St. Lawrence TECHNOLOGIES

ABSTRACT

Québec's pulp and paper industry must introduce secondary treatment systems in order to comply with the government's new environmental standards concerning liquid waste. Biofiltration both biodegrades soluble organic matter and retains suspended solids by filtration.

The BIOFOR® process was tested to evaluate its effectiveness for the biological treatment of effluent from an integrated pulp and paper mill. BOD_5 and SS concentrations were reduced to values that conformed with the new environmental standards, and acute toxicity was removed from the effluent. An estimation of the treatment costs was also undertaken.

INDUSTRIAL WASTEWATER

TREATMENT OF INTEGRATED PULP AND PAPER MILL EFFLUENT BY BIOFILTRATION USING THE BIOFOR® PROCESS

MAIN FEATURES

- **Technology**
  - Aerobic treatment process suitable for diluted effluents
  - Compact installation
  - Resistant to effluent load variations.
- **Environment**
  - Substantial reduction of organic matter and suspended solids concentrations
  - Suitable for integrated pulp and paper mill effluents
  - Removal of acute toxicity from treated effluents.
- **Cost**
  - Capital and operating costs are comparable to conventional biological treatment systems.

ST. LAWRENCE ACTION PLAN

Environment Canada / Environnement Canada
Conservation and Protection / Conservation et Protection
St. Lawrence Centre / Centre Saint-Laurent

Degrémont

DAISHOWA

PROJECT OBJECTIVES

1. To evaluate the effectiveness of the BIOFOR® process for reducing conventional pollutants and removing acute toxicity in effluent from an integrated pulp and paper mill with a de-inking plant
2. To evaluate the response of the biofilter to effluent variations
3. To characterize the biological sludges produced
4. To determine design and operating criteria, as well as treatment costs.

TESTING

Pilot-scale tests were conducted at the Québec City plant of Daishowa Forest Products Ltd. over a five-month period in 1992. The plant produces 1400 t/d of newspaper and cardboard using groundwood, thermomechanical and de-inked pulp. On average, the effluent carries a BOD_5 load of 25 t/d and an SS load of 10 t/d, with a flow rate of 120 000 m³/d.

Tests on the BIOFOR® process were conducted in actual conditions using effluent from the primary clarifier, which included wastewater from the de-inking plant.

BACKGROUND

The pulp and paper industry must meet new regulations for reducing BOD_5 and SS and removing the acute toxicity in effluents. In respect of these new standards, plants must now provide secondary treatment for their effluents.

The installation of conventional treatment systems, such as activated sludge or aerated lagoons, may not be adequate, especially for those plants with limited space. In such cases, biofiltration may prove to be an interesting treatment option. A demonstration project was thus carried out at the Québec City plant of Daishowa Forest Products Ltd.

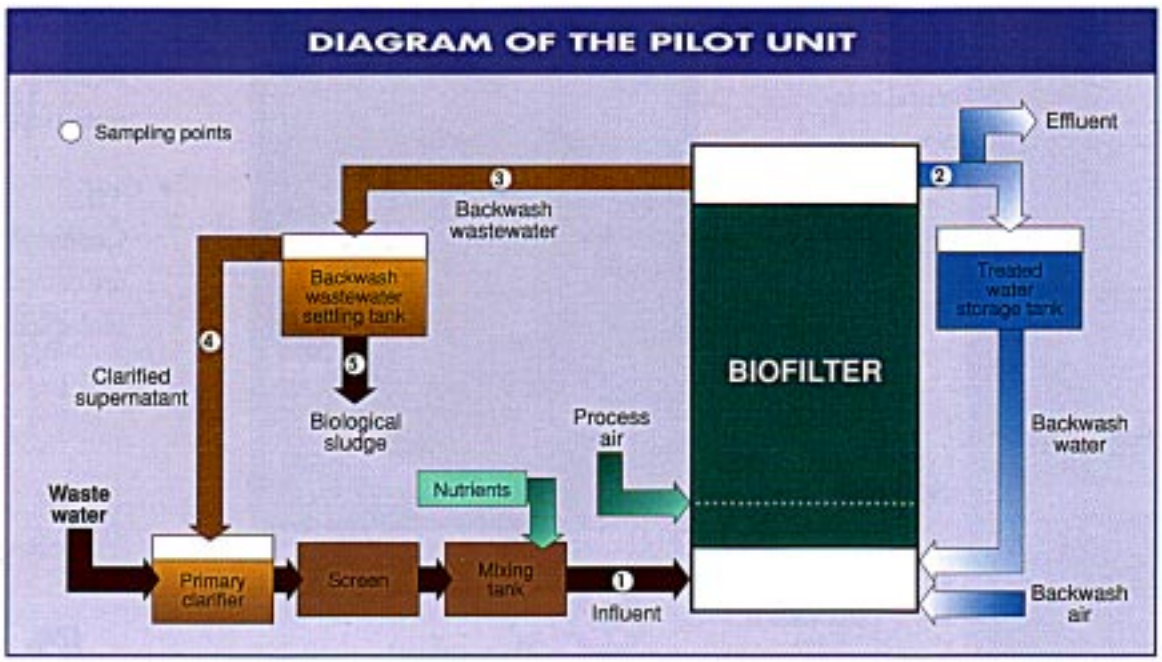
TECHNOLOGY

The BIOFOR® process is an aerated biological filter consisting of an immersed granular medium onto which a bacterial film is affixed. The fixed biomass biodegrades the soluble organic matter as it filters the effluent, retaining the suspended solids.

The raw effluent and the oxygen necessary to the aerobic biodegradation of organic matter are introduced at the base of the filter. The co-current upward flow of air and water ensures an excellent oxygen transfer, allowing the system to operate with heavy loads and at a high rate of efficiency.

The BIOFOR® process was developed by Degrémont (France), which holds the patent. The commercial and technical development of the biofilter in North America is being carried out by its subsidiary, Degrémont Infilco Ltd. of Lachine, Québec.

DIAGRAM OF THE PILOT UNIT



RESULTS

Effectiveness of the BIOFOR® process

Under steady-state operating conditions over 24 filtration cycles, the BIOFOR® process reduced the BOD_5 and SS in the effluent to the values set by the new standards of 5 and 8 kg/tonne of finished product, respectively (monthly averages). The effluent showed no acute toxicity.

Tested under various operating conditions – such as plant start-up and simulated variations in organic matter concentration, sludge loading and effluent temperature – the biofilter's removal efficiency briefly decreased. However, the biofilter quickly recovered.

Backwash wastewater treatment and sludge characterization

A sludge consistency of between 0.8 and 1.4% was obtained by gravity settling of the biofilter's backwash wastewater. However, a consistency ranging from 1.7 to 2.3% was obtained with air flotation. The supernatant can therefore be recirculated to the primary clarifier since it has the same settling properties.

The sludge production rate of the BIOFOR® filter varied between 0.75 to 0.95 kg/kg BOD_5 removed. The sludge can be dewatered to a dryness level of 20% with the addition of polymers. A dryness level of 25% can be attained by mixing these biological sludges with those of the primary clarifier. The sludge did not give off any odours.

Design and operating criteria

The filter design is based on a BOD_5 sludge loading of 5 kg/m³/d. Under this loading and a flow rate of 120 000 m³/d, a filtration rate of 3.5 m³/m²/h removed 80% of the BOD_5 in steady-state conditions. If the flow rate were to be reduced to 100 000 m³/d, the nominal mass loading rate could be maintained by reducing the hydraulic loading rate to 2.5 m³/m²/h.

Cost of the process

Capital costs to install the BIOFOR® process at the Daishowa Forest Products Ltd. plant in Québec City are estimated at $2900/kg BOD_5 based on a flow rate of 100 000 m³/d and a BOD_5 load of 25 000 kg/d. This estimate accounts for the cost of constructing the primary clarifier, biofilters, backwash wastewater settling tanks and spillage tank. It also includes the installation of pumping stations, mechanical and monitoring equipment and pipelines, as well as systems for chemical product preparation and sludge treatment. These costs may be comparable to those of conventional activated sludge treatment units.

Operating costs, including labour, maintenance, chemical products, electricity, sludge disposal and control testing, amount to approximately 0.30 $/kg of BOD_5 removed, which is similar to conventional activated sludge treatment operating costs.

TEST RESULTS OF THE BIOFOR® PROCESS

Parameters	Raw water	Treated water	Efficiency	Discharge standards (MENVIQ)
BOD_5	136 to 201 mg/l	24 to 48 mg/l	73 to 85%	58 mg/l (monthly average)
COD	456 to 618 mg/l	190 to 331 mg/l	41 to 61%	-
SS	61 to 201 mg/l	19 to 58 mg/l	41 to 79%	93 mg/l (monthly average)
Fatty acids	0.7 to 1.5 mg/l	0.1 to 0.6 mg/l	48 to 91%	-
Resinous acids	2.4 to 5.3 mg/l	0.1 to 0.7 mg/l	80 to 97%	-
Toxicity (LC_{50})				
Trout (96h)	8 to 26% v/v	100% v/v	Non-toxic effluent	No acute toxicity (LC_{50} = 100% v/v) Trout (96h) and Daphnia magna (48h)
Daphnia magna (48h)	15 to 20% v/v	100% v/v		

Note: These results were obtained under steady-state conditions with a hydraulic loading rate of 3.5 m³/m²/h and an organic mass loading rate of 5 kg BOD_5/m³/h.

POTENTIAL AND LIMITATIONS

Potential

This study confirmed that the BIOFOR® process can reduce BOD_5 and SS and remove acute toxicity, in compliance with government requirements, for the final effluent of an inte grated pulp and paper mill with a de-inking plant.

The system can operate under high temperature peaks (45°C) for short periods of time and quickly recover its standard efficiency following a shock load. It is suitable for the treatment of diluted pulp and paper mill effluent and requires less space than a conventional treatment system.

Limitations

The efficiency of the BIOFOR® process may decrease if the mill effluent flow rate were to be reduced, thereby increasing the organic matter concentration of the effluent. Recirculating treated effluent at the biofilter inlet may offset this effect.

The process air flow rate must not exceed 15 $m^3/m^2/h$ in order to avoid further enlarging the biomass during filtration and increasing the suspended solids concentration of the effluent. Moreover, the presence of particulate matter, such as plastic or fibres, in the untreated effluent could clog the air and water supply nozzles, thereby necessitating the installation of a screen upstream of the filter.

INFORMATION

This data sheet is based on the results of a technology development and demonstration project carried out by Degrémont Infilco Ltd. with the technical and financial support of Daishowa Forest Products Ltd. and the St. Lawrence Centre.

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St. Lawrence TECHNOLOGIES

St. Lawrence Technologies data sheets are intended for all companies, industries, organizations and individuals interested in new environmental technologies. They are produced by the Technology Development Branch of the St. Lawrence Centre, Environment Canada, as part of the St. Lawrence Action Plan. They serve to disseminate the results of technology development and demonstration projects conducted in the following four sectors: industrial wastewater; contaminated soil; hazardous wastes; contaminated sediment.

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Cette fiche est également disponible en français sous le titre :
Traitement des effluents d'une usine intégrée de pâtes et papiers par biofiltration avec le procédé BIOFOR®.

Canada