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PAPER MACHINE WATER EFFICIENCY

Traditionally, water has been viewed as a virtually free commodity for most paper machines. Changing environmental and economic circumstances have made view obsolete. Understanding the sources and uses of water can lead to efficiency improvements and not just the conservation of water, but better profitability most often through energy savings.

How is water used?

An excellent overview of water sustainability in the paper industry defines three ways to drive to sustainability: reduce, reuse, and recycle. For a paper machine, the first two present fundamental ways for a paper machine to use less water.

- Reduce: tune applications to operate with lower volumes of water
- Reuse: process water mechanically or chemically as necessary to reuse it, replacing fresh water.

Water is the lifeblood of paper machines. A typical headbox can easily flow 30,000 gallons of water per minute (gpm). Most of that water stays on the machine and flows in a loop. How much doesn't, that is, how much is lost, is a fundamental source of inefficiency.

TAPPI TIP 0404-63, "*Paper Machine Energy Conservation*" indicates water consumption for top performing machines varies by grade. Pulp machines should use about 1000 gallons/ton, brown paper machines about 1,500 gallons/ton and publication machines about 2000 gallons/ton. This TIP is currently being revised and all of these numbers will go down. There are lot of mills that actually have zero water discharge. While not typical, these mills represent the possibility of using much less water and overcoming the challenges in doing so.

Typical" is a dangerous word to use to describe paper machines, because they are all unique. However to illustrate potential water disposition, consider a broad, "typical" description. Water can be considered as moving in three large loops. The first is water that leaves the headbox, is drained in the former, and goes back to the headbox as white water. Most of the water that comes to the headbox is white water, that is, water that has been drained from the sheet of paper on the former. Most of the rest comes from the high-density stock chests that supply fiber to the machine. Water can escape from the machine loops in a number of ways, some deliberate and some inadvertent. Water in the paper sheet is lost to evaporation in the dryers by design, but compared to the overall volume of water coming to the machine the volume is almost negligible, usually about 1%..

Consider that first, primary white water loop that supplies water drained from the sheet to the headbox. A 1000 tpd machine, if headbox consistency is 0.8%, would have a headbox flow of about 21000 gpm. If high density stock is supplied at 4% solids, there would be about 4000 gpm of water coming to the headbox with the stock, so 17000 gpm of water in the sheet exiting to the presses, so about 20500 gpm of white water is created by the former (21000 gpm – 500 gpm). If only 17000 gpm is needed, there is a theoretical surplus of 3500 gpm of white water not needed by the headbox (In this very simple model, that volume is the high-density water flow minus what goes to the presses). Either that water becomes effluent and is lost, or it is reused.

The second and third white water loops have two purposes. First, fiber otherwise lost in excess white water is rescued and second, water is captured for reuse in the process.

White water is usually processed through some kind of barrier filter system, commonly a save-all, which separates fiber from white water and creates filtered water, often in multiple levels of quality. Usually the clear white water is used for machine showers and other more critical applications in the wet end of the paper machine. That water defines the second loop, where most of the filtered water ends up back in the white water chest. The third loop uses less clear, cloudy white water, pushing it upstream to pulpers, washers, and cleaners, and downstream to pulpers, especially during sheet breaks. In a perfect system, most of that water theoretically ends up back in the white water system, too.

Water usually overflows from one the white water storage chest. In an ideal world, there would be no overflow, which implies a perfect balance between water entering and exiting the machine that is, using all of the 3500 gpm in the example for showering, washers, cleaners, dilution and other such application. Given the very large volumes and inherent perturbations of the process, such precision is not even remotely feasible. Since the steady-state process would not be sustainable with too little water entering, there has to be at least some excess, that is, there has to be some overflow. Most machines are designed to overflow the lowest value water, which is the water with the least amount of fiber.

How is water wasted, and how can it be saved?

One of the most baffling indications of paper machine fresh water use is flow while the machine is not operating. Paper machines are large, complicated and often evolved systems with thousands of valves. It is not realistic to expect them all to operate perfectly. The volume of down-time water use, if it is measured, is usually surprising, observed as high as 1000 gpm. Some of the most common culprits for non-productive water use are

- Agitator and pump seal lubrications
- Oil and hydraulic cooling water
- Hoses
- Vacuum pump seal water

Shaft packing water is easy to overlook because each shaft requires relatively small volumes of water, typically 3 – 10 gpm. (Larger agitator shafts might need more). This water is almost always left on during shutdowns, which serves no purpose other than to eliminate the possibility that somebody will forget to turn it back on at start-up. Except for new machines, seal and cooling water are usually on individual valves and trying to shut them all is probably not feasible with standard systems. There are a lot of seals and typical total lubrication volumes are hundreds of gpm. Beyond the cost of the wasted water, there is a thermal penalty, too. Usually the cleanest water available is used for packing lubrication, and that water is most often cold. Typically, about ½ of the water ends up migrating to the process side of the seal during operation, and therefore it is a cooling factor requiring steam heating to compensate. There are some things that should be done to minimize seal water waste, and some more expensive things that can be done to eliminate it. First, packing should be kept in good condition to avoid high clearances. Volumes to each packing should be limited. Water pressure should be regulated and individual flow meters can be used to eliminate excessive flow. Mechanical, dry seals can be used, which are more expensive but pay for themselves in the long run. Finally, re-circulating

INDUSTRY NEWS	McDonald's Germany plans to do away with plastic lids for beverage cups in favor of a paper lid with an integrated drink opening for takeout orders, the company said. W& F : KINGSLEY filter is a winning tool in terms of water conservation W&F takes necessary fumigation and safety measures in packing of fabric and screens before movement, this ensures safety at consumption end.

systems are available to recycle lubrication water and eliminate waste. Usually these systems are justifiable only in applications where water is very clear.

The coldest water available is almost always used for oil and especially hydraulic system cooling. It is not hard to understand why, because the price of failure of these systems is very high. The water is heated between 100 F and 300 F, which makes it warm but not hot enough to reach process temperatures for most machines. The water usually gets added to the hot water system of the paper machine, which makes sense because it is very clean water, but again, there is a thermal penalty to pay because it must ultimately be heated to process temperature. No rational machine operation would do this, however, because the elevated temperature would eat into oil temperature safety margins, and again, the cost of a hydraulic or oil system failure could be devastating. Cooling water typically represents hundreds of gpm. It is often left on during shutdowns, usually for the same reason seal water is left on.

Wash-up hoses are always located all over a paper machine. Even the best-run machines usually have at least one hose that is left on to flush a stray fiber stream or cool something. These hoses should only be used for wash-up.

Liquid ring vacuum pumps are perfectly suited to paper machine applications and can be found on the vast majority of Paper machines. They require a lot of water to maintain the liquid ring used to generate vacuum. A pump's size and vacuum level determine its seal water demand. A very large vacuum system can need as much as 2500 gpm. For our example 1000 tpd machine, demand would probably be closer to 1000 gpm. The vacuum pump seal water is inexplicable often not turned off during shut-downs.

Some approaches to water efficiency

Most paper machines in India are not new. Most have run for decades, and most run at high production rates undreamed of when they were built. Our traditional paradigm for water is that it is free and limitless, and there is little incentive to use less of it. If that paradigm is no longer valid, how can we change our approaches to water use? “Reduce and Reuse” provides a new, time paradigm.

Reduce

We have already discussed ways to reduce demand by being clever about vacuum pump seal water, packing lubrication and clean-up hoses. Most of the water that goes to the paper machine in the second white water loop we have discussed goes to showers. The highest volume shower on most machines is the flooded nip knockoff shower. If used continuously, it an easily consume half of the shower water on the machine. (1) Reduce shower pressure during operation. High volumes are needed only to knockoff the sheet. (2) Wash rolls, if properly lubricated and doctored, are proven knockoff devices that work at much lower water volumes than flooded nip showers, usually less than 20%.

The next-highest shower water users are lubrication showers, mostly on wire return rolls in the former. These showers lubricate doctors and keep return rolls wet to prevent build-up. The most critical cleaning showers on the machine are the high-pressure needle showers. These typically use about ½ as much water as the lubrication showers. There are two effective ways to reduce their required water volume. (1) Use smaller nozzles at higher pressure. (2) Single-jet scanning showers can apply equivalent cleaning power to full-width showers and reduce required shower flow by over 90%. They can be expensive, though, and not as simple as full-width showers.

Sometimes reducing flow is just a matter of finding open valves that should be closed or at least not fully open.

Reuse

There are two critical factors that often block the use of white water, and consequently cause its waste. These are (1) Insufficient capacity for filtration of white water to save fiber and create cleaner white water for paper machine use. (2) Insufficient quality of processed white water for paper machine use, causing substitution of fresh water.

Both of these factors are often immediately attributable to a poorly functioning or simple too small save-all. Save-alls are wonderful devices, but they are expensive. Often, inadequate save-all operation can be alleviated by adding simpler mechanical filtration devices to both save fiber and create better water for machine use. These strainers can be used in parallel with save-alls or downstream of clear or cloudy wave-all legs to make more clear or ultra-clear water for use in machine showers. Such approaches have been successful in enough mills to make them state of the art. They are very valuable to economically make up for paper making systems that have simply outrun their save-alls, or for save-alls that are far past their most efficient years.

QUOTABLE QUOTE	“To succeed in life, you need two things: *IGNORANCE and CONFIDENCE*.” — Mark Twain
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WINNER MAY 2023	No Correct Answer Answer : LIGHT ABSORBTION
?QUIZ email answers by 25th June’ 23	QUIZ: __________ is a measure of the power input to the motors of the refiner based on the amount of pulp processed. It's an indirect measure of the energy spent in cutting. (a) Refining power (b) Actualization power (c) Compartmentalization power (d) Degree power
WINNER MAY 2023	Quiz: A long-chain molecule composed of two different types of monomer units (a) Dual polymer (b) Enzyme (c) Copolymer (d) Polymerization Mr. Ganesh Bhadti, Director, M/s Seshasayee Paper & Boards Ltd, ERODE, Tamilnadu Answer : (b) Copolymer
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