EXECUTIVE SUMMARY

Paper dryers are occasionally shut down for periods of time ranging from a few hours to many months. It is important that proper procedures be followed when shutting down dryers to be sure that the process is complete and appropriate for the duration of the shutdown. This white paper provides guidelines for shutting down dryers for various periods of time.

CONTENTS

Executive Summary ................................................................. 2
Introduction ........................................................................... 3
Importance of Proper Procedures ........................................... 4
Brief Stops ............................................................................. 4
Short Shutdowns ................................................................. 5
Cold Shutdowns ............................................................... 7
Extended Shutdowns .......................................................... 9
Blocking Valves .............................................................. 12
INTRODUCTION

After pressing, paper and paperboard are dried by passing over a series of steam-heated cylinders called “paper dryers”. The wet web is passed over these hot-surface cylinders until it reaches the desired moisture content, which is typically in the range of 2-8%. A multi-cylinder dryer section is shown in the following photograph.

Paper dryers can be shut down for a short period of time, for example, for clearing broke out of the machine or changing a doctor blade. They can also be shut down for an extended period of time. This extended time period can range from a few days (“cold shuts”) to several months or years (“mothballed”) or until the equipment is sold (“permanent shutdown”).

<table>
<thead>
<tr>
<th>Term</th>
<th>Duration</th>
<th>Typical Reasons for Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brief stop</td>
<td>&lt; 2 hours</td>
<td>Clear broke, change doctor blade</td>
</tr>
<tr>
<td>Short shutdown</td>
<td>&lt; 24 hours</td>
<td>Felt change, routine maintenance</td>
</tr>
<tr>
<td>Cold shutdown</td>
<td>1-10 days</td>
<td>Boiler shutdown, major machine rebuild</td>
</tr>
<tr>
<td>Mothballed</td>
<td>Months</td>
<td>Temporary capacity reduction</td>
</tr>
<tr>
<td>Permanent</td>
<td>Years</td>
<td>Permanent closure, preparation to sell assets</td>
</tr>
</tbody>
</table>

This report outlines guidelines for shutting down dryers for each of these time periods.
IMPORTANCE OF PROPER PROCEDURES

Proper procedures are important not only to protect the equipment, but also for safety. If a dryer is completely filled with condensate, its journals could crack and cause a catastrophic failure. Excessive felt tensions can cause felt rolls to fail and leaky steam valves can leave piping and dryers hot and pressurized.

BRIEF STOPS

A brief stop is one in which the dryers are stopped (not rotating), but will be placed back into service within the next few hours.

For these brief stops, the following actions should be taken:

1. The dryer bearing lubrication system should continue to operate, heating the oil and circulating it through the bearings. This will keep the bearings lubricated, it will remove moisture and debris, and it will keep the drain lines warm so the oil will not back up when starting up the machine.

2. Dryer fabric tension should be maintained during a brief stop. If the fabric tension system is automatic, simply ensure that the system has sufficient travel to accommodate the change in fabric length (fabrics tend to contract as they dry out).

3. Condensate should be completely drained from the dryers before the dryers are being stopped. This is done by reducing the steam pressure and maintaining the differential pressure as long as possible after taking the sheet off. Considering the normal amount of residual condensate in the dryers, the time for the condensing rate to fall off after taking the sheet off the dryers, and the normal condensate evacuation rates, a time of 10-15 minutes should be sufficient. There will be some heat left in the shell that will help to boil off some of the condensate as well.

4. Vacuum condensers can be used to ensure the condensate is fully drained from the dryers and to cool the dryers further.

5. Dryers with rotating syphons (syphons that are attached to the shell) should be stopped with the manhole covers in the twelve o’clock position. This should position the rotating syphons in the six o’clock position.

6. If the dryers are driven by interconnecting gears, all of the manhole covers in a section will be in the same orientation at the same time.
7. If the dryers are driven through the felt, then the manhole covers will not be in sync. Ideally, felt-driven dryers with rotating syphons should each be rotated until the manhole covers are in the twelve o’clock position. For a brief stop, even with steam on the dryers, the condensate accumulation will be relatively low (400 to 800 lbs over two hours). Rather than taking time to rotate each of the dryers after they are stopped, the dryers can be started up on crawl speed with pressure and differential pressure for a 10 to 15 minute period before bringing the dryers up to speed. This will give the accumulated condensate a chance to clear. Today, most machines that have felt-driven dryers have stationary syphons, so there is no need to rotate the dryers anyway.

8. Dryers with stationary syphons can be stopped with the manhole covers in any position (stationary syphons stay in the six o’clock position).

9. For brief stops, steam can be supplied to the dryers at a low pressure (5-10 psig) in order to keep the dryers warm and reduce the time required for startup. The dryer differential pressure should be maintained, at a low level (2-4 psig) in order to keep the condensate from accumulating in the dryers.

10. Ventilation systems should be shut off to prevent hot air from blowing on the dryer surfaces or through PV roll shells.

11. Doctor oscillators should be shut off.

12. Fabric cleaning systems should be shut off.

13. If maintenance work is to be done in or around the dryers section, the dryer drives and steam systems should be locked out.

**SHORT SHUTDOWNS**

A short shutdown is one in which the dryers are stopped (not rotating) and will remain shut down for up to 24 hours before being placed back into service. Depending on the dryer operating steam pressures, a proper warm-up procedure can be rather long, particularly if the dryers have been allowed to cool to room temperature. If the shutdown is to be fairly short (less than 12 hours), the dryers could be kept rotating at a crawl speed with low steam pressures in the dryers. This can help avoid a long warm-up period after a cold shutdown. It does, however, require that the dryer section be continuously monitored and energy is needed to keep the dryers hot. Further, this prevents maintenance work from being performed in or around the dryer section.

For these short shutdowns, the following actions should be taken if the dryers are stopped:
1. The dryer bearing lubrication system should continue to operate, heating the oil and circulating it through the bearings. This will keep the bearings lubricated, it will remove moisture and debris, and it will keep the drain lines warm so the oil will not back up when starting up the machine.

2. Dryer fabric tension should be reduced by moving the stretch roll. If the fabric tension system is automatic, simply ensure that the system has sufficient travel to accommodate the change in fabric length (fabrics tend to contract as they dry out).

3. Condensate should be completely drained from the dryers before the dryers are stopped. This is done by reducing the steam pressure and maintaining the differential pressure as long as possible (at least 10-15 minutes after the sheet is off the dryers).

4. Vacuum condensers can be used to ensure the condensate is fully drained from the dryers and to cool the dryers further.

5. Flooded dryers (as indicated by low dryer surface temperatures or high drive loads) should be inspected to determine the cause of flooding.

6. Dryers with rotating syphons (syphons that are attached to the shell) should be stopped with the manhole covers in the twelve o’clock position. This should position the rotating syphons in the six o’clock position.

7. If the dryers are driven by interconnecting gears, all of the manhole covers in a section will be in the same orientation at the same time.

8. If the dryers are driven through the felt, then the manhole covers will not be in sync. Dryers with rotating syphons should each be rotated until their manhole covers are in the twelve o’clock position. A large wrench on a dryer head bolt can be used to slowly rotate a dryer after the tension in the dryer felt has been released. As an alternative, the dryers can be left out of sync during the shutdown if they are started up on crawl speed with pressure and differential pressure for a 40-60 minute period before bringing the dryers up to speed.

9. Dryers with stationary syphons can be stopped with the manhole covers in any position (stationary syphons stay in the six o’clock position).

10. For short shutdowns, steam would normally be removed from the dryers in order to provide safe access to the dryer section. If the steam is kept on the dryers in order to keep the dryers warm and reduce the time required for startup, then its pressure should be reduced to 5-10 psig. The dryer differential pressure should be maintained, also at a low level (2-4 psig) in order to keep the condensate from accumulating in the dryers, and the syphons should be in the six o’clock position.
COLD SHUTDOWNS

A cold shutdown is one in which the dryers are stopped (not rotating) and will remain shut down for several days before being placed back into service. The machine may be left unattended during portions of cold shutdowns. Steam to the dryers will be shut off and locked out. Paper dryers should not be steam-heated during cold shutdowns. Steam heating inactive dryers wastes energy. It can also cause degradation of dryer fabrics, cause thermal bowing of adjacent rolls and frame components, and present a burn hazard to people working around the dryer section. Steam joints seal better when the dryers are rotating. If a leak develops across a seal face, there is an increased potential for steam-cutting if the dryer remains pressurized when it is stopped.

For cold shutdowns, the following actions should be taken:

1. Condensate should be completely drained from the dryers as the dryers are being stopped. This is done by reducing the steam pressure and maintaining the differential pressure as long as possible (at least 10-15 minutes after the sheet is off the dryers).

2. Vacuum condensers can be used to ensure the condensate is fully drained from the dryers and to cool the dryers further.
3. Dryers with rotating syphons (syphons that are attached to the shell) should be stopped with the manhole covers in the twelve o’clock position. This should position the rotating syphons in the six o’clock position.

4. If the dryers are driven by interconnecting gears, all of the manhole covers in a section will be in the same orientation at the same time.

5. If the dryers are driven through the felt, then the manhole covers will not be in sync. Dryers with rotating syphons should each be rotated until their manhole covers are in the twelve o’clock position. A large wrench on a dryer head bolt can be used to slowly rotate a dryer after the tension in the dryer felt has been released.

6. Dryers with stationary syphons can be stopped with the manhole covers in any position (stationary syphons stay in the six o’clock position).

7. Once the dryers are drained of condensate, the steam supply lines should be valved off and the drain lines vented. Positive shut-off valves are required. If the dryer steam supply valves do not have a positive shut-off (control valves generally are not tight shut-off valves), then the dryers could fill with condensate. If the dryer drain lines are valved off or blocked, the dryers could fill completely with condensate. Some dryer journals cannot support the weight of dryers that are full of condensate.

8. The dryers can be isolated from the main steam supply header by moving the automatic control valve(s) to the fully-closed position. Individual dryer steam group valves and manual shut-off valves for the dryer sections would normally be left open. When the main steam valve is used as the shut off, however, the shut off valve should have a “double block and bleed” system to prevent the dryers from filling with condensate. This arrangement is shown at the end of this paper. Note that the second block valve is normally the same diameter as the main valve, but the bleed valve can be much smaller.

9. Flooded dryers (as indicated by low dryer surface temperatures or high drive loads) should be opened and the condensate drained. The dryers should also be inspected to determine and correct the cause of flooding.

10. As a further precaution, vent valves from the steam sections and to atmosphere should be opened. If the steam header does not have a tight shut-off valve, but the header is vented and drained, the dryers should not get any condensate in them, provided the “drop legs” come off the top of the headers and not off the bottom.

11. It may be necessary to open drain lines on the condensate separator tanks. This would be recommended if contamination is suspected as a result of maintenance work in the dryers.
12. Dryers that are not rotating may take a slight bow (mechanical or thermal), but this bow will generally disappear when the dryers are later rotated.

13. The dryer felt tension should be removed and the felts should be visibly slack when a dryer section is shut down for a cold shutdown. If there is insufficient travel of the felt stretch roll, it may be necessary to move a hitch roll.

14. The threading rope tension does not have to be removed, provided the ropes have automatic tension control and adequate range.

15. The bearing lubrication system should continue to run even during cold shutdowns, if at all possible, to keep the bearings from corroding, to keep condensation from occurring in the bearing housings, and to flush away any debris.

16. During cold shutdowns, the circulating lubrication oil temperature should be maintained at approximately 135 F so that the oil will continue to drain properly.

17. Ventilation systems should be shut off, to prevent thermal distortion of rolls caused by hot air blowing on the dryer surfaces or through PV roll shells.

18. Doctors should be unloaded (by depressurizing the loading tubes or by manually unloading the doctors).

19. Doctor oscillators should be shut off.

20. Fabric cleaning systems should be shut off.

21. Proper lock-out / tag-out procedures must be followed for all energy sources (steam, electrical power drive motors, pneumatic, and hydraulic). Both make-up and motive steam lines must be valved off.

EXTENDED SHUTDOWNS

Long-term shutdowns are those in which the dryers are not going to be put back into service for many months or years (mothballed or permanent shutdowns). For these situations, all support systems (steam, air, lubrication, ventilation, electrical power, and water) will normally be unavailable. To prepare for this situation, the following work is required:
• Drives should be locked out.
• Electric, hydraulic, and pneumatic motors should be shut off and locked out.
• Steam should be shut off to the dryers and valves locked out.
• Dryer bearings should be protected with heavy oil.
• Dryer felts should be removed from the machine.
• Dryer surfaces should be clean, dry, and coated with a solvent-based rust preventative.

For extended shutdowns and long-term storage, the following specific actions should be taken:

1. Condensate should be completely drained from the dryers as the dryers are being stopped. This is done by reducing the steam pressure and maintaining the differential pressure as long as possible.

2. Vacuum condensers can be used to ensure the condensate is fully drained from the dryers and to cool the dryers further.

3. Dryers with rotating syphons (syphons that are attached to the shell) should be stopped with the manhole covers in the twelve o’clock position. This should position the rotating syphons in the six o’clock position.

4. If the dryers are driven by interconnecting gears, all of the manhole covers in a section will be in the same orientation at the same time.

5. If the dryers are driven through the felt, then the manhole covers will not be in sync. Dryers with rotating syphons should each be rotated until their manhole covers are in the twelve o’clock position. A large wrench on a dryer head bolt can be used to slowly rotate a dryer after the tension in the dryer felt has been released.

6. Dryers with stationary syphons can be stopped with the manhole covers in any position (stationary syphons stay in the six o’clock position).

7. Once the condensate is drained, the vacuum condenser can then be shut down.

8. Flooded dryers should be opened and pumped out.

9. The main steam supply and dryer drain lines should be valved off and blank flanges installed at the main feed point.

10. The steam supply and condensate drain flex hoses should be disconnected from each dryer to prevent any steam from leaking into the dryers or any condensate from backing up and entering the dryers.

11. The dryer bearing lubrication system should be shut off. Pumps, heaters, and coolers should be disabled and oil lines allowed to drain. Dryer bearings should be coated and protected by heavy oil.
12. For extended shutdowns, dryer surfaces should be coated with a solvent-based rust preventative protective coating. Felts have to be removed from the machine to do this. Felts that are removed will likely not be put back on the machine. They might be damaged in removing them and it is difficult to re-seam used felts.

13. As an alternative for extended shutdowns (not for mothballed machines), the dryers could be left unprotected with the felts on the machine. The resulting rust and debris on the dryers could be cleaned using doctors (if available) when the dryers eventually go back in service. The old felts could be run during this clean-up period and then replaced with new fabrics.

14. Ventilation systems should be shut off, to prevent hot air from blowing on the dryer surfaces or through PV roll shells.

15. Doctors should be unloaded (by depressurizing the loading tubes or by manually unloading the doctors).

16. Doctor oscillators should be shut off and locked out.

17. Fabric cleaning systems should be shut off and locked out.

18. Proper lock-out / tag-out procedures must be followed for all energy sources (steam, electrical power, drive motors, pneumatic and hydraulic systems).
BLOCKING VALVES

When the steam is shut off, the main shut off valve should have a “double block and bleed” system. This arrangement is shown schematically below. This arrangement prevents the dryers from filling with condensate and is the best way to isolate a dryer from the steam supply header.

Note: Dryer cylinders, steam lines, steam valves, and other steam components can be hot and under pressure. Use caution when working around these components.
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