St. Lawrence TECHNOLOGIES

ABSTRACT

Increasingly stringent environmental standards are being applied to the pulp and paper industry: in this context, the Biocarbone™ process — an aerated biofiltration treatment process for urban wastewater — was tested to determine its effectiveness in achieving secondary treatment levels for integrated pulp and paper mill effluent.

The Biocarbone system is an aerobic biological process to treat wastewater and remove suspended solids by percolation of untreated effluent through an aerated and fixed immersed bed. Its effectiveness in reducing BOD_5, COD, SS concentrations and toxicity is equivalent to that of the biological processes currently used in the pulp and paper industry.

INDUSTRIAL WASTEWATER

TREATMENT OF PULP AND PAPER MILL EFFLUENT BY BIOFILTRATION USING THE BIOCARBONE™ PROCESS

MAIN FEATURES

- **Technology**
  - -High loading rate aerobic treatment process using a bacterial fixed film attached to an immersed granular support media.
  - -Compact installation.
- **Environment**
  - -Biodegradation of organic matter and capture of SS.
  - -Removal of toxicity from treated effluent.
  - -Promising for application in mills producing groundwood pulp, thermo-mechanical pulp, de-inked pulp and cardboard.
- **Cost**
  - -Construction and operating costs are comparable to conventional biological treatment processes generally used for pulp and paper effluent.

ST. LAWRENCE ACTION PLAN

Environment Canada — Conservation and Protection — St. Lawrence Centre

Environnement Canada — Conservation et Protection — Centre Saint-Laurent

JOHN MEUNIER DAISHOWA Kruger Inc.

OBJECTIVES OF THE PROJECT

1. To evaluate and demonstrate the potential of the Biocarbone process to treat effluent from integrated pulp and paper mills.
2. To evaluate the effectiveness of the process in reducing conventional (BOD_5, COD and SS) and non-conventional (fatty and resinous acids, metals) pollution parameters which are the primary sources of acute toxicity.
3. To compare the economics of the process with those of conventional processes.
4. To identify operational problems and determine design criteria for full-scale industrial applications.

PHASES

PHASE I
Kruger mill (Bromptonville)
Determination of the technical feasibility of the process. Testing took place between December 1988 and December 1989.

PHASE II A
Kruger mill (Bromptonville)
Continuation of the tests on an industrial-scale pilot unit in order to establish the design parameters for a full-scale unit and evaluate the economic and operational aspects of the system in pseudo-dynamic operating conditions. Testing took place from May to September 1990.

PHASE II B
Daishowa Forest Products Ltd. (Québec City)
Installation of the industrial-scale pilot unit in order to complete the technical evaluation using effluent from TMP, cardboard manufacturing and de-inking processes. Testing took place from May to September 1991.

BACKGROUND

By 1994, the Canadian pulp and paper industry will face stricter environmental standards for the removal of BOD_5 and SS, as well as acute toxicity*, measured in terms of LC50**. Consequently, pulp and paper mills will be required to install secondary treatment systems in order to comply with the new regulations.

Since most mills are located in urban environments, space requirements for conventional effluent treatment systems are a major constraint. Thus the aerated biofiltration process appears to be an attractive option. A two-phase pilot project was therefore carried out at Kruger Inc. in Bromptonville, Québec, and at Daishowa Forest Products Ltd. in Québec City.

* Property of a substance which has a lethal effect on fish subjected to lethality tests.

** LC50 (lethal concentration 50) : the level of concentration of a substance in solution at which 50% of the fish subjected to lethality tests die.

TECHNOLOGY

The Biocarbone process is a down-flow filter whose immersed and aerated material supports a fixed film biomass. The Biocarbone removes the BOD_5 and operates like a filter due to the grain size of the material (expanded shale) which captures the suspended solids (SS). Nutrients are added to the mills' wastewater as it moves toward the biofilter.

The oxygen essential to biological aerobic activity is supplied by air diffusers which blow air up into the material. This system ensures an exceptionally high oxygen transfer.

The diffused air rises countercurrent to the liquid flow, continuously loosening most of the filter bed. In this way, the suspended solids contained in the wastewater securely penetrate the filter bed and are trapped in a layer of the supporting material located beneath the air diffusers.

The Biocarbone biofiltration process was developed by OTV (France), which holds the worldwide patent. The technological and commercial development of Biocarbone in North America is being carried out by John Meunier Inc., which supplied Kruger Inc. and Daishowa Forest Products Ltd. with the pilot units and equipment.

RESULTS

TREATMENT EFFICIENCY OF THE BIOCARBONE PROCESS

The Biocarbone process removes the BOD_5 and SS loads, as well as the principal toxic substances, from integrated thermomechanical pulp mill effluent.

- **BOD_5**

The Biocarbone process removed up to 90% of the initial BOD_5 load (300 mg/l) of the effluent, reducing it to between 20 and 30 mg/l. This complies with the strictest government standard of 5 kg BOD_5 per production ton (monthly average) of allowable discharge.

- **TSS**

The process efficiently reduced the suspended solids in the effluent by approximately 70% to 95% (5 to 50 mg/l), thereby meeting the strictest government standard of 7.5 kg TSS per production ton (monthly average) of allowable discharge.

- **Toxicity**

No acute toxicity was detected as measured by the LC50 test.

COST OF THE PROCESS

Compared to conventional systems, the Biocarbone process has advantages in terms of capital expenditure and operating costs. A comparative study conducted for the Kruger pulp mill showed the estimated capital expenditure for a conventional activated sludge system to be \$4500/kg BOD_5 removed, with annual operating costs of \$0.36/kg BOD_5 removed. Capital costs for a Biocarbone process were estimated at \$3900/kg BOD_5 removed, with operating costs of \$0.30/kg BOD_5 removed.

These operating costs (in 1990 Canadian dollars) do not include equipment depreciation. Capital costs for both treatment processes include costs associated with the pumping station, the primary clarifier, the biological treatment unit, the secondary clarifier for the activated sludge treatment, the Biocarbone wastewater settling tank, the sludge treatment and the spillage tank. Operating costs include labour, chemicals, sludge disposal, spare parts and analytical tests required by government regulation.

RESULTS			
Phases	Phase I : Kruger Laboratory pilot test	Phase II A : Kruger Industrial-scale pilot test	Phase II B : Daishowa Industrial-scale pilot test
Characteristics of raw water : conventional parameters	BOD_5: 150 to 300 mg/l COD : 300 to 600 mg/l SS : 50 to 100 mg/l	BOD_5: 150 to 300 mg/l COD : 300 to 600 mg/l SS : 50 to 100 mg/l	BOD_5: 200 to 300 mg/l COD : 500 to 750 mg/l SS : 90 to 150 mg/l
Flow rate	1.5 m^3/d	75 m^3/d	100 m^3/d
Effluent quality : conventional parameters	BOD_5: 3 to 24 mg/l COD : 57 to 172 mg/l SS : 2 to 6 mg/l	BOD_5: 18 to 64 mg/l COD : 172 to 366 mg/l SS : 6 to 26 mg/l	BOD_5: 20 to 50 mg/l COD : 170 to 220 mg/l SS : 16 to 55 mg/l
Treatment efficiency : non-conventional parameters			
• Removal of fatty acids	23 to 78%	24 to 71%	80 to 95%
• Removal of resinous acids	79 to 98%	71 to 99%	80 to 91%
Detoxification	Non-lethal 100% effluent (LC50 test)	Non-lethal 100% effluent (LC50 test)	Non-lethal 100% effluent (LC50 test)

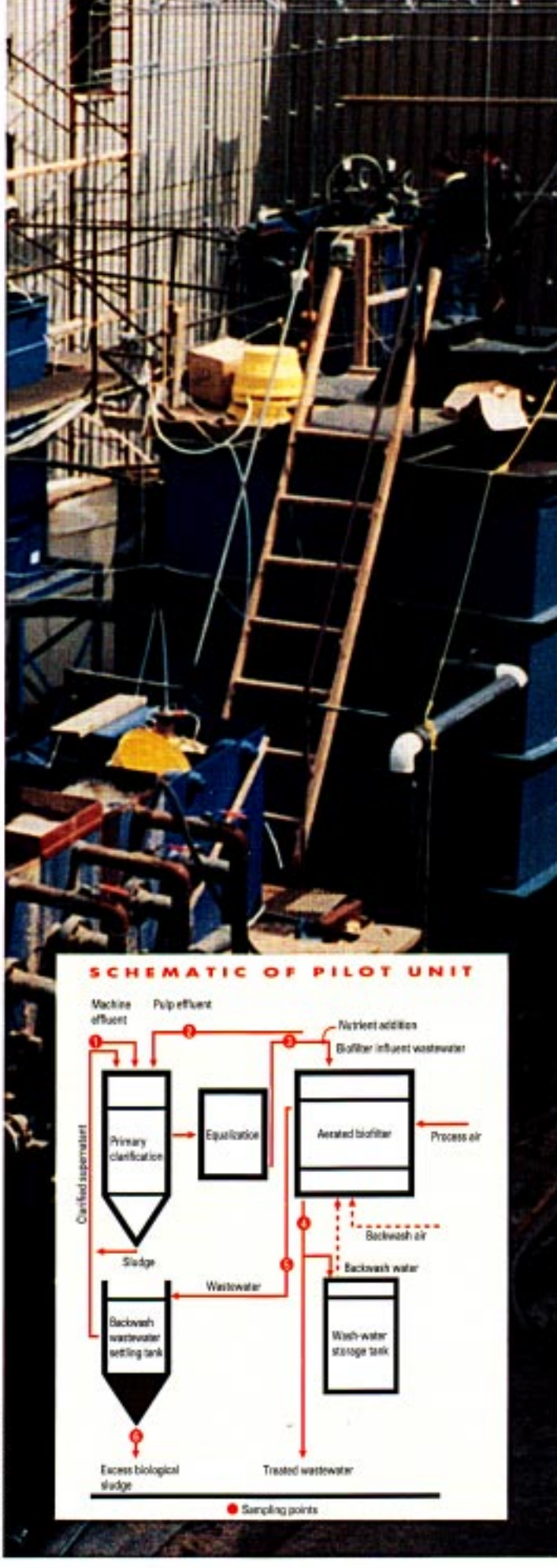

Photo : John Meunier Inc.

POTENTIAL AND LIMITATIONS

DESIGN AND OPERATING CRITERIA

The stated treatment efficiency of the Biocarbone process can be attained for similar effluent if the organic load of untreated wastewater is between 2 and 5 kg of $BOD_5/m^3/d$ for the same grain size as the material used in the pilot project. The hydraulic load must not exceed 2 $m^3/m^2/h$, and the concentration of suspended solids must be less than 120 mg/l. These criteria were obtained using untreated wastewater with a BOD_5 level of under 300 mg/l.

A spillage tank with a one-day storage capacity is also required to protect the biological treatment system in case of accidental spills. Yet, the Biocarbone process can tolerate a temporary nutrient deficiency (24 hours), as well as relatively hot effluent (41°C) with no loss of efficiency.

POTENTIAL

Generally speaking, the Biocarbone process yields results comparable to those of conventional activated sludge processes for volume loads two to three times larger. The process removes the main toxic elements, reduces BOD_5, COD and SS concentrations efficiently and withstands hydraulic and organic shock loads.

LIMITATIONS

Wastewater treated using the Biocarbone process may not attain the effluent quality obtained during pilot tests if the organic load of raw water exceeds 5 $kg/m^3/d$ and the BOD_5 is greater than 300 mg/l. Moreover, a reduction in water consumption within a given mill may require a recirculation of water already treated by the Biocarbone process, to reduce the potential effects of an increase in the concentration of organic matter.

The amount of biological sludge produced by the Biocarbone process is comparable to that of biological activated sludge processes.

INFORMATION

This data sheet is based on the results of a technology development and demonstration project carried out by John Meunier Inc. with financial support from the St. Lawrence Centre, in cooperation with Kruger Inc. and Daishowa Forest Products Ltd. The project also received financial assistance from Industry, Science and Technology Canada, and Supply and Services Canada.

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Data sheets may be obtained free of charge from :
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Cette fiche est également disponible en français sous le titre *Traitement d'effluents d'usines de pâtes et papiers par biofiltration avec le procédé Biocarbone*[MD]

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