How to Reduce Water Consumption in Papermaking
By Christy Hofherr, Spraying Systems Co.

In the U.S., industry uses 45% of freshwater annually. The paper industry is one of the heaviest water consumers along with the food, chemical, primary metal and refined petroleum industries.

In Canada, the largest quantity of industrial water withdrawal is made by the paper industry, accounting for 49.8% of the surface freshwater withdrawals by manufacturing industries.

In the last ten years, water costs have more than doubled in some areas causing the paper industry to take a hard look at water costs. When wastewater disposal costs are included, it is a significant expense. The average cost per 1000 gallons (3,785.4 liters) is approximately $7.00 USD, including sewer charges.

Nozzle Wear Means Water Waste
Spray nozzles are at the heart of all the applications that utilize water throughout the mill. These seemingly simple components have a significant impact on performance and operating costs in moisturizing, cleaning, lubricating, edge trimming, bleaching, knock-off, gluing and dozens of other applications.

As spray nozzles wear, their orifices become larger and, at any given pressure, the flow rate will increase. Even slight nozzle wear that can’t be detected visually can be extremely wasteful, costing tens – sometimes hundreds – of thousands of dollars annually in increased operating expenses.

Worn nozzles that spray over capacity are wasting more than water. Electricity costs will rise due to excess pump operation, and chemical consumption costs will also increase. Figure 1 illustrates just two examples of how quickly costs can rise.

**Example 1: Dryer Section Shower**
**Increased Operating Expenses (USD)**

One shower with 70 nozzles spraying a release agent on dryer felt.

<table>
<thead>
<tr>
<th></th>
<th>New nozzles</th>
<th>15% worn nozzles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>$5,335</td>
<td>$6,135</td>
</tr>
<tr>
<td>Chemicals</td>
<td>$46,800</td>
<td>$53,820</td>
</tr>
<tr>
<td>Electricity</td>
<td>$2,667</td>
<td>$3,118</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$54,802</strong></td>
<td><strong>$63,073</strong></td>
</tr>
<tr>
<td><strong>Increased expense for one shower</strong></td>
<td><strong>$8,271</strong></td>
<td></td>
</tr>
</tbody>
</table>

If you have six showers in the dry end, your costs will increase by almost $50,000 annually.

**Example 2: Knock-off Shower**
**Increased Operating Expenses (USD)**

One shower with 72 nozzles in the dry end of a press section operating 15% over capacity due to worn nozzles.

<table>
<thead>
<tr>
<th>Additional water consumption annually</th>
<th>32,908,080 gallons (124,570,640.9 liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased annual cost of water and electricity for pump operation of one shower</td>
<td>$65,156</td>
</tr>
</tbody>
</table>

If you have ten showers, the amount wasted quickly becomes over **half a million dollars** annually.
Ways to Reduce Water Consumption

#1: Replace worn spray nozzles on a regular schedule

Worn spray nozzles are a common problem in pulp and papermaking largely due to the chemicals and water being used. Many mills replace their spray nozzles annually. Depending on the number and type of spray operations, the cost of replacement nozzles can be far less than the cost of wasted water even if the nozzles are only 15 to 20% worn.

Spray Nozzle Maintenance Checklist

- **Flow Rate – Each Nozzle**
  
  Centrifugal Pumps: Monitor flow meter readings to detect increases. Or collect and measure the spray from the nozzle for a given period of time at a specific pressure. Then compare these readings to the flow rates listed in the manufacturer’s catalog or compare them to flow rate readings from new, unused nozzles.
  
  Positive Displacement Pumps: Monitor the liquid line pressure for decreases; the flow rate will remain constant.

- **Spray Pressure – In Nozzle Manifold**
  
  Centrifugal Pumps: Monitor for increases in liquid volume sprayed. (Spraying pressure likely to remain the same.)
  
  Positive Displacement Pumps: Monitor pressure gauge for decreases in pressure and reduction in impact on sprayed surfaces. (Liquid volume sprayed likely to remain the same.) Also, monitor for increases in pressure due to clogged nozzles. Visually inspect for changes in spray coverage.

- **Drop Size**
  
  Examine application results for changes. Drop size increases cannot be visually detected in most applications. An increase in flow rate or a decrease in spraying pressure will impact drop size.

- **Impact**
  
  Examine application results for premature wear of the fabric and/or paper quality problems. This can indicate an increase in impact which cannot be detected visually.

- **Spray Pattern**
  
  Visually inspect each nozzle for changes in the uniformity of the pattern. Check spray angle with protractor. Measure width of spray pattern on sprayed surface.

#2: Change nozzle material to extend wear life and ensure optimal performance

Nozzles made from harder materials generally provide longer wear life. In addition to standard materials such as brass and stainless steel, more durable spray nozzles are often available in specialty materials, carbides or with ruby orifices.

Nozzles with a synthetic ruby orifice are frequently used for web trimming because they provide superior spray precision for a sharp, crisp edge and up to 2000 times greater wear resistance than brass. In addition, the stream remains steady even in the early stages of wear.

Many solid stream shower nozzles also are available with ruby or sapphire orifices. Keeping the stream integrity high for longer time means better cleaning of the fabrics for longer time period too.

Figure 2 provides standard abrasion resistance ratios for many of these materials to help you determine if you should consider a change.

**Approximate Abrasion Resistance Ratios**

<table>
<thead>
<tr>
<th>Spray Nozzle Material</th>
<th>Resistance Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>1</td>
</tr>
<tr>
<td>Brass</td>
<td>1</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>1 - 2</td>
</tr>
<tr>
<td>Steel</td>
<td>1.5 - 2</td>
</tr>
<tr>
<td>Monel®</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Hastelloy®</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Hardened Stainless Steel</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Stellite®</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Silicon Carbide (Nitride Bonded)</td>
<td>90 - 130</td>
</tr>
<tr>
<td>Ceramics</td>
<td>90 - 200</td>
</tr>
<tr>
<td>Carbides</td>
<td>180 - 250</td>
</tr>
<tr>
<td>Synthetic ruby or sapphire</td>
<td>600 - 2000</td>
</tr>
</tbody>
</table>
#3: Reduce spray pressure if performance won’t be compromised

Although it is not always possible, decreasing pressure, which will slow the liquid velocity through the orifice, may help reduce the rate at which the orifice wears.

#4: Use self-cleaning nozzles or strainers to protect nozzles and minimize wear

In many applications, orifice deterioration and clogging are caused by solid dirt particles in the sprayed liquid. This is particularly common in systems using continuous spray water recirculation. In an average production process, recycling of water enables approximately 17 uses before discharge, as opposed to one or two uses without recirculation.

Self-cleaning nozzles feature a piston-type design. When line pressure is low, the piston retracts to purge debris from the nozzle orifice. Self-cleaning nozzles are ideal for use in showers with high-solids content in the water and also inside paper machines because of the compact design.

Strainers, or nozzles with built-in strainers, trap larger particles and prevent debris from entering the nozzle orifice or vane to significantly reduce wear.

#5: Use spray guns instead of open hoses

For clean up throughout the mill, use low-pressure spray guns instead of open hoses. You can reduce water consumption by 50% or more using spray guns. Ensuring water is “on” only when needed significantly reduces waste.

#6: Automate your chest and/or tank cleaning

Tanks and chests are often cleaned manually by workers equipped with hoses or by filling and draining the tank or chest multiple times. Depending on the chest size, these cleaning methods can use hundreds of gallons (liters) of water every time the chest is cleaned.

Automated tank cleaning systems are an effective alternative to manual cleaning. Some mills have reported saving up to $50,000 USD per year per stock chest by switching to automated cleaning.

Clean-in-place (CIP) systems use spray nozzles to provide controlled, thorough cleaning and rinsing. High-impact, fluid-driven or motorized tank washers and automated turnkey systems are other options. In addition to using considerably less water than manual and fill/drain methods, automated tank cleaning offers many other benefits.

- Faster, more thorough cleaning.
- Reduced use of costly chemicals.
- Reduced disposal costs.
- Improved worker safety.
- Reduced labor costs and maintenance downtime.

Turnkey systems integrate pumps, sensors, motors and valves designed to optimize the performance of tank cleaning nozzles. Systems can be equipped to recirculate cleaning liquid in a closed loop, allowing the reuse of a portion or all water and chemical cleaning solutions.
Ways to Reduce Water Consumption

Optimized spray systems contribute to a sustainable and profitable future

Spray nozzles are precision components designed to yield specific performance under specific conditions. Just because a nozzle is spraying doesn’t mean that it is working optimally. When your showers and/or moisturizing, coating, cleaning and web trimming operations aren’t optimized, you’re not only depleting a valuable resource, you may experience many other costly problems such as:

- Quality control issues.
- Unscheduled production downtime.
- Increased maintenance.
- Increased consumption of costly chemicals and electricity.

To ensure your system is operating at peak efficiency and not wasting water, begin with an audit of your spray system by a reputable nozzle manufacturer. An audit is typically offered at no cost and may require several hours of work.

Most experts agree that to ensure the world has enough safe water in the future, we must act aggressively now. Water conservation is becoming an imperative rather than an option.

We hope you found this white paper helpful and that you will take any additional steps required to minimize unnecessary water use. To consult with one of our experts, call 1.800.95.SPRAY.

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