A Southern integrated linerboard mill in the U.S. requested a white water filtration system capable of delivering up to 2,800 gpm of filtered white water for reuse on non-critical paper machine showers.

Non-critical showers include wet end showers with the exception of headbox internal showers, high-pressure showers, internal suction roll showers, and press felt lube cleaning showers. Depending on width and speed of a paper machine, flow requirements for non-critical showers can be high.

The mill had previously attempted to use competitive micro strainers for white water filtration, but the system was unreliable and failed to meet expectations.

As a result, the mill chose to place all non-critical showers on mill fresh water to prevent shower nozzle plugging. Whenever cooler fresh water is used for paper machine wet end showers, all shower water that enters the white water system must be heated to the process temperature. Since the heating process is typically accomplished using low-pressure steam, the result is significant costs to the mill.

The following equation can be used to calculate annual cost (350 operational days) of heating fresh water to process temperature with low-pressure steam:

Steam Cost for 350 Days:

\[ = \text{GPM} \times 8.25 \times \Delta T \times 60 \times \frac{\$\text{MMBTU}}{1,000,000} \times 24 \times 350 \]

Where:

- GPM = Gallons per minute
- 8.25 = Conversion factor GPM to lbs/min
- \( \Delta T \) = Difference between the inlet water temperature and process water temperature required
- $\text{MMBTU}$ = Dollars per million BTU

Using these calculations with a low-pressure steam cost of $5.00/MBTU, a flow of 2,800 GPM (4,032,000 gallons per day), an average annual fresh water temperature of 72°F, and a process temperature set point of 135°F (differential of 63°F), the annual cost to heat the fresh mill water used for non-critical wet end paper machine showers was $3.7 million.

With additional costs associated with treating incoming fresh water and the effluent treatment cost, total annual cost associated with using fresh mill water on non-critical machine showers was nearly $4 million.

The cost justified the project to remove non-critical machine showers from fresh mill water and supply with heated and filtered white water. The challenge was to provide a reliable filtration system.

To improve reliability, the system design required the inclusion of measurement sensors and a managed control strategy. These elements are typically absent in white water filtration systems used in the paper industry.

The essential measurement sensor measures suspended solids. Using the sensor as the fundamental input for the system control logic, maximum suspended solids values for the filtration equipment supply and filtrate can be established and equipment protection strategies implemented.
Filtering White Water for Reuse

A second suspended solids sensor is recommended in the filtrate piping exiting the filtration equipment to monitor and take corrective action in the event filtrate quality increases beyond the expected range. This approach ensures a stable and reliable water supply to the non-critical showers.

If the suspended solids concentration increases to the established maximum set point for either the supply into or the filtrate out of the filtration equipment, automatic valves will stop supply to the filtration equipment and direct the supply to an appropriate chest in a recirculation loop at a reduced flow.

The recirculation loop is important. It permits the suspended solids measurements to continue and the system to automatically return to normal operation as the suspended solids concentration decreases following the end of the initiating process upset.

The control strategy includes fresh water makeup to the filtrate tank in the event a process upset initiates corrective action that reduces or stops flow to the filtration equipment. This provides water supply to the machine showers during all conditions.

Figure 1 illustrates a modern paper machine white water filtration system using the design outlined here. The suspended solids sensors are highlighted in blue. The system includes a single RotoFlex resource recovery strainer and is capable of filtering up to 1,200 GPM of white water.
Incorporating the system sensors into the DCS system allows data to be collated with additional system components to develop a complete picture through the data historian. The system is now visible and trouble shooting and system optimization becomes possible based on the collected data.

Figure 2 shows typical process variations recorded by the suspended solids sensors in the supply to the filtration equipment and can be measured in real time. The scale on the left is in ppm or mg/l and the sample frequency is every minute. This chart provides an indication as to how well the filtration equipment operates as a “surge protector” against the white water system process variations. The filtrate from the RotoFlex resource recovery strainer is stable and continues to provide white water suitable for reuse on non-critical showers.

The suspended solids sensors are also useful to assist with “upstream” filtration devices such as a Saveall. In Figure 3, the effect of the Saveall vat level on the process variation is clearly identified and the information can be used to optimize the Saveall performance in a manner that would bring increased stability to the Saveall filtrate output.

This new technology allows for sensing equipment and managed control strategies in the filtration system design. The visibility of the process in allows for correlation and optimization of the system in real time. Eliminating system failures establishes confidence in the equipment and the cost savings of reusing filtered white water can be realized without risk to the machine and associated equipment.

![Figure 2](image1)

![Figure 3](image2)