Millar Western starts APP/BCTMP mill at Meadow Lake in Canada

Richard Sherbaniuk

Millar Western Pulp Ltd. begins operations at its newest pulp mill next month. Located at Meadow Lake, Saskatchewan, the zero-effluent, chlorine-free APP/BCTMP will use 100% aspen.

Less than four years ago, Canada's Millar Western Pulp Ltd. opened its first pulp mill, in Whitecourt, AB. Since then, the company has gained an international reputation as producers of high-quality alkaline peroxide/bleached chemithermomechanical pulp (APP/BCTMP), to the extent that it is the largest producer of hardwood BCTMP in the world, marketing its pulp as a one-to-one replacement for hardwood kraft pulp. Its 210,000-metric tons/year mill at Whitecourt is operating at a virtually sold-out position, with production exceeding design capacity.

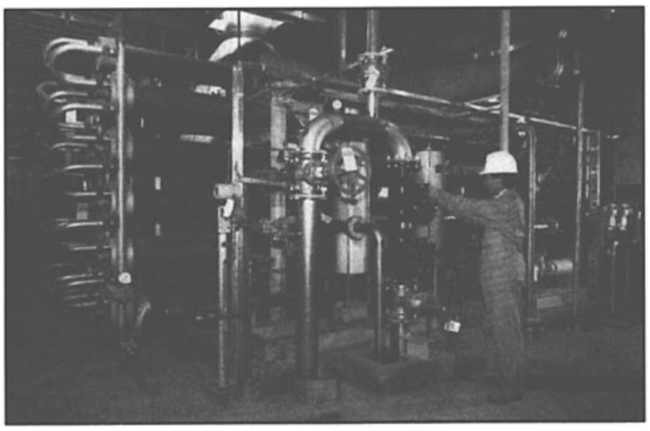
In February 1992, Millar Western will begin operations of a new zero-effluent, chlorine-free APP/BCTMP mill at Meadow Lake, Saskatchewan—on budget and on schedule. The mill is an impressive 100% aspen, chlorine-free, zero-effluent, 240,000 metric-tons/year APP/BCTMP mill. When this second mill reaches its design capacity, Millar Western's market pulp capacity will have more than doubled, to 450,000 metric tons/year—40% more capacity than any other BCTMP maker in the world.

"Of course, with our zero-effluent technology and other changes, there are some big differences between our Whitecourt and Meadow Lake mills," says Mac Millar, president of Millar Western Pulp Ltd. "But we've learned an awful lot from Whitecourt that we've been able to put to good use in the new mill. We intend to produce the world's best APP/BCTMP in the world's most efficient and environmentally responsible mill. Zero-effluent is still a relatively new concept, and no one has seen it succeed yet. But... we know we can do it, and we're going to do it right."

The similarities between the Whitecourt and Meadow Lake mills lie in the unique APP/BCTMP process. This bleaching process uses alkaline peroxide chip treatment, rather than the alkaline sulfite treatment used at most BCTMP mills.

"The alkaline peroxide treatment of hardwood chips has been investigated for about 30 years," explains Ron Reis, corporate technical director, marketing. "The process can make pulps of exceptional strength, and the use of hydrogen peroxide for bleaching helps us environmentally because there are no chlorine or sulfur compounds to be disposed of. The major problems with the process in the past were inadequate pulp brightness and the scaling of the refiner plates with sodium silicate. Millar Western's alkaline peroxide pulping process, developed from Scott Paper's patented alkaline peroxide process, has solved many of these problems."

Reverse osmosis unit at the water recovery plant at Millar Western's Meadow Lake pulp mill.



The alkaline peroxide process is based on a cycle of high compression chip squeezing using Hymac (4:1 compression ratio) plug screw feeders, followed by impregnation of the fiber with chemicals. This cycle is repeated in three subsequent stages using different chemical combinations, and results in a largely destructured chip, free of debris, chemically treated and ready for the refining process.

"Use of alkaline peroxide chip treatment is particularly well suited to the production of aspen-based pulps for printing and writing papers," says Reis. "By providing higher levels of chemical treatment, we can produce pulps that behave more like traditional hardwood kraft or sulfite pulps. We not only achieve high brightness levels, but our energy requirements are as much as 50% less than conventional BCTMP."

Joe Costantino, corporate technical director, operations and projects, has had a lot to do with the process developed for Meadow Lake. "What we've done at Meadow Lake, working once again with NLK-Celpap, is take the successes we've had at Whitecourt and build on them. We learned from our expe-

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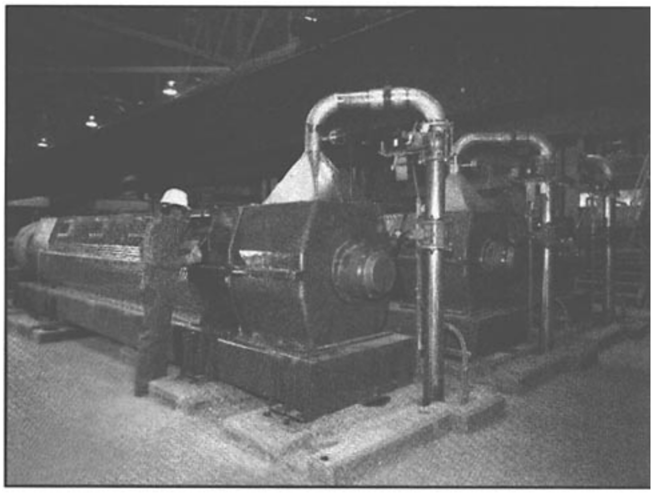
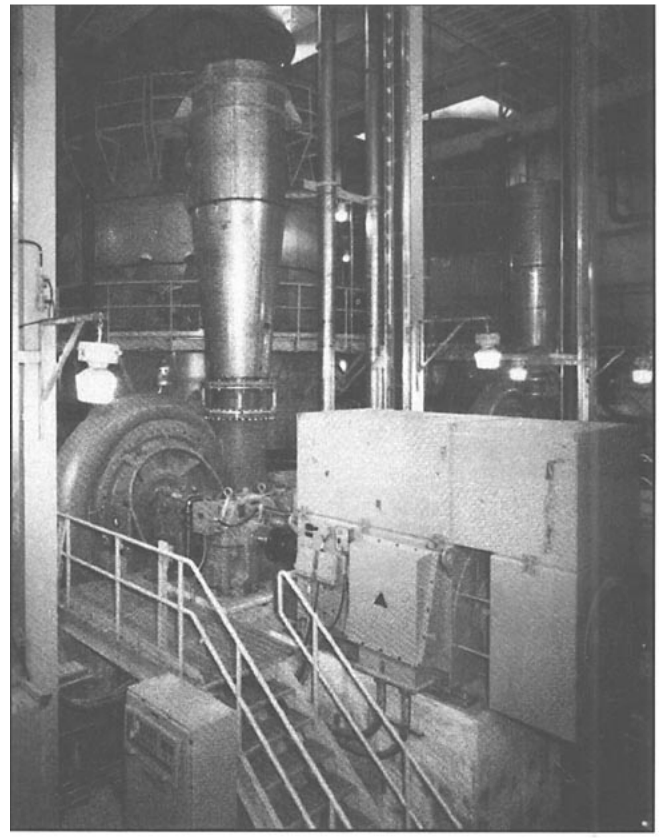
After refining, pulp is washed in a bank of three screw presses at the Meadow Lake mill.



The Meadows Lake mill's water recovery plant uses three evaporators, each with a recompressor.



riences there, duplicated the best elements, and made improvements wherever we could."

The environmental edge

As everyone in the pulp and paper industry is aware, the last five years have seen sharply increased public concern about environmental protection. This concern about the environmental impact of the pulp and paper industry is directly related to pulping processes, with a focus on the use of chlorine and the production of chlorinated organics.

Peter Knorr, executive vice president of Millar Western Pulp, has enjoyed the challenge of developing APP/BCTMP pulps that respond to some of society's environmental concerns. He believes environmental issues will dictate directions in the pulp and paper industry during the next several years. APP/BCTMP pulps offer many environmental advantages:

- 50% higher pulp yields, meaning fewer trees need to be harvested
- Reduced air emissions of SO_2 and odorous compounds
- No generation, use or emission of dioxin, chlorinated furans, and other chlorinated organics
- Zero effluent discharge, as at Millar Western's Meadow Lake mill, is possible with technology that exists today.

"Consulting with local community and environmental groups has been and will continue to be a very important element of our business process," says Millar. "Most of the groups we have talked with like our approach. They feel that as long as there is going to be a pulp mill, they want a CTMP mill with no chlorine, zero effluent, and a fiber yield of 90%."

Continues Reis, "While most environmentalists are not happy with the current environmental track record of the pulp and paper industry, they have recognized that all papers can't be produced from recycled fiber. The challenge to Canada's pulp, paper and forestry industry is to adapt existing technologies to environmentally friendly processes and still remain competitive in world markets.

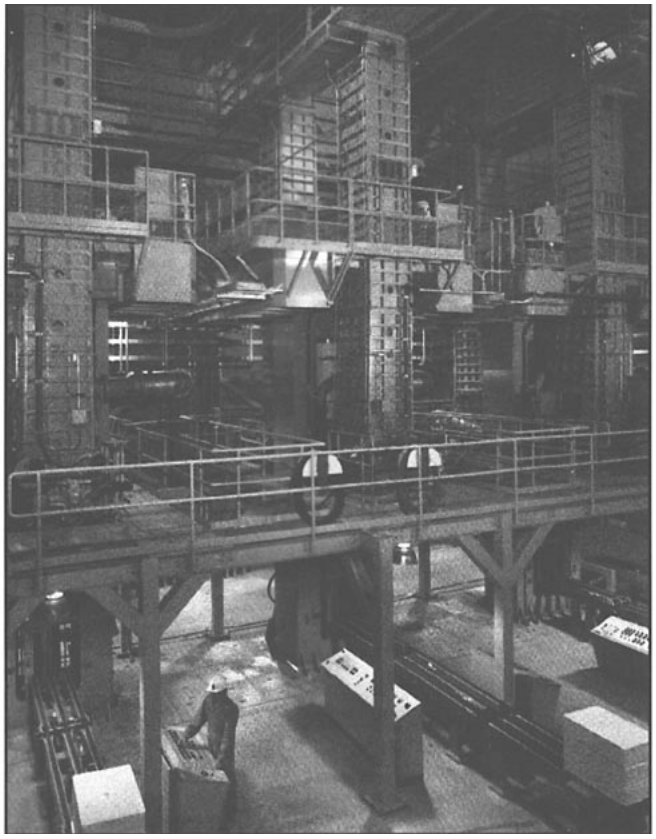
Satisfying public concerns and perceptions will require more than just a shift in the products manufactured—there will have to be a shift in the processes used as well.

"Originally, we intended to have an effluent discharge to the Beaver River," says Millar of the decision to make the plant a closed-loop, zero-effluent facility. "To ensure we were responsive both to community concerns and to the special sensitivities of the Beaver River system, we really went the extra mile when it came to designing a very advanced biological effluent treatment system. In fact, the water we were going to put back into the river was going to be cleaner than the water we took out. But the longer we looked at this thing, the more we thought that maybe we should go even further. We studied our options, and came to the conclusion that, if we were willing to make the investment, we could scrap the biological treatment system and go to a closed loop, zero-effluent system. It was the right decision—we've never looked back."

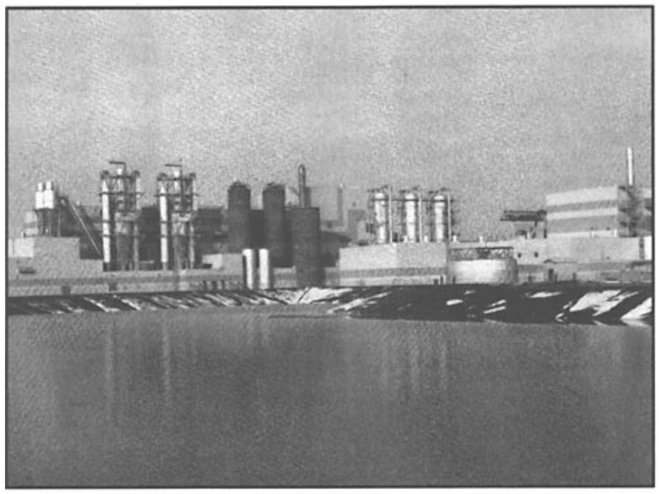
The zero-effluent process used in Meadow Lake was developed jointly by Millar Western and NLK-Celpap, the consulting engineers for both the new mill and the Whitecourt operation. "There isn't any magic involved in our zero-effluent process," Millar says. "We just looked at things a little differently. We took proven technology and put it together in a new configuration."

John Eccleston, mill manager of the Meadow Lake facility, says of the zero-effluent process: "Absolutely every bit of effluent coming out of this mill block goes into the water recovery plant. Makeup water to replace the small amount lost to the atmosphere through process steam and evapora-

Flash-dried BCTMP is compressed, weighed, and wrapped on parallel finishing lines at the Meadow Lake mill.



Millar Western's new 240,000-metric tons/year, zero-effluent, chlorine-free, 100% aspen APP/BCTMP mill at Meadow Lake, Saskatchewan.



tion from our water ponds will come from Meadow Lake. Our water intake will be about 1800 m^3/day, which is extremely low compared to standard BCTMP mills and kraft mills."

The Meadow Lake zero-effluent system is based on the use of evaporators to concentrate the effluent to 70% solids for burning in a recovery boiler. The only discharges to the environment are steam, wood waste (e.g., knots, chip fines), grit (e.g., sand), boiler ash (sodium carbonate), and boiler stack gases (e.g., CO_2).

Boiler feedwater treatment will include lime softening, clarification, multi-media filtration, desalination using reverse osmosis technology, and zeolite softening. Eighty-five to 100% of the main water source for the pulp mill will be recycled evaporator distillate. Evaporator and concentrator distillates will be segregated into clean and foul streams and will be treated to remove methanol, phenols, and other impurities.

The distillate treatment system will include biological treatment to remove organics. Water storage capacity is built into the system to allow up to one month of operation without any makeup water. This storage capacity also allows the pulp mill, the water treatment plant, and the evaporator-boiler system to operate independently.

The effluent treatment system will be composed of: Krofta clarifiers, fiber screens, three-stage Resources Conservation Co. (RCC) vapor recompression evaporators, RCC concentrators, a Babcock and Wilcox recovery boiler, and an electrostatic precipitator.

Because the APP process does not use sodium sulfite, there will be low sulfur levels in the system. The only source of sulfur will be sulfuric acid, which is used for touch-up in a two-stage carbon dioxide pH control system. This will minimize boiler sulfur dioxide (SO_2) emissions, which contribute to acid rain. The low sulfur levels will minimize any potential odor problems and will also minimize sulfate scaling in evaporators as well as potential sulfate deadloads in a future recausticizing operation.

The removal of silicates in the effluent treatment system is required because silicates pose potential problems in evaporator scaling and recaust operations. A system for removal of sodium silicate, which is used to stabilize peroxide during APP bleaching, was integrated into the mill during its design phase.

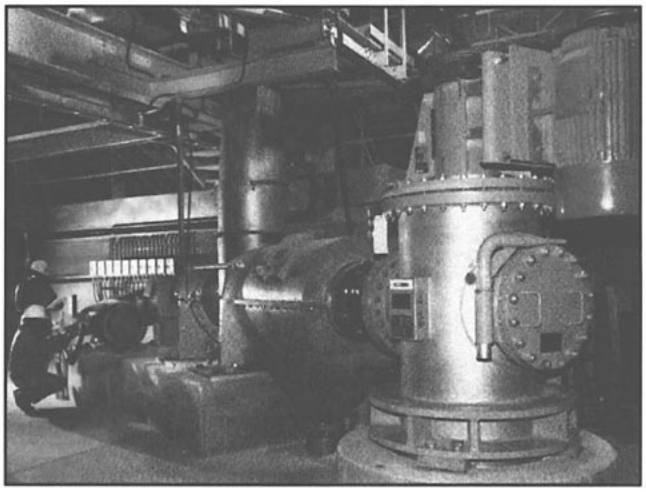
"Zero-effluent, closed loop pulping is not for everyone," says Millar, "but it was the right thing for us to do at the Meadow Lake location. It is expensive, but we think it's a solid investment in the environment and in the future."

Aspen will be pulp stock

Millar Western's Meadow Lake mill will use 100% aspen feedstock. Says Millar, "Until a few years ago, aspen was considered a weed. But exciting things are happening with aspen. Given the right sites and freedom from competition, aspen grows quickly. The University of Minnesota has conducted experiments with aspen clones and hybrid aspen species that should grow even more rapidly. But apart from growth characteristics and fiber production, aspen has a lot of end product benefits to the papermaker. There are also plenty of sound reasons why aspen makes good sense from a woodlands point of view. (See related story.) We do our forestry on a 60-year rotation, but there's no doubt in our minds we'll eventually halve this growth period."

Harvested aspen will be trucked to the mill. A 30-ton Kranco traveling log-handling crane will unload wood at the north end of the mill and either pile the logs in storage or load them onto an infeed deck. To ensure an uninterrupted supply of chips for the mill, the woodroom consists of two independent lines of debarkers, chippers, and screens, each of which is capable of supplying the mill's total fiber needs. Logs will enter the woodroom on a

Special screws, designed to eliminate hangups of chips, are located outside the feeder.



From left, **Mac Millar**, president, and **Peter Knorr**, executive vice president, of Millar Western Pulp Ltd., tour the company's new Meadow Lake pulp mill in Saskatchewan, Canada.

rubber belt conveyor and will move to Nicholson ring debarkers, then to a Nicholson knife chipper. The chips will then be screened for acceptable size.

Acceptable chips will be conveyed by a rubber belt conveyor to a chip storage bin, then fed on an inclined belt conveyor to the CTMP mill. The chips will never touch the ground.

In the mill, chip pretreatment will be carried out in two separate and parallel lines—one for tissue and toweling, one for printing and writing papers. Chips will be conveyed to an atmospheric pre-steaming (APS) bin. There, they will be heated to 90–95°C, using backflow steam generated in the refiners. They will be stored up to 45 minutes, and metered into parallel Hymac chip washers, where they will be submerged and agitated to remove sand and other heavy materials. Inclined screw drainers will remove water, which will be screened, cleaned, and recycled to the chip washers.

Chip handling

A key to the success of Millar Western's APP process is its three-stage impregnation system, consisting of special 4:1 Hymac plug screw feeders, impregnators, and SHW reaction bins. Each plug screw feeder will compress the chips to squeeze out air and resins. Chips will be squeezed to 25% of their original volume, creating micro-compressions in the chip structure that allow better chemical impregnation. The chips will expand as they enter the impregnator, allowing maximum absorption of the chemical solution.

Impregnated chips will feed the three SHW reaction bins for a retention time of up to 15 minutes in the first two bins and up to 45 minutes in the third. Backflow steam generated in the refiners will be used for chip steaming to ensure uniform chip temperature.

The size of the plug screw feeders used at Meadow Lake has been increased over those used at Whitecourt, not only in terms of volume, but also in terms of the amount of horsepower delivered to break up the chips and allow chemicals such as alkaline peroxide better access to the fibers. By the time the fiber passes through the three stages, it will be a destructured mass, no longer in chip form.

Chips will be metered out of the final reaction bin into a 2:1 plug screw feeder which will squeeze out excess liquid and feed the chips to the primary 14,000 hp, 64-in. diameter Hymac single-disc refiners. Line one features a single primary refiner, while line two has dual primary refiners, which will refine the pulp before it drops into the wash chest. An improvement included at Meadow Lake is the addition of interstage washing on Hymac/Thune presses. After washing, the pulp will be refined in the secondary refiner to the desired pulp freeness level. All refiners in Meadow Lake will run at atmospheric pressure, since this improves the stability of residual hydrogen peroxide in the pulp and provides better bleaching efficiencies in the refiners.

All refiner-generated steam, plus vent steam from process chests, will be sent via fans to a heat recovery system. The heat recovery system will supply steam to the APS bins.

When process heat is required, a process hot water heater will draw steam from the recovery system and indirectly heat mill water.

Tissue pulp will be pumped from the latency chest to a Hooper screening system, using slotted baskets. Tissue primary screen rejects will feed a secondary screen system. The printing/writing primary screening system will also feature only slots, but will have two-stage primary screening, with high reject rates. Rejects, again, will feed a secondary screen.

Any fiber bundles and stiff fibers rejected in the screening system will be transferred back to the secondary refiners. The proportion of rejects to either line can be adjusted. Accepted pulp will be pumped to a five-stage Celleco centrifugal cleaning system to remove dirt and bark.

Primary cleaner accepts will be thickened to 10–15% BD consistency on a Celleco disc filter and pumped to a medium consistency storage tower for up to eight hours.

Bleaching and dewatering

There will be two parallel lines for bleaching. A bleaching solution of hydrogen peroxide and sodium hydroxide will be added to a mixer ahead of the first bleaching tower, for two hours retention at 60–70°C at 10% BD consistency to ensure controlled and uniform bleaching. Chemical charges will be adjusted to control pulp quality as well as brightness levels.

The dewatering system will also consist of two parallel lines. Pulp will be pumped from the bleach tower to a set of Hymac/Thune wash presses for post-bleach washing. From there, the pulp will be pumped to Sunds Defibrator twin roll presses for final dewatering prior to drying. Dewatering pressates will be recycled counter-current to the pulp flow, to ensure maximum hydrogen peroxide reuse.

The system also features two parallel pulp dryer lines supplied by Flakt. Pulp will be conveyed to disc fluffers which will break up any lumps of fibers created in the presses. The fluffed pulp will be discharged into a hot air stream from a natural gas burner.

The pulp will be heated in the Flakt flash drying tower; moisture will be flashed off. The steam and air will be separated from the pulp and vented from the first-stage cyclone. A second drying stage, identical to the first, will complete pulp drying, to a moisture content of about 14%.

The pulp will then be cooled to 30°C in the cooling stage to minimize brightness reversion. From the cooling stage, the pulp will be discharged to three slab presses. Conveyors will be provided to use the swing slab press in either line, when required.

Pulp finishing will consist of two parallel lines by Sunds Defibrator. The slab presses will compress the dried and fluffed pulp into 250 kg bales. The bales will be weighed, and further compressed by bale presses. The bales will be wrapped with purchased pulp sheets, tied, labeled and unitized in units of four bales.

Steam and power supply

Normal process steam requirements amounting to 10 metric tons/h will be required for water heating and bleaching. Steam will be generated in a 50 metric tons/h Nebraska natural gas-fired packaged boiler. A dedicated high-quality water softening system is located adjacent to the boiler. The boiler feedwater and chemical dilution water will have earlier been treated sufficiently to permit the use of reverse osmosis for the final removal of calcium and magnesium salts.

The electrical power required for the APP/BCTMP refiner motors, the process auxiliary loads and the non-process loads will be supplied by two utility tie transformers. Each transformer, rated at 40/52/68 MVA, will feed a section of 13.8 kV switchgear. The 13.8 kV switchgear will be arranged into two bus sections, tied together with tie breakers.

The system is designed to operate with the 13.8 kV tie breakers normally open. If one of the transformers is out of service, both lines of refiner motors and the auxiliary loads can be fed from one transformer without exceeding its fan-cooled maximum rating.

The 13.8 kV, 750 MVA metal clad switchgears are installed in an electrical room located in the APP/BCTMP plant. The switchgear contains draw-out vacuum breakers to switch and control the incoming tie circuits, the 13.8-kV refiner motor feeders and the feeders to other APP/BCTMP process and non-process load centers. The load centers are served by oil-filled outdoor and one indoor dry-type area substation transformer, which transform the 13.8-kV primary distribution voltage to the utilization voltages of 4.16 kV and 600 V.

Water use and management

Water consumption rates for the mill have been established at 1800 m^3/day. These rates include water for mill process, chemical dilution, boiler feed, domestic mill supply, and all other ancillary uses. The water consumption rate, based on zero effluent, is approximately 2.7 m^3/a.d. metric tons.

Millar comments, "Our system has a very low water requirement when measured against kraft and standard CTMP mills. A kraft mill producing the same amount of pulp would need about 75,000 m^3 of water per day while a standard CTMP mill would need about 15,000. Meadow Lake, on the other hand, will need about 1800 m^3 per day."

All water will be recycled and reused in the process. The conventional approach for water utilization and management is to use fresh water at critical locations, such as final washing of pulp, and to discharge water from the process at selected points to minimize equilibrium buildup of substances which could affect process conditions or pulp quality. Using this approach, the design requirement for fresh process water for a CTMP mill is approximately 15 m^3/a.d. metric ton. To reduce water consumption below this value for the Meadow Lake mill, it was necessary to incorporate water treatment and purification steps not used at other CTMP mills.

Specifically, near-complete removal of organic and inorganic soluble compounds is required before effluent can be reused for applications typically requiring fresh treated water. The technical specifications for pulp mill process water are significantly more stringent than for high-quality drinking water. To achieve such high standards, a physical process to separate dissolved compounds is required.

All mill effluent will be collected with a floor trench system, clarified to remove suspended solids and directed to an evaporator train.

The evaporation system consists of three identical RCC mechanical vapor recompression evaporator bodies, and Roots motor-driven centrifugal compressors. This configuration, which employs the heat pump principle, is very energy efficient. Approximately 95% of the energy required for evaporation is recovered. The selected evaporator system allows the units to be operated in parallel, series, or parallel/series configuration. This flexibility ensures system reliability, provides conservative capacity, and enhances energy efficiency.

Extensive pilot plant studies have been completed at Millar Western Pulp's Whitecourt mill to simulate evaporation of Meadow Lake effluent. These studies have enabled characterization of distillate fractions, as well as evaluation of evaporator performance. Based on these studies it has been determined that 60% of the distillate can be used directly for process applications in the mill.

The top fraction of the distillate (about 10% of the total) will be steam distilled on a Lundberg-Allen system to remove low molecular weight organics, principally methanol. This fraction, along with the balance of the distillate not returned directly to the mill, will be pumped to the distillate equalization pond, which has a hydraulic retention capacity in excess of five days. Following lime/alum softening and coagulation, the makeup lake water will also be directed to this pond.

The distillate equalization pond will be aerated and required nutrients will be added to establish biological activity to degrade the organic fraction. With extended aeration, the yield of biomass is low, making it feasible to remove residual biomass with sand filtration. The stabilized, combined distillate and treated lake makeup water will be used in the mill for applications requiring cool, essentially organic-free water.

Mark Hoddenbagh, senior mill chemist, says, "Because our mill is a closed system, we face some special challenges. With no effluent going out, the chemicals in the process have the opportunity to build up and cause problems. We have to monitor things very closely, and so we're using some very specialized equipment.

"In fact, one of the things that sets this mill apart from others in North America is that we're using the kind of equipment that you might only expect to find in university or research labs." That equipment includes a gas chromatograph/mass spectrometer, an atomic absorption unit, an ion chromatograph, and u-v visible and Fourier Transform Infra Red (FTIR) spectrophotometers.

The 35% solids leaving the evaporators will be further concentrated to 70% solids on two RCC concentrators, prior to incineration. Studies have confirmed the feasibility of producing a concentrate with a dry solids content of up to 70%. The Babcock and Wilcox incinerator is a soda recovery boiler unit, proven effective in similar service. This configuration will permit recovery of the thermal energy from combustion of the organic fraction.

The inorganic fraction will be removed from the incinerator as a liquid smelt and converted into a solid form suitable for landfilling or for shipment to potential customers. Millar Western Pulp is currently investigating potential markets for this material. □

Forest management an integral component of Millar Western's Meadow Lake pulp mill

The wood fiber required for Millar Western Pulp's Meadow Lake mill, in large part, will be obtained from a Forest Management License Agreement (FMLA) area in northern Saskatchewan. A unique forest management company, Mistik Management Ltd., has been given the mandate to operate within the terms and conditions of an integrated resource management approach to the forest land base.

Integrated resource management (IRM) refers to the inclusion of all identifiable forest values and uses in the forest management and operations planning process. Values such as fisheries, wildlife, heritage, and traditional resources, and uses including hunting, fishing, trapping, gathering, bird watching, canoeing, hiking, preservation, and other forms of human-forest interaction, must be considered.

The IRM approach means that planning must incorporate all forest uses into operating plans, so that the harvest of timber does not limit the benefits future generations will derive from the forest.

Millar Western, and their partners at Mistik Management, believe the community of local stakeholders must be permanently included in the IRM process. Barry Peel, Woodlands Manager at Mistik Management Ltd., says, "We have established a local advisory committee to provide input into the planning process and enhance appreciation of forest resource values. The committee is composed of local individuals representing diverse interests, such as trappers, sportsmen, outfitters, environmental organizations, woodlot owners, and Treaty Indian and Native groups."

Mistik is committed to seeking a sustainable balance between all ecological and commercial interests through sound forest ecosystem management. Attention is paid to aesthetics and environmental impacts during design of the type, size, and location of areas to be harvested. Areas will be harvested using a patch harvesting method, varying in size from 1/2 hectare to 60 hectares. Approximately 1/2 to 1% of the productive land base in the FMLA will be harvested in any one year to provide a fiber supply to Millar Western and NorSask Forest Products.

Harvest block size will be determined to a large extent by the other values and users of the land base. For instance, certain areas of the FMLA area have been designated as elk, moose, and deer habitat. Harvesting blocks will be designed to enhance the populations of these species. This type of harvesting pattern increases forest diversity and has benefits for many species by increasing the food supply over a wide area without major disturbance to habitat.

Forest renewal will be conducted following harvesting through encouraging natural regeneration, or through a seedling planting program.

David Harman, Management Forester for Mistik, says, "Our belief in integrated management has meant that we've made a big investment in time and dollars collecting detailed information on wildlife needs, soil types, watercourse locations, etc., and coordinating that information by computer. Through the Geographic Information System (GIS), we can generate multi-layered maps that reflect many forest resources, and these help guide our harvest and reforestation plans."