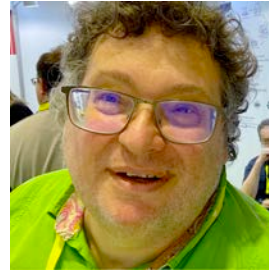


Closing Water Loops and Reducing Freshwater Consumption in Paper Mills

Fine Filtration for Reliable Reuse of Clarified Water in Spray Applications



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Water is one of the most important auxiliary materials for papermakers. Essentially, it is the solvent in which we dissolve wood. And once the water has evaporated, we have the finished paper. From stock preparation to winding, water is the papermaker's most important tool.

Ideally, paper manufacturers would use fresh water or city water, if it weren't so expensive. So, in many applications, they try to use recycled water and keep freshwater consumption as low as possible. However, clarified water and ultra-clarified filtrate are often not of sufficient quality to be used as water for spray pipes, as they contain too many fibres and particles, which cause the nozzles to clog over time.

The Jet Wing Liquid Filter from Klass is designed to remove the larger particles and fibres that can contribute to spray-nozzle blockage. The application results presented below show the separation performance achieved under specific mill conditions.

Jet Wing Liquid Filter

The Jet Wing Liquid Filter was originally developed for sewer flushing. In that application, it enabled the flushing water to be recycled repeatedly by separating solids and suspended solids. The Jet Wing Liquid Filter makes it possible to remove sinkable, floatable, and suspended solids in a single process step, even at high water flow rates.

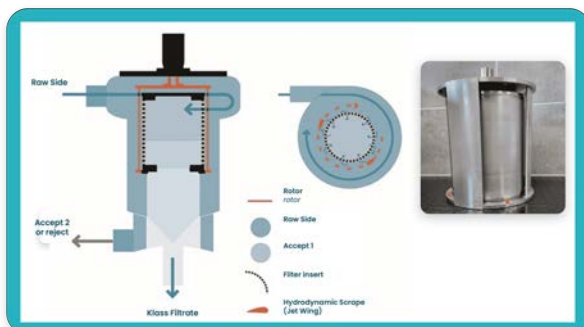


Figure 1: Schematic diagram of the Jet Wing Liquid Filter, showing a side view on the left, a top view in the centre, and the rotor on the right.

The filter itself consists of a laser-drilled filter basket with 60 µm or 100 µm holes for standard applications. A rotor, consisting of two negative airfoil profiles and two additional struts, orbits around the filter basket. It rotates around the filter basket at 1,000 rpm. This makes the filter self-cleaning; every 0.03 seconds, the filter plate is flushed clean by a negative pressure pulse. The rotor also generates high centrifugal forces exceeding 100 g.

This keeps all heavy and abrasive particles away from both the filter basket and the rotor, preventing wear. Only particles with same specific weight as water or lighter will reach the filter basket. Besides it creates a high differential speed of the water tangential to the filter basket's surface, which makes the passing of particles even more unlikely.

The Klass filtrate contains no suspended solids larger than 99 µm or 59 µm, but even particles larger than 25 µm are increasingly separated out as their size increases. Long fibres are also separated; only small fragments pass through the screen basket.

In a paper mill, many of the processes yield two types of accepts:

- Accept 1, the Klass filtrate at the outlet of the filter basket, can be used in applications such as spray pipes, spray nozzles, lubrication or barrier water where removal of larger particles and fibres is required.
- Accept 2, which did not pass through the filter basket and still contains many long fibres. This fraction is used for pulping in a pulper or dissolving drum.

For the applications described here, the reported specific energy requirement ranges from 40 to 160 Wh/m³ of Klass filtrate.

For applications evaluated by customers, reported payback periods have ranged between 6 and 18 months; the actual payback depends on the mill configuration, freshwater costs, operating conditions and the scope of the installation.



Figure 2: Jet Wing Liquid Filter in the basement of a folding-boxboard machine

Application Examples

One application of the Jet Wing Liquid Filter in paper mills is as a police filter for process water used in spray systems, where nozzle protection and water reuse can provide operational benefits. These applications have shown the best payback times.

The following case studies illustrate how improved filtration of process water can reduce freshwater demand in applications that would otherwise require fresh or municipal water.

Case Study 1 – Corrugated Base Paper Mill

In the press section, the customer uses spray pipes with nozzles 700 µm in diameter and municipal water. Previously, the customer used clear filtrate, but this caused the nozzles to clog too frequently.

On average, the three spray pipes had to be cleaned every 18 to 21 days because too many nozzles were clogging. At times, this happened as early as two days after installation.

The filtrate had a solids content of 1,878 mg/l — with particles too large and thus clogging the nozzles. So municipal water was used instead.

We provided the customer with a Jet Wing Liquid Filter equipped with a basket featuring 100 µm perforations for eight weeks and had them treat the clarified filtrate. The Klass filtrate still contained 342 mg/l of solids; 81.7% had been removed. This included all solids larger than 99 µm (see fig. 3).

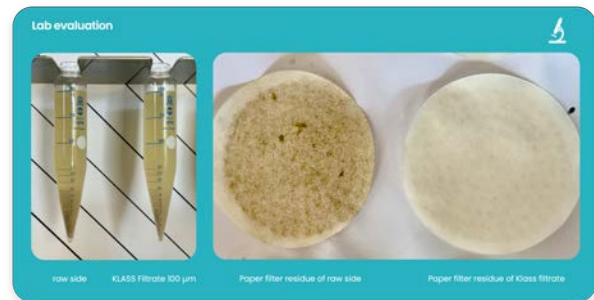


Figure 3: Feed stream, Klass filter, and paper filter residues. The large particles in the feed stream, which cause the nozzles to clog, are clearly visible on the left filter. The right filter exhibits just minute particles and fibres

For first evaluation, a 9-meter-long spray pipe was supplied with the Klass filtrate. This pipe was equipped with all the nozzles available at the plant, as well as all the nozzles desired by the paper mill. While the pipe had to be removed after just 18 to 21 days when using the clarified water, not even nozzles with a 200 µm orifice became clogged during the entire experiment when using the Klass filtrate. Thus, they achieved a service life that was at least three times longer than with clarified water.

Based on the trial results, the customer planned to redesign the water system so that the spray bars could be supplied with Klass filtrate instead of municipal water. The actual resulting cost impact depends on the mill's water consumption and local water costs, but the customer expects significant savings.

Case Study 2 – Corrugated Base Paper Mill

A corrugated base paper mill is having problems with its ultra-clear filtrate. This filtrate is only partially suitable for spray pipes. The clear filtrate passes through four sand filters and enters an ultra-clear filtrate tank. This tank can also be filled with fresh water if the flow from the sand filters is too low. At the same time, it is possible to supply the ultra clarified filtrate tank from the clarified filtrate tank. This occurs when there is an insufficient supply of ultra-clear filtrate, but the clarified filtrate is of particularly high quality.

A 10-bar line for low-pressure spray nozzles and cleaning hoses, as well as a 30-bar line for high-pressure spray nozzles are supplied from the ultra-clear filtrate tank (see fig. 4). The high-pressure nozzles frequently become clogged.

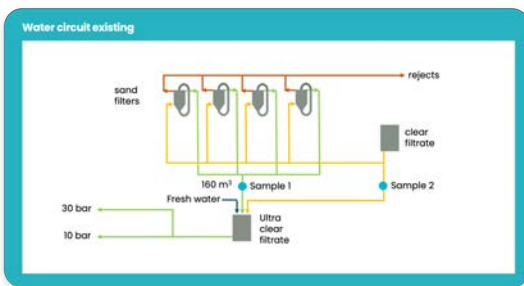


Figure 4: Original design for supplying the low-pressure and high-pressure spray pipes

Initially, the plan was to remove all contaminants from the water in the 30-bar line using a Jet Wing Liquid Filter (see fig. 5). As the project progressed, it became clear that the sand filters enhance biological activity in the system. The bacteria then contaminate the felts and forming fabrics. In addition, the required water consumption indicated that two Jet Wing Liquid Filters would be needed at times for the high-pressure spray nozzles.

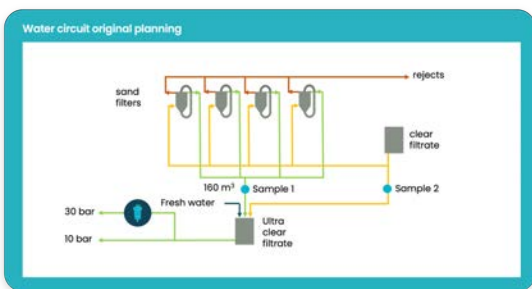


Figure 5: Planned layout for supplying the low-pressure spray lines as well as Jet Wing Liquid Filter to feed the 30-bar high-pressure spray lines

A trial showed that a Jet Wing Liquid Filter produces better water than sand filters. Based on the trial, two Jet Wing Liquid Filters were selected to replace the four existing sand filters for the required purification duty (see fig. 6). The alternative arrangement also reduces the installation footprint and separates longer fibres from the clarified filtrate so they can be returned to the pulping drum, reducing fibre losses from this stream.

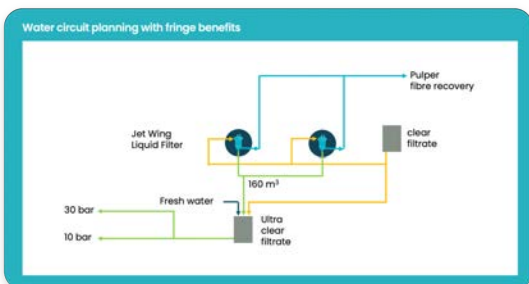


Figure 6: Modified design for the water supply system, replacing the sand filters with Jet Wing Liquid Filters to reduce biological fouling

The Klass filter will be used for all high-pressure and low-pressure spray pipes, as well as for the cleaning water.

Case Study 3 – Folding Box Board Mill

A cardboard factory uses fresh water for the spray nozzles on its screen belt presses. The quality of the clarified water is inadequate, and the nozzles clog too frequently. For this reason, municipal water was used for this application.

An initial audit revealed that the Jet Wing Liquid Filter removes all harmful particles from the clear filtrate and reduces the total particle count by over 90% (see fig. 7). Besides, 100% of big and harmful particles as well as fibres are eliminated. In the initial audit, the Jet Wing Liquid Filter reduced the total particle count by more than 90% and removed the larger particles and fibres identified as relevant to nozzle blockage in this application (see fig. 7).

The high-pressure spray bars of the belt filter presses can now be fed with the Klass filtrate.

As a follow-up, the high-pressure spray nozzles on the screens are now also being retrofitted.



Figure 7: Laboratory test with clear filtrate on the left, and results using the Jet Wing Liquid Filter in normal operation on the right.

Case Study 4 - Specialty Paper Mill

A specialty paper mill must reduce its specific freshwater consumption; otherwise, it risks losing its environmental certifications. The nozzles of the disc filter account for a good 40% of the total freshwater consumption. They can only be supplied with fresh water as they cannot be accessed for replacement while the system is running, so they must not become clogged.

We tested various types of water, and the customer decided to improve the ultra-clear filtrate using the Jet Wing Liquid Filter. The ultra clarified filtrate still occasionally contains particles that are too large, which clog the nozzles. It also contains many fibres. Until now, the ultra-clarified filtrate could only be used to break down the pulp in the pulper and

for dilution ahead of the fan pump. The rest went to the wastewater treatment plant. And with the ultra-clarified filtrate, about 0.5% of the fibres ended up in the wastewater treatment plant.



Figure 8: Filtration of the super-clear filtrate from a specialty paper mill. The turbidity caused by fibres was reduced, and all particles larger than 99 µm were removed.

The Jet Wing Liquid Filter now processes the ultra-clarified filtrate. The Klass filtrate, i.e. accept 1, is fed into the nozzles of the disc filter. The accept 2 contains the fibres and is now used to feed the pulper. This ensures that highly valuable specialty fibres are retained. Fibre purchases will be reduced by 0.5%.

Another side effect: those 0.5% of fibres accounted for one third of the paper mill's COD value.

As a result, the paper mill reduced its freshwater consumption by a good 40%, lowered its COD level by one-third, and reduced its fibre consumption by 0.5%.

Case Study 5 - Fine Paper Mill

A fine paper mill wanted to use clear filtrate for several applications, but larger particles caused nozzle blockage. An initial evaluation indicated that filtrate treated with the Jet Wing Liquid Filter could be considered for spray nozzles with openings as small as 200 µm under the tested conditions.

In this evaluation, approximately 70% of the particles were removed, including the larger particles associated with nozzle blockage. The separation characteristics are governed by the filter-basket opening and the hydrodynamic conditions described above.



Figure 9: Clarified water and Klass filtrate from a fine paper mill, as well as screen residue.

Summary

The applications show that fine filtration can expand the use of clarified or ultra-clarified water in spray systems that would otherwise rely on freshwater. The self-cleaning filter design is intended to limit maintenance requirements, while removal of larger particles and fibres support the use of smaller-diameter nozzles where process conditions permit.

The filter is continuously self-cleaned by the rotor-induced pressure pulses. For the applications described in this paper, the reported specific energy requirement is 40 to 160 Wh/m³ of filtrate.

A particular advantage is that the reject usually contains fibres and is therefore used as dilution water—thus keeping the fibres in the cycle.

Further applications may be possible where process-water quality is limited by particles or fibres and should be evaluated case by case.