St. Lawrence TECHNOLOGIES

INDUSTRIAL WASTEWATER

INTRODUCTION OF THE ULTRAFILTRATION PROCESS TO A PULP AND PAPER MILL

ABSTRACT

As part of a technology adaptation and demonstration project conducted by the company Cascades Inc. Research and Development Environment Service, in collaboration with Les Entreprises Denis Darveau Inc., an ultrafiltration unit was introduced to the Papier Kingsey Falls, Division of Cascades Inc. (PKF) mill. The effects of the unit's closed-circuit operation were studied and its operating parameters were adapted to the plant's existing facilities. Different methods and solutions for cleaning the unit were also tested. The project demonstrated that the ultrafiltration technology had no short-term impacts on the paperboard manufacturing process or equipment, or on paperboard quality.

Operation of the ultrafiltration unit at the PKF plant led to a reduction in water consumption, and a concomitant reduction in the volume of wastewater discharged (0 to 2.2 m^3/mt of final product). This translates into lower wastewater treatment costs. Lower fibre loss and a decline in energy consumption are also projected.

HIGHLIGHTS

- **Technology**
  - Membrane ultrafiltration
  - Adaptation of the technology to the pulp and paper industry
  - Refinement of optimal use of ultrafiltration water to allow for closed circuit water usage
- **Environment**
  - Closure of process-water supply systems
  - Reduction of water consumption
  - Reduction of energy consumption
- **Cost**
  - More rational use of primary materials (fibres and water)
  - Reduced energy and water-treatment costs
  - Opening up of ultrafiltration market to the pulp and paper sector

Saint-Laurent Vision 2000

Environment Canada Protection Québec Region

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Cascades Inc.

Full Flow

Les Entreprises Denis Darveau Inc.

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PROJECT OBJECTIVES

1. Verify adaptation of the ultrafiltration unit to the closure of process water systems in a plant producing multi-layer board from recycled fibre.
2. Determine the operating parameters for the ultrafiltration of plant process water.
3. Characterize process waters before and after ultrafiltration.
4. Assess fresh water and process water usage at the plant, before and after installation of the ultrafiltration unit.
5. Determine the effects of closing the process water system on plant operations, on the paperboard machine, and on the quality of the product attributed to the use of ultrafiltered water as a substitute for fresh water.
6. Produce promotional information on the ultrafiltration of process water.

BACKGROUND

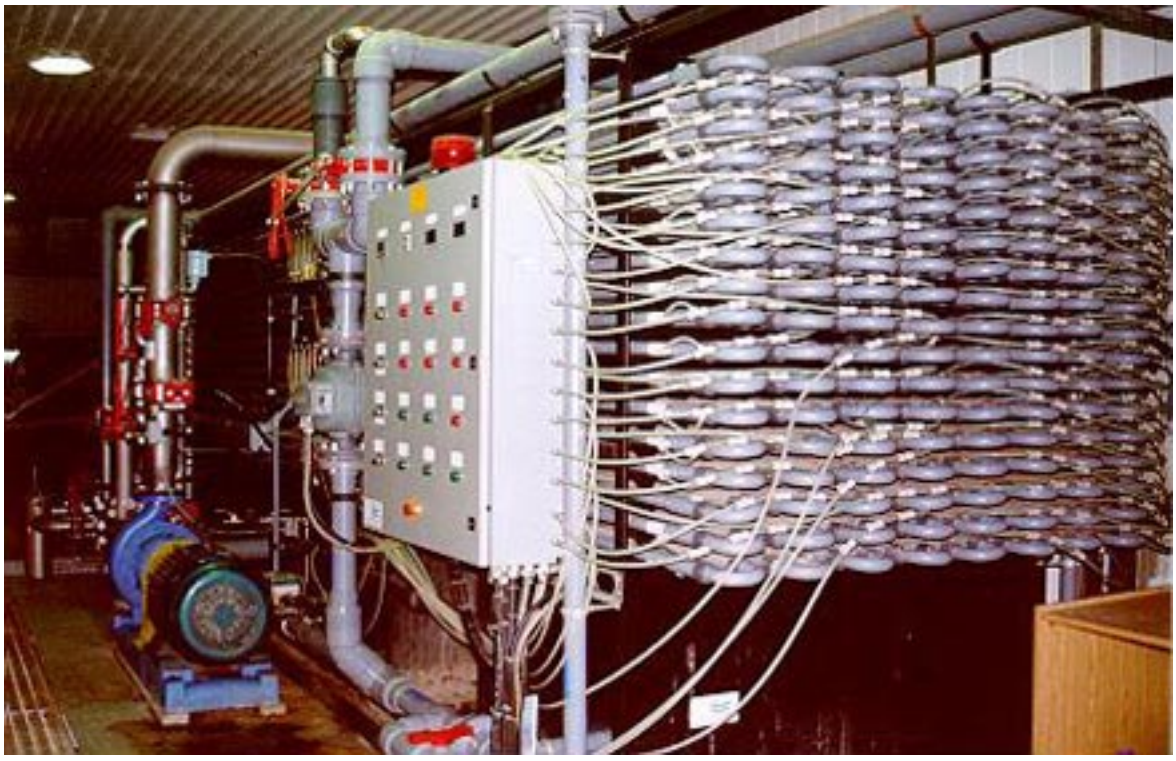
Reducing the amount of water consumed in the production of pulp and paper presents a major challenge: recirculating treated process water is one possible option. In order that process water can be safely reused, however, it must first be treated, in-plant or externally, to lessen its concentration of suspended and dissolved matter, which can damage equipment or hinder normal plant operations. It can also replace, in part, some of the fresh water normally used in the process.

TECHNOLOGY

The goal of the project was to adapt the ultrafiltration technology to the closure of water supply systems at Cascades Inc.'s Kingsey Falls plant. The ultrafiltration unit is fed by surplus white water—water which, up to this point, had been channeled to Cascades' process-water treatment facilities. The principle of ultrafiltration consists of simple tangential-flow membrane filtration. The unit built by Les Entreprises Denis Darveau Inc. is equipped with tubular membranes (manufactured by Koch Membrane Systems Inc.) with a pore diameter of 0.01 microns.

Once it has passed through the membranes, the permeate is channeled into a chest and recycled in the process. Water which has not passed through the membrane (i.e. the concentrate) is returned to the white water chest.

Operation of the ultrafiltration unit was optimized to foster its integration into the plant's industrial process. Ultrafiltered water is sent directly to the plant's freshwater chest. The permeate is used to seal pumps, for felt showers and in the AQUATROL humidifying system.



RESULTS

Optimizing operation of the ultrafiltration unit and washing solutions

An ultrafiltration unit was integrated into the industrial process of the PKF plant to optimize its operations and optimize use of the permeate (see Table 1).

The recovery rate for ultrafiltered water was adapted to the needs of the PKF plant so as to maximize permeate produced, in order that it could be used instead of fresh water in the process. By maintaining a lower level of concentrate in the white water chest, operating time for the ultrafiltration unit is optimal with an elevated permeate production. This explains the 30–40% recovery rate, which, at first glance, appears weak for a tubular membrane system whose yield can attain 90% and more. Because some products employed in the plant (dyes, sizing agent, and a type of starch) are potential fouling agents, use of the ultrafiltration unit is restricted when these products are involved. Research is still being done to find an appropriate washing solution. The ultrafiltration unit generally functions for three to five days (72 to 120 h) before membranes need to be cleaned.

Various combinations of chemical and mechanical washing methods have been tried on the unit. The best chemical method was found to be an alkaline solution mixed with a chelating agent. Good results were also obtained with an acid soaking. Optimization of the necessary soak time should lead to a reduction in wash frequency. Other chemicals are employed as needed. On occasion, when there is a build-up of inorganic compounds such as calcium or iron, an acid solution is used. Mechanical washing is done with hundreds of sponge balls, whose combined action is like brushing membrane walls.

Evaluating the impacts of permeate use on the process and on paperboard-manufacturing equipment

The characterization of process waters and the establishment of a computerized balance allowed us to determine the effects of the ultrafiltration unit on the paperboard manufacturing process. During closed-circuit operation—that is, when no effluent is generated—the main consequences were an increase in dissolved matter and in the concentration of some metals in the white water. The ultrafiltration unit was effective in removing over 97% of the suspended matter. Moreover, the plant's effluent discharge was significantly reduced when the ultrafiltration unit was in operation, varying from 0 to 2.2 m^3/mt of product, compared to the usual 3.3 m^3/mt. No fouling of the paperboard machine's felt showers was observed with the use of ultrafiltered water, nor was shower pressure reduced. Further, there was no premature felt wear. Laboratory tests were conducted to assess the substitution of fresh water for permeate in preparing bentonite and in diluting the polymers and coagulants employed at the PKF plant. The results for bentonite preparation were positive; in-plant tests will be performed to draw more definitive conclusions. Lastly, quality testing was performed on the paperboard produced before and after start-up of the ultrafiltration unit. To date, there have been few divergences from the plant's paperboard quality standards. Minor variations have been attributed to variations in the primary materials.

TABLE 1.
OPERATING PARAMETERS OF THE ULTRAFILTRATION UNIT

Feedwater	White water
Average temperature	44°C
Q feed	300 USGPM
Q maximum permeate	125 USGPM
Q minimum concentrate	175 USGPM
Recovery rate	30–40%
Optimal inlet pressure	85 psi
Optimal outlet pressure	26 psi
Fouling time	72–120 hours

POTENTIAL AND LIMITATIONS

The use of an ultrafiltration unit to allow for the closure of water supply systems at a paperboard plant produced promising results. The zero-effluent target was reached when the ultrafiltration unit was in operation, with no disruption in plant operations.

The main advantages of this technology are significant reductions in effluent volume (and, consequently, in water treatment costs), in steam consumption (reduction of energy costs), and the maximum reuse of fibres (optimal recycling of concentrate). The ultrafiltration process thus appears to be a good choice for industrial plants seeking to move to closed-circuit operation.

The use of some products in the manufacturing process may hasten membrane fouling. Pilot-scale testing of the ultrafiltration technology should be conducted at the start, and research into effective solutions for washing the unit must be pursued so as to optimize operating time.

It is possible to shorten the time required to clean the membrane by employing a second washing vat and using clean warm water.

Further, the installation of an automatic injector of sponge balls would facilitate the mechanical washing process, thereby increasing the frequency of this preventive cleaning while reducing its duration.

INFORMATION

This technology data sheet is based on the results of a technological adaptation project by Les Entreprises Denis Darveau Inc., Papier Kingsey Falls, Division of Cascades Inc., Cascades Inc. Environmental Services, Cascades Inc. Research and Development Centre, and Cascades Inc. Wastewater Treatment.

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