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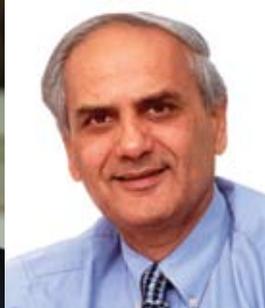
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By BRIAN DUFFY and STEVE HOEFS

The best way to minimize capital investment during water optimization is to proceed logically through a step-wise planning process

ESSENTIAL EXPERTISE FOR WATER

The issue of mill closure, or water optimization, is a common concern globally throughout the pulp and paper industry. While it is the case that most mills have accomplished some degree of closure, some mills practice water optimization either to comply with existing government regulations, or because they lack sufficient water resources. Mill closure concerns both papermakers and suppliers because it is not truly known what it means or where it will lead. Most systems can tolerate a certain amount of water closure. However, the real battle begins when the level of system contaminants, which increases with closure, negatively affects productivity and product quality. Unfortunately, the point at which this happens cannot be predetermined. Thus, it is important to know your system so that, when changes start to occur, a mill can react appropriately. Water use optimization can involve a significant investment of time and money. The level of capital equipment expenditures can be reduced if the level of water reuse within the mill is addressed as a first step. In this article two new technologies will be identified that are designed to help today's papermakers meet challenging water closure targets by minimizing fresh water usage without sacrificing quality and negatively impacting productivity.

SYSTEMATIC APPROACH TO MILL CLOSURE

As referenced earlier, water optimization can involve a large amount of investment in time, resources, and money. It takes time to learn the system and its parameters, and to observe the results of changes made during the project before subsequent actions are taken. Financial investment will eventually be required,

with the amount dependent on the project depth. Equipment options are often the first consideration in a water optimization project. Before major capital is expended, a mill can perform some very basic actions to progress towards improved water resource management. Some are considered best practices while others are slightly more complicated. Once these actions are taken, at that point equipment options can be evaluated. Proceeding through a step-wise process will help the mill realize its water optimization goals while minimizing capital expenses, operating costs and downtime, but still maintain productivity and finished product quality.

Mill closure, as it is known today, is now widely being investigated so there is more comparison data becoming available. Any data that is available is subjective, however, based on who is providing it.

Some mills calculate closure based on the influent and effluent flows of the mill. The average effluent flows can look very different in varying regions of the world even when producing similar grades of wood-grade paper. This data can also look very different for mills producing virgin linerboard, recycled paperboard and printing and writing grades using bleached virgin fiber.

Table 1 provides background information on the amount of fresh water used per ton of paper made. Included for reference in the table are figures for North American linerboard mills surveyed by Nalco. Additionally, Tables 2-3 provide information on the North American water consumption for unbleached board and bag mills, and paper mills producing mechanical pulps, as provided by the Lockwood-Post's Directory of the Pulp, Paper and Allied Trades.

Mills in North America currently are consider-

ing more source point reduction and in-process treatments to reduce or minimize the amount of wastewater treatment. If water optimization can be done within the process, it will reduce the overall cost of the project because smaller and less expensive types of equipment can be used both in the process and wastewater treatment plant. Figure 1 shows the total water consumption per ton of paper produced for 63 North American linerboard mills using FisherSolve.

Parameter Measured	Open (11 Mills)	Closed (6 Mills)
Water usage (average)	4,639 gal/ton 19.4 m ³ /tonne	173 gal/ton* 0.7 m ³ /tonne*
Headbox conductivity (µohms)	1,000 – 3,000 (2,250 average)	1,600 – 18,000 (7,550 average)
Utilization of a DAF process clarifier (No. of mills)	7 of 10 (1 unknown)	All 6
pH	30% acid 38% neutral 32% alkaline	20% acid 60% neutral 20% alkaline
Size	22% AKD 23% Rosin 41% ASA 14% none	40% AKD 43% ASA 17% Rosin

* Three of five mills were zero discharge. The exact figure for one of the closed mills was unknown so it was not included in the average.

Table 1 - PARAMETER CHANGES IN OPEN VERSUS CLOSED NORTH AMERICAN RECYCLE LINERBOARD MILLS

IMPLICATION OF CLOSURE ON CHEMICAL PROGRAMS

Closing a water system often leads to an increase in dissolved and suspended solids, an increase in temperature and a reduction in dissolved oxygen. If these conditions are not addressed, the mill will suffer a loss in productivity and product quality.

Water chemistry plays a major role in retention aid effectiveness. In general, high salt concentrations interfere with the adsorption of polymeric additives onto the fiber and fines surfaces. This can reduce the effectiveness of retention and drainage programs as well as the adsorption of strength aids such as dry strength additives and cationic starch. An increase in water conductivity from 1,000 to 10,000 µohms due to system closure can reduce absorption of cationic starch by as much as 80%.

It is also the case that the level of dissolved oxygen in water decreases as the temperature rises. When a mill increases water reuse, an increase in temperature of 10°F or more is common. This change in environment causes a shift in the microbial population from aerobic bacteria to facultative or obligate anaerobes. Problems associated with anaerobes in paper systems include corrosion, formation of explosive or toxic gases and odors in the finished sheet.

The shift from an oxidizing to reducing environ-

Category	Mills reporting water use	Mean water use	Median water use	Highest water use	Lowest water use
repulping of preconsumer and post consumer wastes	81	5,432 gal/ton 22.7 m ³ /tonne	2,632 gal/ton 11.0m ³ /tonne	83,276 gal/ton 348 m ³ /tonne	0 gal/ton 0 m ³ /tonne
repulping of preconsumer and post consumer wastes + coating	18	3,039 gal/ton 12.7m ³ /tonne	2,919 gal/ton 12.2m ³ /tonne	7,490 gal/ton 31.8 m ³ /tonne	36 gal/ton 0.15 m ³ /tonne
semi-chemical pulping	15	5,312 gal/ton 22.2 m ³ /tonne	4,116 gal/ton 17.2m ³ /tonne	22,183 gal/ton 92.7m ³ /tonne	909 gal/ton 3.8 m ³ /tonne
unbleached kraft pulping	24	12,156 gal/ton 50.8 m ³ /tonne	11,080 gal/ton 46.3 m ³ /tonne	29,362 gal/ton 122.7 m ³ /tonne	3,183 gal/ton 13.3 m ³ /tonne
unbleached kraft pulping + coating	1	8,328 gal/ton* 34.8 m ³ /tonne*			
unbleached kraft pulping + Semi-chemical pulping	5	9,859 gal/ton 41.2 m ³ /tonne	6,581 gal/ton 27.5 m ³ /tonne	20,628 gal/ton 86.2 m ³ /tonne	6,246 gal/ton 26.1 m ³ /tonne

* denotes a meaningless number because calculation based on one mill.

Table 2 - WATER CONSUMPTION FOR NORTH AMERICAN UNBLEACHED BOARD/BAG MILLS

ment also affects the efficacy of certain biocide chemistries. This, coupled with the change in microbial population, results in the need to review and change the microbiological control program.

Obtaining and maintaining acceptable levels of small particle retention becomes critical for mills as systems become more and more closed. One example of small particle management is preventing or minimizing pitch outbreaks. Whether in the paper mill or the pulp mill, the ultimate point of exit for contaminants from the process is the finished sheet. Recent studies have shown that successful management of small particles, like pitch, in closed systems may require unique combinations of treatment pro-

grams and feed points to prevent the contaminants from aggregating and depositing throughout and later in the process.

NEW PARETO MIXING TECHNOLOGY

This technology from Nalco optimizes chemical injection into a process pipe and allows mills to optimize fresh water use. The design parameters are based on computational fluid dynamics modeling and Nalco's best application practices. This patented technology has been confirmed in hundreds of commercial installations globally. It is applicable to most chemical injections and is especially applicable to high molecular

Category	Mills reporting water use	Mean water use	Median water use	Highest water use	Lowest water use
mechanical pulping, none or reductive bleaching, no deinking, no coated broke	6	8,639 gal/ton 36.1 m ³ /tonne	7,179 gal/ton 30.0 m ³ /tonne	13,306 gal/ton 55.6 m ³ /tonne	4,762 gal/ton 19.9 m ³ /tonne
mechanical pulping, none or reductive bleaching, no deinking, coated broke	3	23,164 gal/ton 96.8 m ³ /tonne	17,804 gal/ton 74.4 m ³ /tonne	39,245 gal/ton 164 m ³ /tonne	12,539 gal/ton 52.4 m ³ /tonne
chemimechanical pulping, none or reductive bleaching, no deinking, no coated broke	13	21,441 gal/ton 89.6 m ³ /tonne	17,277 gal/ton 72.2 m ³ /tonne	78,490 gal/ton 328 m ³ /tonne	2,225 gal/ton 9.3 m ³ /tonne
chemimechanical pulping, none or reductive bleaching, no deinking, coated broke	1	35,656 gal/ton* 149 m ³ /tonne*			
mechanical pulping, peroxide bleaching, no deinking, no coated broke	7	18,905 gal/ton 79.0 m ³ /tonne	16,799 gal/ton 70.2 m ³ /tonne	54,321 gal/ton 227 m ³ /tonne	1,292 gal/ton 5.4 m ³ /tonne
mechanical pulping, peroxide bleaching, no deinking, coated broke	3	10,457 gal/ton 43.7 m ³ /tonne	10,816 gal/ton 45.2 m ³ /tonne	13,664 gal/ton 57.1 m ³ /tonne	6,892 gal/ton 28.8 m ³ /tonne
chemimechanical pulping, peroxide bleaching, no deinking, no coated broke	1	50,732 gal/ton* 212 m ³ /tonne*			
peroxide bleaching, no deinking, coated broke	0				
mechanical and/or chemimechanical pulping, none or reductive bleaching, deinking, no coated broke	20	12,731 gal/ton 53.2 m ³ /tonne	11,678 gal/ton 48.8 m ³ /tonne	24,648 gal/ton 103 m ³ /tonne	3,972 gal/ton 16.6 m ³ /tonne
mechanical and/or chemimechanical pulping, none or reductive bleaching, deinking, coated broke	1	18,163 gal/ton* 75.9 m ³ /tonne*			
mechanical and/or chemimechanical pulping, peroxide bleaching deinking, no coated broke	5	10,577 gal/ton 44.2 m ³ /tonne	11,175 gal/ton 46.7 m ³ /tonne	13,839 gal/ton 58.0 m ³ /tonne	4,977 gal/ton 20.8 m ³ /tonne

* denotes a meaningless number because calculation based on one mill.

Table 3 - WATER CONSUMPTION FOR NORTH AMERICAN MILLS PRODUCING MECHANICAL PULPS

weight polymers as is encountered in water treatment applications and/or products being fed in the top of the chest (dripped in open tanks) such as defoamers, sizing agents and coagulants (organic and inorganic).

PARETO Mixing Technology can help reduce chemical consumption through more effective mixing in the process stream by as much as (10%-40%) and by the potential to move the chemical addition points to a lower shear area (where applicable). This technology also allows the use of process water to replace fresh water for secondary dilution to reduce energy costs and conserve water. Mill water reuse targets can be achieved with PARETO installations across multiple applications.

The benefits of the technology in waste water treatment can include improving system performance and operational stability by:

- Increasing cake solids
- Optimizing injection system (device/feedpoint)
- Less variability on system
- Reducing effluent solids

CASE STUDY: LINERBOARD & MEDIUM

Grade: Linerboard and corrugated medium

Basis Weight Produced: 23 to 45 lb/1,000ft²

Machine Type: Two-ply fourdrinier (70:30)

Production Rate: 72 tons/hr

Machine Speed: 2,000-3,000 ft/min

Furnish: 100% recycled

pH: 6.8

Business situation: A recycled linerboard and corrugated medium mill wanted to capture the benefits of running RDF chemistry post screen and reducing fresh water usage. These benefits include chemical efficiency, drainage, production and process reliability. In the past, post screen RDF chemistry created variability in the process due to poor mixing. The end result was paper machine breaks.

In an effort to assist the mill with their key business drivers, Nalco proposed installing PARETO Mixing Technology post screen on the base ply for both the flocculant and microparticle retention aids. In addition to the aforementioned benefits of running RDF chemistry post screen, the technology also al-

lows use of filtered white water for secondary chemical dilution. The net result is improved drainage, reduced freshwater usage and energy savings from not heating cold water. Additionally, Nalco reports water and energy savings environmental return on investment (eROI) values to customers to account for contributions in delivering both environmental performance and financial payback. The eROI results for this mill application are:

1. 24% reduction in flocculant dosage without loss in tray solids
2. Production increase of 1.4% or 1.0 ton/hr
3. 8% reduction in Base ply ASA usage with a 26% improvement in variation
4. 21% reduction in anti-skid chemical usage
5. Fresh water reduction of 28,000,000 gal/yr
6. Energy reduction associated with heating fresh water, >15,000 MM Btu/yr
7. Water and energy savings >\$100,000/yr.

3D TRASAR® TECHNOLOGY FOR COOLING WATER

Fresh water is commonly utilized as a make-up water source for open recirculating cooling towers to compensate for water losses due to evaporation and cooling tower blowdown. As mills close up, alternative sources of cooling tower make-up have begun to be utilized; reclaimed process water, as a result the stress being placed on the cooling water systems can dramatically increase. When system stress is too high, scale, corrosion and fouling can occur, resulting in a loss of heat transfer at the process interface and subsequent process inefficiency.

Nalco's 3D TRASAR Technology optimizes system performance and prevents operational problems by constantly measuring key parameters related to system stress, identifying changes in system conditions and taking appropriate corrective actions to address the varying process demands thereby maintaining clean heat transfer surfaces throughout the cooling water system, which minimizes operational costs.

3D TRASAR Technology for Cooling Water is designed to deliver superior performance, system efficiency, and asset protection, and can address the following operational concerns:

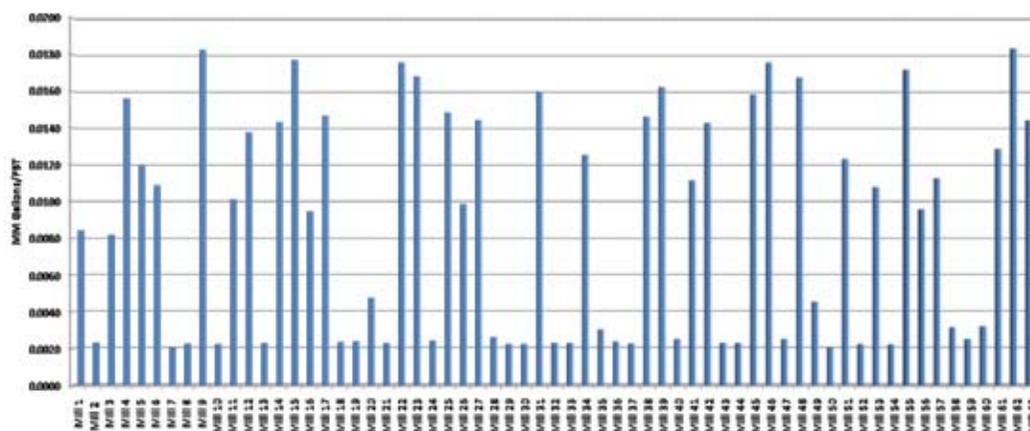


Fig. 1 - WATER CONSUMPTION FOR NORTH AMERICAN LINERBOARD MILLS

- Maximize cooling tower scale and corrosion protection via real time TRASAR® chemical control technology.
- Monitor scale and corrosion stress conditions via the use of “tagged” chemistry and Nalco Corrosion Monitor (NCM) and adjust treatment programs to address changes in those conditions.
- Improve cooling tower operation/control, water quality and heat transfer surface cleanliness and efficiency.
- Improve water and energy savings by allowing for maximum control of cooling tower cycles.

CONCLUSION

The best way to minimize capital investment during water optimization is to proceed logically and slowly through a step-wise planning process. People throughout the mill need time to observe the results of any changes. These changes can be as simple as the removal of a fresh water source, movement of water to other locations, or the addition of a mechanical or chemical application. By making too many changes at once, positive results can easily be obscured by the negative impact of another change. Furthermore, a mill may be able to realize its water optimization goals before the main recycle project is tackled, thus minimizing capital investment.

Along with closure comes the need to re-evaluate many of the chemical additives and treatment pro-

grams used throughout the mill. Changes in water chemistry and solids loadings also can impact the performance of most papermaking additives. **PPI**

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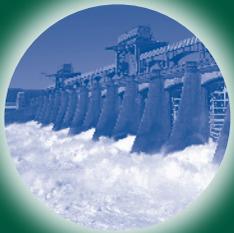


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Nalco – Your partner for sustainable growth

Cost reduction is a key business driver for every papermaker.

Nalco solutions are specially designed to deliver cost improvement, while reducing environmental impact.



Water usage

- ◆ System closure
- ◆ Shower optimization
- ◆ Additive dilution
- ◆ Water management

Energy savings

- ◆ Felt performance
- ◆ Press dewatering
- ◆ Boiler efficiency

Nalco's key solutions

PARETO mixing technology
NAL-TEX® advanced cleaning
3D TRASAR® technology for cooling and boiler water
VELOX® press dewatering
Integrated Water Management (IWM)

Value delivered

Water reuse

GRADE: uncoated fine paper

APPLICATION: PARETO

- ◆ increased production by reducing wet-end breaks
- ◆ reduced fresh water usage: 105,000 m³/year
- ◆ estimated annual savings: US\$3,400,000

Steam savings

GRADE: coated fine paper

APPLICATION: VELOX

- ◆ increased machine speed from 1,150 to 1,200 m/min
- ◆ estimated annual savings: US\$1,500,000

Water & energy savings

GRADE: board

APPLICATION: 3D TRASAR technology

- ◆ real-time monitoring and control
- ◆ reduced acid cleaning frequency by 50%
- ◆ eliminated unscheduled shutdown
- ◆ estimated annual savings: US\$30,000

Waste water recycle

GRADE: gypsum liner

APPLICATION: Waste Water Treatment

- ◆ improved end product quality by eliminating chlorine ions from waste stream
- ◆ enabled 16,000 m³ per day of waste water to be recycled to papermaking process

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