Meadow Lake marks fourth year of zero liquid effluent pulping

DONALD G. MEADOWS

Modifications and improvements contribute to mill's success.

It's a three-hour drive from Saskatoon to Meadow Lake in northwestern Saskatchewan. Along the way, stalks of barley, wheat, sorghum, and other grains sway in the breeze. Each field releases a distinct smell that you move through one-by-one along the highway. Sun-warmed leaves and husks give voice to the wind, blending with bird songs and insect chatter to form a prairie chorus.

At first, a pulp mill would seem out of place among the patchwork of farms that spread out to the far horizon. As you work your way north, however, you start to move into the boreal forests. Then the logic of plopping a brand new 240,000-a.d. metric ton/year pulp mill in the midst of prairie farms becomes apparent, especially if the mill draws little water.

When it began operation in February 1992, Millar Western's Meadow Lake pulp mill was unique. It was designed to produce hardwood bleached chemi-thermomechanical pulp (BCTMP) and to have zero liquid effluent. No other mill had yet succeeded in achieving zero liquid effluent, but Millar Western—working with NLK Consultants—took a conservative gamble that it could be done.

"The given in this project was to go with proven technology," said Bob Leslie, mill manager. The company looked at membrane technology, freeze crystallization, evaporation, and biological treatment as options for handling effluent at the new mill. "We knew evaporators would work," he said, so design studies focused on that option.

A pilot evaporator was set up at Millar Western's Whitecourt mill to confirm that different liquors could be concentrated effectively. Samples were also sent for testing to Resources Conservation Co. (RCC), the manufacturer of the evaporator system that would be installed at the new mill.

"The performance of the 'zero liquid effluent' process has continually improved since startup," said Bryon Reid, the mill's steam and recovery manager. Production has increased from 240,000 to 280,000 tons/year. Likewise, the effluent processing capability has been steadily improved over the four years since startup. Mill operators have learned how to deal with problems such as foaming and fouling in the evaporation system. Data from process control and measurement systems have contributed to improved performance, also.

Millar Western's Meadow Lake pulp mill

Farms blanket the southern prairies of Canada

Grain elevators in the town of Meadow Lake

Bob Leslie, mill manager

Hymac refiners are kept clean as new

The process control room

The hardwood pulp produced at Meadow Lake is totally chlorine free (TCF), bleached using an alkaline peroxide process (APP). Both the Whitecourt and Meadow Lake mills use alkaline peroxide chip treatment rather than alkaline sulfite treatment for impregnation. The process was developed from a similar process patented by Scott Paper.

The APP process involves three cycles of high compression chip squeezing in plug screw feeders, followed each time with chemical impregnation of the chips. Final bleaching takes place in a conventional bleach tower.

About half the pulp is used for tissue and towel grades worldwide. The other half is used by printing and writing grade manufacturers, mostly in Europe—especially Germany—Southeast Asia and the United States.

7. Vapor recompressor

9. Meadow Lake's only discharge

8. The pulp finishing line

10. Sodium carbonate smelt bricks

The wood supply

Meadow Lake uses aspen exclusively as its pulp furnish. That allows it to bleach to a higher brightness and compete with kraft pulp, Leslie said.

Mistik Management—a forest management company created by NorSask Forest Products and Millar Western Pulp in 1990—supplies sawmill and pulp wood to the two partners. NorSask uses the softwood and Meadow Lake uses the hardwood. Mistik has access to about 3.3 million hectares of provincial land, about half of which is productive forest.

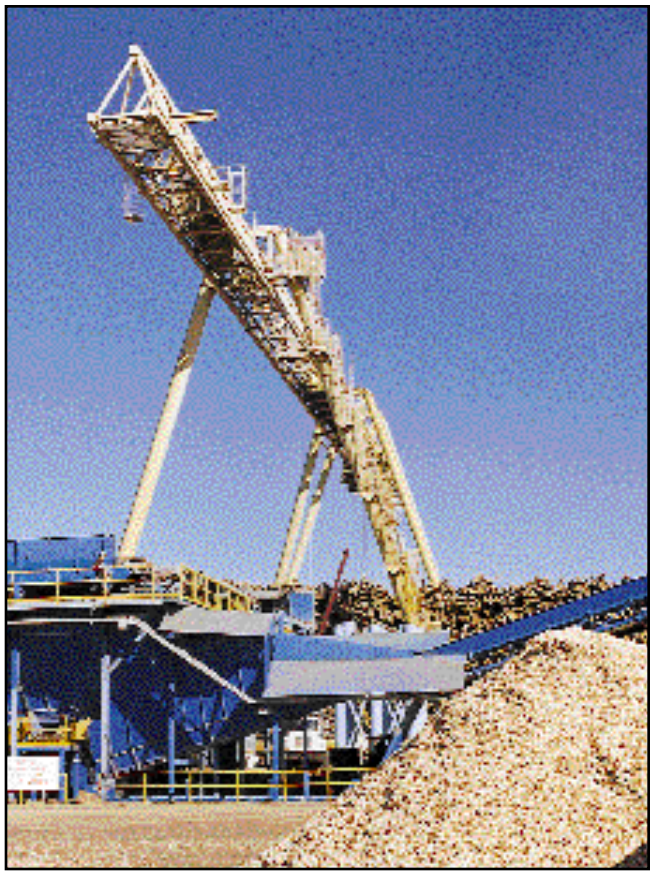
Through co-management boards, aboriginal communities within the region work with Mistik's forest managers to plan harvesting, hauling, and reforestation operations.

Mistik puts a lot of effort into maintaining healthy, productive forests that also serve other social needs.

One facet of that concern is a demonstration forest area established by Mistik along Alcott Creek, about 40 km south

A-frame chip storage under construction

The portal crane and woodyard



of town. The site includes a 7-km driving trail and a 2-km recreational trail. Both are marked with interpretive signs and visitors can arrange for a guided tour of the forest area. The trails are especially oriented toward families and school groups.

The mill itself has become something of a tourist attraction for Meadow Lake. The local chamber of commerce conducts mill tours on a fairly regular basis, Leslie said.

The lab, in particular, is the envy of visitors from other mills. It is used for research as well as operational support. Analytical equipment includes a gas chromatograph-mass spectrometer, an ion chromatograph, a Fourier transform infrared spectrophotometer, an atomic absorption spectrometer, and more standard pieces. Tests performed in the lab can identify a multitude of organic compounds. The ion chromatograph has been useful for tracking chlorides. The information can be used to combat corrosion and scaling.

Changes here and there

Although the mill has been a success from Day 1, adjustments have been made here and there. To a certain extent, parts of the mill were over-designed. The retention ponds, for example, ended up being bigger than necessary, said Reid.

As a consequence, large amounts of sludge and organic material accumulated in the settling and water recovery ponds. That led to an odor problem caused by anaerobic bacteria growing in the ponds, Reid explained. It was also expensive to dispose of the sludge.

To address the problem, a water recovery pond aeration system was installed and the settling ponds were taken out of operation. "All suspended material is now carried through the water recovery pond, evaporators, and concentrators to be incinerated in the recovery boiler," Reid said. As an added benefit, the water recovery pond agitation increases the heat loss from the water. That reduces the load on the cooling tower, which had been exceeding design capacity during the summer.

As Leslie likes to say, the water recovery plant runs by physics, not biology. A lot depends on heat balances and controlled use and reuse of water and steam. "The heat balance was a significant thing to learn about," Leslie said.

During spring and summer, the mill produces more steam through incineration of concentrated liquid effluent than it can use. A heat exchanger has been added to one of the mill's two flash dryers to make use of that extra steam. The result is an 18% savings in natural gas use and a capacity increase. A steam accumulator and improvements to the steam distribution control system should result in additional savings, Reid expects.

As pulp mill capacity increased, the cooling tower was being pushed to its limit during summer months. To avoid possible production restrictions during 1995, cool water from the water storage reservoir was routed to the reflux and concentrator vent condensers to dissipate some of the heat.

The cleanest distillate fraction condensed from the three falling film mechanical vapor recompression (MVR) evaporators is referred to as the "mids." That fraction is cooled by heating the evaporator feed, Reid explained. A change from the original design has been to reconfigure the "mids" cooler as a 2% effluent feed preheater, he said. That helped reduce cooling water flow and made the effluent preheating easier to control. The reconfigured cooling system also allows better control of distillate temperature during the winter, which should improve chemical treatment effectiveness.

Cleaning the effluent

Originally, the mill used one Bird Centrifilter pressure screen to remove coarse debris and residual fiber from the effluent before the evaporation stage. Any time the screen was bypassed because of fouling or damage, evaporator performance dropped sharply, Reid reported. To maintain evaporator performance, a second pressure screen was installed parallel to the first to serve as a backup.

"When the mill started up, all of the effluent was processed by the flotation clarifier," Reid explained. About 35 ppm of polymer was used to lower accepts TSS to acceptable levels. But that was expensive. As it turned out, one effluent stream equal to about half the total volume was relatively low in TSS, Reid said. By diverting that directly to the evaporator feed, the mill was able to reduce its polymer costs by 50%, with no adverse effects, he said. For awhile, the mill was able to lower the polymer dosage to as little as 6 ppm. Eventually, however, increasing pulp mill production pushed the recovery boiler nearly to its limits. To decrease solids throughput, the polymer dosage has been readjusted to 20 ppm.

Both the Meadow Lake and Whitecourt mills use sodium silicate as a peroxide stabilizer and buffer during the bleaching reaction. Both have experienced problems with silicate scaling. At Meadow Lake, silicate-based deposits—as well as organic and carbonate foulants—are a particular concern for the evaporators. Chemical, high pressure and dilute effluent washes have all been effective in restoring evaporator capacity.

As a further step to reduce fouling in the MVR evaporators, all three concentrate total solids from 2% to 35%. That's a switch from the original setup in which effluent was concentrated from 2% to 8% total solids in two parallel MVR evaporators. The supernatant was further concentrated to 35% in a lag MVR. Although the new regimen consumes more power, that's offset by the reduction in fouling, the elimination of foaming, and an increase in evaporator run times of 30–40 days beyond 100% design capability, according to Reid.

"The 35% effluent liquor from the MVR evaporators is raised to 68% in two falling film steam driven concentrators," Reid said. These have also been reconfigured to operate in parallel rather than in series. That has reduced downtime for boilouts.

Working with water

Even though the mill recirculates water, a certain amount is lost through evaporation from the ponds, flash drying, and venting. To makeup for the loss, the mill adds from 2 to 2.5 m^3/a.d. metric ton of water from Meadow Lake. (That compares with 20–25 m^3/a.d. metric ton at other BCTMP mills and 60–100 m^3/a.d. metric ton at kraft mills, Leslie noted.) The lake water is clarified and used for potable water, boiler feed water, chemical dilution, cooling tower makeup, and pond replenishment, Reid explained.

Additional steps have also been taken to conserve water. Those efforts have reduced water and effluent purges to less than 10 m^3/a.d. metric ton, from a design rate of 15 m^3/a.d. metric ton.

Still other changes have occurred in the area of water treatment. Part of the initial mill design included a cold lime softening process for water drawn from nearby Meadow Lake. By limiting the volume of lake water drawn into the distillate equalization ponds, the total hardness of the combined distillates is kept to 40–60 ppm. That has allowed the mill to decommission the lime-softening equipment.

In addition, the lake water contains a lot of organic matter that exceeds the recommended levels for the mill's reverse osmosis (RO) units. The RO units performed well at first, but then started fouling after a few months of operation. Chemical washes were marginally effective. A "flush" with zeolite feed water has so far worked best to address the problem, Reid said.

Recovery boiler modifications

Although everyone involved was confident back in 1992 that the operation would be successful, there's always an element of uncertainty. Several unknowns involved the recovery boiler.

The Babcock & Wilcox recovery boiler installed at Meadow Lake was specifically designed to handle the mill's sodium-based concentrate. It is one of the smallest units built by the company, measuring 3.65 m by 4.25 m by 30 m high. It has a design capacity of 225 metric tons/day of dry solids. It was built tall to ensure that flue gas vapors would cool sufficiently, Reid noted.

Soon after startup, the recovery boiler had some problems with excessive carryover and fuming. Replacing the steam atomized burners with splash plate liquor guns took care of the carryover problem, Reid said. Increasing the air penetration into the furnace has also improved combustion of concentrate.

However, because of the compact size of the furnace, the spray patterns off the four splash plates proved ineffective. Buildups developed on the furnace walls, resulting in poor smelt bed control. After reconfiguring the furnace last March so that only two splash plates are used, the operation of the recovery boiler was significantly improved, Reid said.

All dissolved wastewater solids are incinerated in the recovery boiler. The recovery boiler smelt and precipitator ash serve as the purge for inorganic salts, Reid said. Molten smelt is cooled and formed into ingots on a moving conveyor that dumps the ingots in a collection area outside the building.

A water spray header was installed to spray a mist of water on the bottom of the ingot trays. That helps quench and solidify the ingots, making removal easier. For the time being, the ingots are being landfilled for later recovery.

Millar Western is a family-owned group of companies. It traces its roots back to 1906, when J.W. Millar opened a blacksmith shop in North Battleford, SK, about halfway between Meadow Lake and Saskatoon. Headquartered in Edmonton, AB, the corporation now has forest products, construction and chemical operations at several locations in Alberta and Saskatchewan. The company received environmental awards in 1991 and 1993. Its Whitecourt mill was the first in North

America to be certified to the British Standard 7750 for environmental management systems—a precursor to the ISO 14000 series. Both Whitecourt and Meadow Lake are ISO 9002 certified.

With the success of the Meadow Lake operation, Millar Western and NLK are together marketing the zero liquid effluent technology through the Zerotech company, headed by Robert O. Ward. Uniforêt's Port Cartier pulp mill in Quebec is a recent convert to the technology (see related story, p. 69).

Meadows is editor of Tappi Journal.

An overview of pulping operations at Meadow Lake

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A detailed report on Millar Western's Meadow Lake pulp mill appeared in *Tappi Journal* four years ago (Vol. 75, No. 1, 1992, p. 61). A further report on the startup was presented at the TAPPI 1992 Pulping Conference. Various other reports have been given and articles published since then. John Poirier, production manager, and Bryon Reid, steam and recovery manager, recently provided a further overview of the pulping operation at the Meadow Lake mill.

To produce its pulp, the mill uses trembling aspen harvested and trucked in from the surrounding area. A portal crane is used to unload the logs and place them on the main log pile. At full capacity, about three months' worth of logs can be stored.

Recent improvements were made to the woodyard to keep pace with increases in pulp production. That includes off-site chipping to supplement the volume produced at the mill. A three-day BMH A-frame to store chips was scheduled for completion by the end of 1995. A Barko 850 mechanical loading crane was also put into service late last year.

From the main pile, the logs are sorted and fed to one of two production lines. Cut-off saws are used to trim the logs before debarking. The trimmings, the bark, fines, rejects from chip washing, sludge from the water recovery plant, and other debris are transported to an Olivine incinerator.

The debarked logs are fed through two 85-in., 1100-hp chippers. The chips are combined and pass over two rotating sizing screens. Accepts are conveyed to a silo, Poirier said. From the silo, the chips are put into an atmospheric pre-steaming (APS) bin, then sent on to one of two similar production lines.

Chips progress on through a washer and drainer, to another APS bin, then through three impregnation stages. An APS bin follows each impregnation stage. The pretreated chips next pass through one or two refining stages. The refining units consist of Hymac 64-in. single-disc refiners driven by 14,000-hp General Electric motors at a constant 1800 rpm. Pulp discharged into the wash chest is diluted with pressate from the interstage presses. The pulp is then pumped up to three interstage presses, then on to a second refiner. Stock from the refiners is collected in a latency chest. From there, it continues through primary and secondary screens. Accepted fiber is diluted with cloudy white water and sent on to a series of centrifugal cleaners. Rejected material from the last stage of cleaners is purged to the water recovery system, Poirier explained. Accepted fiber is thickened in a vacuum disc filter and sent to a medium-consistency storage tower. From there it is again bleached in a medium consistency tower.

After alkaline peroxide bleaching, the pulp is pumped from a blend chest to second stage presses for dewatering. The pressate is collected and recycled for use as dilution water. The pulp continues on through a steam mixer where it is heated, diluted with twin roll press pressate, and "soured" to prevent alkaline darkening. The liquid is then removed from the pulp by twin roll presses. Afterward the pulp is passed through a fluffer and flash dried.

Meadow Lake operates two flash dryers in series. Dryer temperature is adjusted to control the dryness of the finished pulp. After the second tower, the pulp is cooled and sent to one of two slab presses, Poirier explained. It's then packaged to customer specifications, collected in the warehouse, and shipped out by rail.