St. Lawrence TECHNOLOGIES

ABSTRACT

Disposing of the hazardous wastes generated by industry is costly and recycling technologies are not always available or are too expensive. The Firm Zenon Environmental Inc., in cooperation with the Reynolds Aluminum Company of Canada plant in Cap-de-la-Madeleine, conducted demonstration tests of the ZenoGem™ tubular membrane bioreactor process for the treatment of oily wastes. The results were compared to the ultrafiltration system currently in use at the plant. The benefits of the process on toxicity removal and on hazardous waste volume reduction were both demonstrated.

INDUSTRIAL WASTEWATER

ZENOGEM™ MEMBRANE BIOREACTOR FOR THE TREATMENT OF OILY WASTES

MAIN FEATURES

- **Technology**
  - Meets sewer discharge requirements
  - Withstands organic shock loads
  - Requires minimum installation space for a higher quality of effluent
  - Meets low flow and concentrated waste treatment requirements.
- **Environment**
  - Detoxifies biologically treatable industrial effluents
  - Effluent requires further treatment to meet river discharge criteria
  - Significant reduction of sludge quantities for disposal.
- **Cost**
  - Reduced cost of hazardous waste disposal
  - Capital and operating costs should be compared with other biological treatment options.

ST. LAWRENCE ACTION PLAN

Environment Canada
Protection
Québec Region

Environnement Canada
Protection
Région du Québec

ZENON

PROJECT OBJECTIVES

The Reynolds Aluminum Company of Canada plant in Cap-de-la-Madeleine uses ultrafiltration to treat oily wastes from its hot rolling process operations. This technology annually produces about 900 000 liters of a concentrate considered a hazardous waste, and another 2.1 million liters of effluents discharged into the sewers.

This demonstration project assessed the membrane bioreactor technology as an alternative to the plant's existing treatment process.

The four major objectives of the project were:

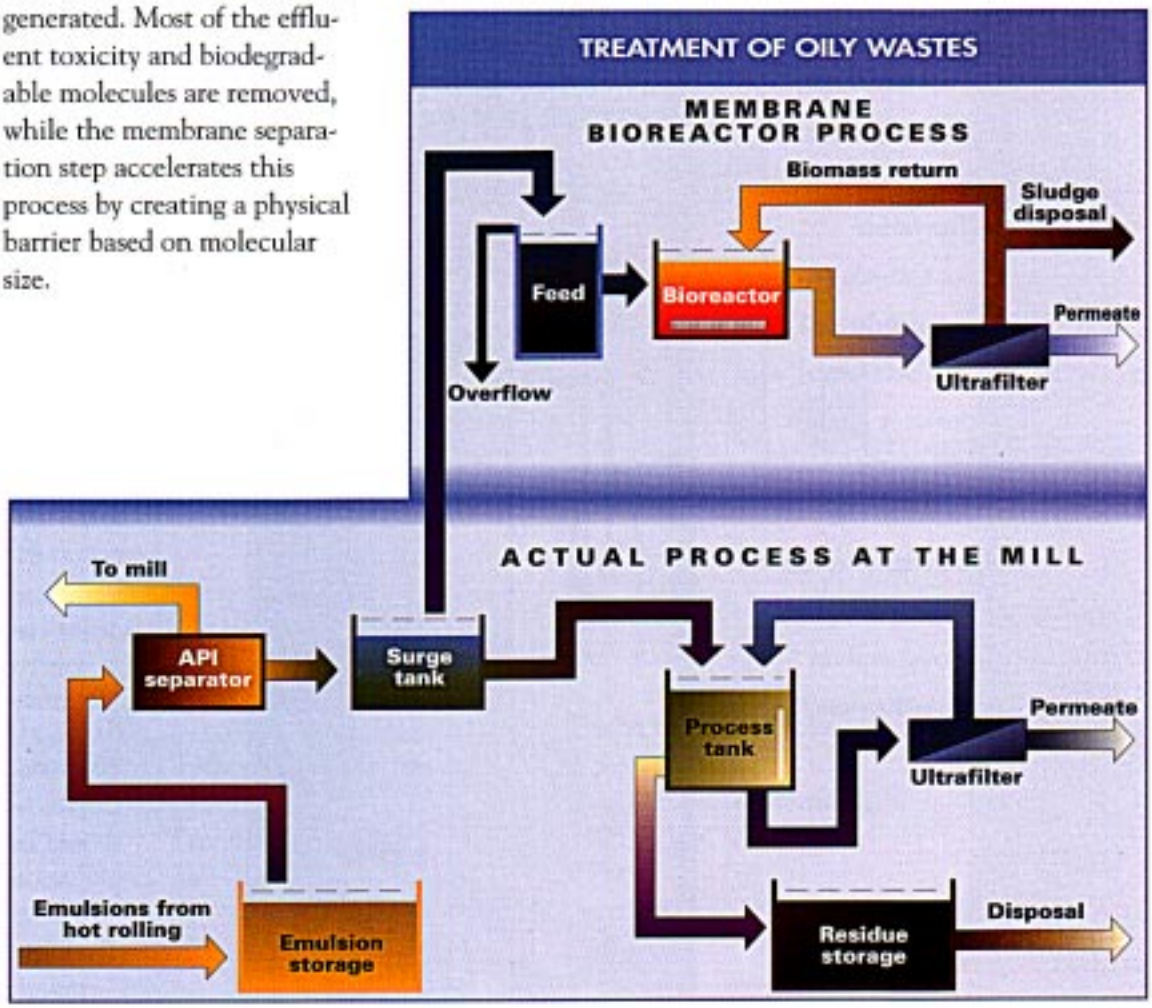
- To examine the capability of the membrane bioreactor technology for the treatment and detoxification of emulsified effluents from hot rolling operations at a metal processing mill;
- To compare the performance of the membrane bioreactor to the waste treatment process currently applied at the mill;
- To assess the new technology's benefits in terms of waste management;
- To establish which discharge criteria, river or sewer, can be met for this application.

BACKGROUND

At present, the Reynolds Aluminum Company of Canada mill in Cap-de-la-Madeleine treats oily wastes from its hot rolling operations using an ultrafiltration process. This results in a substantial quantity of hazardous waste for disposal. An option like biological treatment, coupled with membrane ultrafiltration, considerably reduces the amount of sludge generated. Most of the effluent toxicity and biodegradable molecules are removed, while the membrane separation step accelerates this process by creating a physical barrier based on molecular size.

TECHNOLOGY

With the tubular membrane bioreactor technology, wastewater is treated in a biological reactor where bacteria breakdown the organic matter, removing a substantial amount of toxicity. The filtration membrane process then removes the biomass from the liquid phase. The biomass is returned to the biological reactor and the permeate is discharged into the sewers. The membrane process used here is in the ultra and nanofiltration range. The diagram below shows both the treatment system demonstrated at the Reynolds Aluminum Company of Canada mill and the existing ultrafiltration system.



RESULTS

Membrane bioreactor performance

The bioreactor performed well under transient and equilibrium conditions, even under drastic changes in effluent concentrations, as demonstrated during the study period. A typical wastewater characterization is shown below.

WASTEWATER CHARACTERIZATION

Parameter	Minimum	Maximum	Mean
Oil and grease	680	104 000	9 875
Total BOD	1 164	26 400	5 105
Total COD	7 650	177 000	29 434
SS	370	13 200	2 020
Phenols	0,049	11,6	0,73
pH	5,2	6,7	6,0

N.B.: All results in mg/L except for pH. Colour was not measured.

During these experiments, the biological reactor was capable of buffering incoming organic and toxic shock loads. The oil and grease were concentrated in the reactor and the permeate adequately respected sewer discharge criteria for both hydraulic retention times tested. However, because of the proposed requirements for phenols, oil and grease, further treatment is necessary in order to meet river discharge criteria. The experimental results for three operating conditions tested are presented below.

MEMBRANE BIOREACTOR PERFORMANCE

	Period			Proposed R-300 discharge regulation	
Parameter	1	2	3	Sanitary	Storm / River
Total BOD	5	117	17	N/A	30
Total COD	2 720	1 395	1 200	N/A	N/A
Oil and grease	60	49	20	150	15
Phenols*	0,032	n/d	0,053	1	0,01
Colour**	n/d	265	237	N/A	15

* Total phenols.

** Colour units, all other values in mg/L.

The results for the performance of the ultrafiltration membranes coupled with the bioreactor are shown below.

ULTRAFILTRATION MEMBRANE PERFORMANCE

Flux rates	37 L/m²-hr @ operating differential pressure of 480/140 kpa
Cleaning frequency	Chemical cleaning: once every 10 days
Sludge production	Reduction from 900 000 to less than 300 000 L/year

The operating conditions of the membrane bioreactor for the three testing periods are presented below.

MEMBRANE BIOREACTOR OPERATING CONDITIONS

	Period		
	1	2	3
HRT*	10	10	6
SRT**	75	50	50

* HRT: Hydraulic retention time, d.

** SRT: Solids retention time, d.

Toxicity removal

The results of the Microtox test on untreated wastewater, the effluent from the mill's ultrafiltration membrane system and on the membrane bioreactor permeate are presented below.

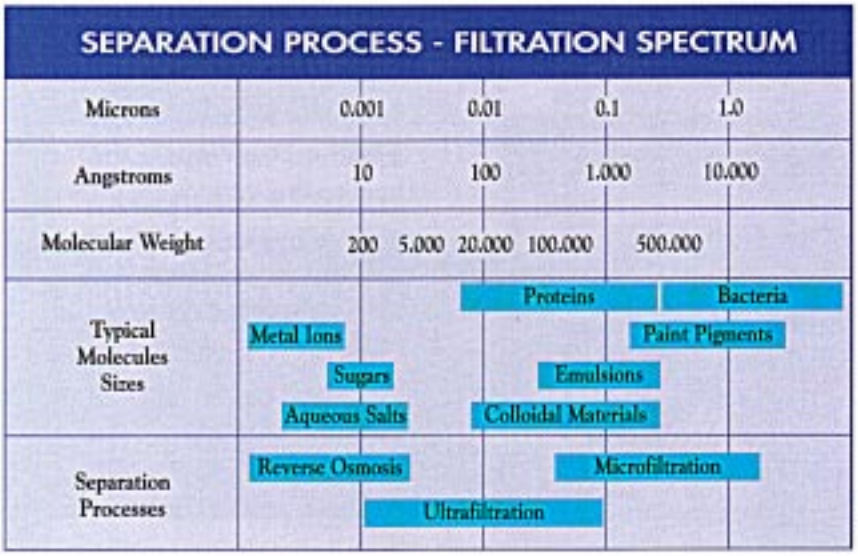
MICROTOX TEST RESULTS

Toxicity test	Untreated wastewater*	Mill permeate*	Bioreactor permeate ZenoGem™*
Microtox 15 min.	16 667	130	16

* L.O.E.C.: Lowest observable effect concentration in toxic units.

POTENTIAL AND LIMITATIONS

The membrane bioreactor technology can detoxify the effluents from the hot rolling operations and adequately treat the oily wastes from the metal transformation mill to meet sewer discharge requirements. Further treatment is necessary to meet river discharge criteria. The biological system reduced significantly the amount of hazardous waste in comparison with the mill's actual system. However, this sludge is still considered a hazardous waste on account of the high concentrations of oil and grease and other substances. Considering the cost of disposal, the membrane bioreactor concept of treatment offers relief. The cost of implementing such a system deserves consideration and should be compared with other alternatives. The membrane bioreactor system was capable to withstand the effect of organic and toxic shock loads.



INFORMATION

This data sheet is based on the results of a technology development and demonstration project carried out by Zenon Environmental Inc. in cooperation with Reynolds Aluminum Company of Canada plant in Cap-de-la-Madeleine. The project received financial support from Environment Canada.

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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 Section, 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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