reintroduce turbulence in the dryer

Dryer Definitions

- Flooding
  - Condensate is building up inside the dryer
- Flooded
  - Condensate level has risen over the syphon shoe
- Blow-Through Steam
  - Steam that does not condense
  - Entrains condensate and flows out the discharge
  - Typically 10%–25% by mass, over 95% by volume
Condensate Evacuation  
Dryer Speed = 0 fpm

\[ P_s - P_c = 0 \]

Syphon submerged

---

Condensate Evacuation  
Dryer Speed = 0 fpm

\[ P_s - P_c = 2.5 \text{ W.C. (1.1 psi)} \]

Syphon submerged
Condensate Evacuation

Dryer Speed = 3000 fpm

\[ P_s - P_c = 14.4 \text{ psi} \]

Aspirator Hole

Dryer Speed = 3000 fpm

\[ P_s - P_c = 8 \text{ psi} \]
Syphon Design and Selection

• Maximize dryer shell temperature to achieve maximum drying rate
• Minimize cross-machine temperature deviation to achieve a uniform moisture profile
• Provide reliable condensate removal

Syphon Design and Selection

• Two categories for syphon design
  – Stationary
  – Rotating
• Stationary syphons are fixed relative to the dryer
• Rotating syphons are rotating with the dryer
Stationary Syphons

- Bent pipe
- Syphon elbow
- Spring-lock syphon elbow
- Bushing supported syphon elbow
- Locking syphon elbow
- Cantilever stationary syphon
Stationary Syphons

Spring-Lock Syphon Elbow

Stationary Syphons

Journal Mounted Bushing
Supported Syphon Elbow

Internal Spider Flange
Bushing Support
Stationary Syphons

- Cantilever Stationary Syphon
- Rigid mounting
- High stiffness
- Low vibration
- Low deflection
Stationary Syphons

Rotating Syphons

- Scoop
- Rotocurve
- Conventional rotary syphon
Rotating Syphons

• Scoop
  – Uses the rotational energy of the dryer to lift the condensate
  – Good for slow speeds, puddling stage

Rotocurve  Conventional Rotary
Rotating Syphons

- Syphon clearance is pre-set
- Close clearance minimizes condensate inside cylinder
- High mechanical stability
- Blow-through steam requirements increase with speed
- Differential pressure requirements increase with speed
Rotating Syphons

FLOOD RECOVERY DIFFERENTIAL PRESSURE

<table>
<thead>
<tr>
<th>SPEED</th>
<th>cm/hr</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
<th>6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>mpm</td>
<td>300</td>
<td>600</td>
<td>900</td>
<td>1200</td>
<td>1500</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>ΔP, psi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔP, bar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turbulator® Bars

- Axial bars inside the dryer cylinder
- Held in place by segmented hoops
- Increase condensate turbulence
- Improve heat transfer rate
- Improve heat transfer uniformity
- Improve dryer response time
- Improve runnability
Temperature Profile Comparison

- Stationary Syphon with dryer bars
- Rotating Syphon no dryer bars
Optimizing Heat Transfer

- High values at resonance
- Minimum loss with speed
- Optimum clearance depends on:
  - Syphon design
  - Syphon shoe location
  - Dryer diameter
  - Condensing load
  - Machine speed
  - Bar configuration
- Optimum, not generic

Applications

- For speeds > 900 fpm
- Dryer limited machines
- Poor CD moisture profile
Drying Rate Improvement

Syphon Applications

- Rotating Syphons
  - Applied to slow to moderate speeds
  - Require additional $\Delta P$ and blow-through steam
  - High mechanical stability
  - Typical grades include liner, medium, specialty, Kraft, etc.
Syphon Applications

• Stationary Syphons
  – High speed, high performance
  – ΔP and blow-through steam requirements are minimal
  – Provide system flexibility
  – Typical grades include newsprint, LWC, P&W, SC, etc.

Syphon Applications

<table>
<thead>
<tr>
<th>Speed (fpm)</th>
<th>0-500</th>
<th>500-1000</th>
<th>1000-2500</th>
<th>2500-4000</th>
<th>&gt;4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent Pipe/Elbow</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Internal Bushing</td>
<td>Good</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Locking Elbow</td>
<td>Good</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cantilever Stationary</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Scoop</td>
<td>Good</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Rotocurve</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Conventional Rotary</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>No</td>
</tr>
</tbody>
</table>
Rotary Joint Overview

Unions, Joints, Steam Fits, Heads

• Mechanical seal used between a stationary supply pipe and a rotating cylinder
• Media includes steam, water, oil, coolant and air
• Also commonly referred to has rotary union
Rotary Joint Overview

• Single Flow
  – The media flows in only one direction through the rotary joint
Rotary Joint Overview

- Dual Flow
  - The media flows into and out of the rotary joint using a syphon or distribution pipe
Rotary Joint Overview

• Dual Flow – Stationary Syphon

Rotary Joint Overview

• Dual Flow – Rotating Syphon
Mounting Configurations

- Self supported joints:
  - Carbon bearings
  - Ball bearings
- External supported joints:
  - Support rods
  - Mounting brackets
  - Circular ring brackets
Self Supported Rotary Joint

Carbon Bearings

Ball Bearings

Externally Supported Rotary Joint
Rod-Supported Rotary Joint

LJ™ rotary joint for stationary syphon service

LN™ rotary joint for rotating syphon service

Overhang Bracket-Supported Rotary Joint

Internally Compensated (IC) rotary joint
Ring Bracket-Supported Rotary Joint

PT™ steam joint for stationary syphon service

Rotary Joint Head Configurations

- A wide range of head configurations is available
- In the case of new installations, the proper head configuration will permit the most simplified and straightforward pipe design
- With retrofits, a suitable head configuration means minimal modifications must be made to existing piping
Rotary Joint Head Configurations

A-type head  C-type head  T-type head

Rotary Joint Head Configurations

B-type head  B2-type head  AF-type head
Threaded Nipples

- The threaded nipple threads into the journal or journal flange and tightens as the roll rotates
- Threaded nipples are available with either tapered or straight threads

Threaded Nipples

- Tapered Thread (NPT, BSPT)
- Straight thread (UNF, NSF, BSP)
Threaded Nipples

Tapered threads seal without a gasket

Threaded Nipples

Straight threads rely on a gasket to seal the nipple to the roll
Flanged Nipples

‘Q’ Quick Release Nipple Flange

Integral Flange

‘Q’ Quick Release Nipple

- The nipple flange is bolted to the journal flange and wedges against a split ring, locking the nipple into place
Assembly Plates

• Assembly plates fit between rotary joint body and head
• Secures internal parts when the head is removed

Assembly Plates

• Assembly plates are optional on some rotary joint models (e.g., SX™ and LJ™ rotary joints)
• Assembly plates are always included on rotary joints that require packing to be tightened during installation (e.g., SNH™ and LN™ rotary joints)
Renewable Wearing Plates (Seal Plates)

- Seal plates allow the user to replace the wearing surface of the rotary joint body at a fraction of the cost of a complete rotary joint body.

Materials and Plating

- Ductile Iron
  - Standard material for most models
- Bronze
  - Used with water and brine having a high iron and mineral content
- Stainless Steel
  - Used with highly corrosive liquids and vapors
Materials and Plating

• Most ductile iron rotary joints are QPQ plated
• QPQ is a salt bath nitride that hardens the surface of the part
• “Super-B” is the Kadant Johnson term for plating
• Plating is applied to parts that are exposed to the media (e.g. nipple, seal plate, etc.)

Seal Ring Wear Parameters

• Seal Ring Load Calculations
  – Standard rotary joints
  – Internally Compensated (IC) rotary joints
  – Piston Type (PT) rotary joints
Standard Rotary Joints

Fo = Opening Force
Fc = Closing Force
P = Operating Pressure
P1 = Outlet Pressure
Fs = Spring Force

\[ F_o = 0.62P\left(\frac{\pi}{4}\right)(S^2 - S1^2) \]

\[ \text{Net } F_c = P\left(\frac{\pi}{4}\right)(S^2) - F_o + F_s \]

IC Rotary Joints

\[ \text{Net } F_c = P\left(\frac{\pi}{4}\right)(S^2 - N^2) - F_o + F_s \]
PTX/PT Rotary Joints

\[ \text{Net } F_c = P \left( \frac{\pi}{4} (C^2 - S_1^2) \right) - F_0 + F_s \]

'S1' = Seal Ring I.D.
'C' = End Cap I.D.

Why Rotary Joints Fail?

- Piping strains
- Misalignment
- Lack of attention
- Improperly repaired
- Improperly applied
Improper Piping

- Excessive force is exerted on the rotary joint body
- Excessive guide wear with self-supported rotary joints
- Deflection of the support rods with rod-supported rotary joints
- Broken fasteners in the nipple flange and journal flange

Preventing Piping Strains

- Flexible hose
- Piping support
- Proper joint installation

[Diagram of piping system with labeled parts: Inlet, Flexible Hose, Rotary Joint, Elbow, Outlet, Compound Hose]
Rotary Joint Misalignment

- A rotary joint is misaligned when the centerline of the rotary joint parts are not aligned with the centerline of the journal

Symptoms of Rotary Joint Misalignment

- Spring breakage
- Excessive key and key-way wear
- Broken horizontal syphon pipes
- Broken journal flange bolts
- Broken ‘Q’ nipple flange studs
- Flexible metal hose failures
Improving Rotary Joint Life

- Select correct rotary joint design
- Ensure proper installation
  - Rotary joint alignment
  - Flexible hose piping
- Check for visible wear
- Utilize support from Kadant Johnson

Rotary Joint Summary

- Rotary joints are used to make a seal between a stationary pipe and rotating cylinder
- Various configurations are used depending on machine design and application demands
- A seal ring is used in all designs
- Good installation prolongs life
- Preventative maintenance reduces costs
Rotary Joint Nomenclature

What It Means.

Part Number or Symbol Number

- All Kadant Johnson products have both a symbol number and a part number
- Symbol numbers identify a family of products
- Part numbers identify a unique product
- A typical symbol number will look like:
  - 2700ELSNARQ
- A typical part number will look like:
  - 16M59163
Symbol Numbers

• Will
  – Identify the size
  – Identify the type of rotary joint

• Will Not
  – Identify the connection sizes
  – Provide all the information needed to order

Part IDs

• Part ids are unique identifiers that provide all the information needed to order
• They are not derivable in the field
The Kadant Johnson Alphabet

This presentation focuses on how to use the Kadant Johnson Alphabet to identify a rotary joint or union in the field.

A

*Designates a rotary joint with 90° angle head*
The Kadant Johnson Alphabet

AI
Antimony Impregnated seal ring; resin material good up to 650° F

The Kadant Johnson Alphabet

B
Designates a rotary joint head for stationary syphon or distribution pipe service; inlet and outlet are 180° apart
**The Kadant Johnson Alphabet**

**B2**

*Designates a rotary joint head for stationary syphon or distribution pipe service; inlet and outlet are 90° apart*

![Diagram of B2 joint head]

---

**The Kadant Johnson Alphabet**

**C**

*Designates a rotary joint head for through-flow service*

![Diagram of C joint head]
**CJE**
External-mounted c-cast joint (e.g. CJED)

**CJI**
Journal inserted c-cast joint (e.g. CJID)
The Kadant Johnson Alphabet

**D**

Designates a rotary joint head for stationary syphon or distribution pipe service; inlet and outlet are on the same plane.

The Kadant Johnson Alphabet

**EL**

Extended Life rotary joint
The Kadant Johnson Alphabet

**F**

*Flanged, rather than screwed, connections on inlet and outlet*

The Kadant Johnson Alphabet

**GS**

*Green Streak seal ring; resin material good up to 550° F*
The Kadant Johnson Alphabet

H

Heavy-duty construction for high pressure service (510 psig)

The Kadant Johnson Alphabet

IC

Internally Compensated rotary joint
The Kadant Johnson Alphabet

J

Rotary joint for through-flow or stationary syphon/distribution pipe service

The Kadant Johnson Alphabet

L

Rotary joint with lugs cast on body to accommodate support rods
N

Rotary joint that accommodates rotating syphon or rotating internal pipe

P

Designates an assembly plate to hold internal parts in position when head is removed
PT

Piston-type rotary joint

Q

Quick release nipple
The Kadant Johnson Alphabet

R
Renewable wear (seal) plate

The Kadant Johnson Alphabet

S
Rotary joint that is self-supporting
The Kadant Johnson Alphabet

T

Designates rotary joint with blind head, body inlet for through-flow service

The Kadant Johnson Alphabet

WR

Ball bearing rotary joint
The Kadant Johnson Alphabet

X

Next generation rotary joints (e.g. PTX, SX, WRX)

The Kadant Johnson Alphabet

Y

Designates 150 lb ANSI flange connection
The Kadant Johnson Alphabet

Z

Designates 300 lb ANSI flange connection

### Rotary Joint Size and Model Number

<table>
<thead>
<tr>
<th>Nominal Dia. Of Nipple</th>
<th>Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>¼</td>
<td>2050</td>
</tr>
<tr>
<td>3/8</td>
<td>4038</td>
</tr>
<tr>
<td>½</td>
<td>2100</td>
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<tr>
<td>¾</td>
<td>2200</td>
</tr>
<tr>
<td>1</td>
<td>2300</td>
</tr>
<tr>
<td>1¼</td>
<td>2400</td>
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<td>2500</td>
</tr>
<tr>
<td>2</td>
<td>2550</td>
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<td>1000</td>
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<td>1050</td>
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<td>7</td>
<td>1075</td>
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<td>8</td>
<td>1150</td>
</tr>
<tr>
<td>8½</td>
<td>1150</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Kadant Johnson Numbering System

- Most rotary joints start with a 4 digit number
- First digit tells a lot about the rotary joint configuration
- Next 3 digits give rotary joint size

Kadant Johnson Numbering System

- 1000 Series – reserved for rotary joints over 6” in size
- 2000 Series – Used for lug supported sizes and self supported rotary joints with rotary syphons
- 3000 Series – Used for self supported rotary joints with stationary syphons
Kadant Johnson Numbering System

- 4000 Series – The WR and RX products (Ball bearing supported rotary unions)
- 5000 Series – Ball bearing rotary unions with rotating bodies
- 6000 Series – Rotary unions designed to be used with a shelf style bracket

Kadant Johnson Numbering System

- 7000 – Used only on 1” textile rotary joint
- 8000 – (or 80000) Internally compensated rotary joint without a thrust collar
- 9000 – Rotary joints designed to be mounted on a ring bracket
Rotary Joint Example

- 3” rotary joint size
- Dual flow, rotating syphon
- Quick release nipple flange
- Self-supported

2700ELSNARQ
Part Nomenclature

- All parts numbers contain both alpha and numeric characters
- Parts always start with the alpha characters
- Some of the common letters used are J, S, SNR, SJ
- The next three numbers are the rotary joint size like J250, S355, J980

Part Nomenclature

- The next two digits identify the part
- Common Part numbers are:
  - 01 Body
  - 02 Head
  - 03 Thrust Collar
  - 04 Nipple
  - 05 Nipple Flange
  - 06 Seal Ring
  - 07 Spring
  - 08 Gasket
  - 10 Guide/Packing Gland
  - 31 Assembly Plate
  - 16 Wear Plate
Part Nomenclature

• If the part is available in more than one configuration it will be followed by more alphanumeric characters to identify the part
• Common following letters are: Q, N, W-IC, S, or any head descriptor

Some Part Number Examples

• A thrust collar for a 3” LJ rotary joint
  – J2703
• A thrust collar for a 3” SN rotary joint
  – S2703N
• A thrust collar for a 3” LN rotary joint
  – J2703N
Some Part Number Examples

- Body for a 3500SB
  - S3501
- Body for a 2500LN
  - J2501L
- Body for a 2500SNH
  - S2501NH
- Body for a 2500LJ
  - J2501L

Dimensional References

*K*

*Size of rotary joint; nominal diameter of nipple*
M

Designation of connection for inlet or outlet; usually located in the body of the rotary joint.

---

P

Designation of connection for inlet or outlet; usually located in the head of the rotary joint.
Dimensions References

S

Syphon size for both stationary and rotating

Dimensions References

N

Distance between support rod holes in L body
Dimensions References

O

*Size of hole in the cast lugs or anti-torque device*

Thread Reference

- Thread type and hand must be specified
- Choices are:
  - NPT RH/LH
  - British RH/LH
  - Straight RH/LH
  - Metric RH/LH
PLACING ORDERS

Orders can be placed by mail, Fax, E-mail or telephone.

Orders will be processed by the Customer Service Representative (CSR) [or their backup] who is responsible for the Region the order is SHIPPING TO.

Orders should contain the following information:

- Complete “Bill To” information.
- Complete “Ship To” address – this CANNOT be a PO box.
- PO# for both “Bill To” and “Ship To” (unless they are the same).
- How is the order to be shipped – if “collect” freight via UPS or Fed EX, we must have an account number for the freight charges.
- Name of person who placed the order.
- If a new customer, phone and Fax number for the “Bill To” address.
- Quantity
- Part ID # (8 digits)
- Part # (or symbol number).
- Description of what is being ordered.
- Customer item/tag number.
- Sell price to customer.
- When does customer want material?
- Will customer accept partial shipments?
- Any Special Instructions pertaining to order.
- If a new customer:
  - Are they taxable (if not, we need a copy of their Tax Exempt certificate).
  - What type of business are they in.
Reselling your current customers

Upgrade the Existing Product

• When to upgrade?
• When product life becomes too short
• When existing product is being replaced
Upgrade the Existing Product

- Two methods of upgrades
  - Improved parts within the same line
  - New product

Improving the Existing Product

- Improve the seal ring
- Improve the gaskets
- Focus on quick release
- Syphon supports for stationary syphons
- New seal technology
Improving the Existing Product

• Upgrade the seals
  – Upgrade GS (Green Streak) Seal Rings to Antimony (Al)
    • Increases rotary joint life in many cases
  – Upgrade the seal package in water unions
    • Older W rotary unions M1 to M5 Seal Packages
    • RXs –1 to –3 seal packages

• Improve the gaskets
Improving the Existing Product

- **Quick Release**
  - Eliminates the need for RH and LH units
  - Saves customer on store room costs

  ![Tapered Thread (NPT, BSPT)](image1)
  ![‘Q’ Quick Release Nipple Flange](image2)

---

Improving the Existing Product

- **Syphon Supports**
  - Can be applied to LJ and SX rotary joints
  - Support system reduces stresses on pipe threads
  - Increases syphon life
  - Must be used with an assembly plate

![Split Wedge Syphon Support](image3)
Upgrading the Existing Product

with split-wedge syphon support

Upgrading to a New Product

• Some product lines can be upgraded to the newest in seal technology
• The J rotary joint and N rotary joint families can be upgraded to “Internally Compensated” or Piston Type rotary joints (limited sizes)
Typical LN Joint

Typical LN-IC
Typical LJ PT

Upgrading to a New Product

• Some products need to be replaced by newer technology
• All Type S rotary joint applications up to 3” should be converted to SX technology
• All Type W, and WR Fluid applications should be converted to RX technology
S to SX Upgrade

• The SX rotary joint is the replacement for the S rotary joint line
• The SX is available in sizes up to 3”
• S rotary joints on steam should be converted to SX
• Water and Oil applications should be reviewed (a RX may be a better fit)
• The SX fits in the same envelope
• Customer can reuse existing head
Fluid Applications (Water, Oil, etc)

- Kadant Johnson currently offers RX rotary unions for fluid applications

W Rotary Unions to RXs

- Historically the Type W rotary joint was our heavy duty fluid rotary joint
- It came with 1 of 4 different seal packages based on service
- Commonly found in paper mills
W Rotary Unions to RX’s

- The RX is available in 4 configurations based on service
- Currently available in sizes 3/8” through 6”

W Rotary Unions to RXs

- The conversion may require a new horizontal pipe
- New journal flanges are often needed to allow for application of STANDARD RX configurations