St. Lawrence TECHNOLOGIES

INDUSTRIAL WASTEWATER

TREATMENT OF DE-INKING EFFLUENTS BY ACTIVATED SLUDGE AND AERATED LAGOON SYSTEMS: PILOT STUDY AND SCALE-UP

ABSTRACT

Wastewater from the Kingsey-Falls and Breakeyville de-inking plants of Cascades Inc. was used to assess the effectiveness of activated sludge and aerated lagoon processes on de-inking effluent. Following characterization, this wastewater was subject to pilot tests at the Centre de Recherche en Pâtes et Papiers of the Université du Québec à Trois-Rivières (UQTR). The study measured process efficiency in removing BOD_5, COD, and resin and fatty acids, and in decreasing effluent toxicity for trout and daphnia.

Results indicate that the SS concentration and BOD_5 conformed with new environmental standards and that the effluent was no longer acutely toxic. Test data was used in the design and optimization of the activated sludge system at the new Désencrage C.M.D. plant in Cap-de-la-Madeleine.

MAIN FEATURES

- **Technology**
  - New application of proven conventional technologies at de-inking plants
  - Aerobic treatment processes applicable to all de-inking effluent
  - Resistance to effluent loading variations.
- **Environment**
  - Concentrations of organic matter and suspended solids significantly reduced
  - Applicable to waste paper de-inking plants
  - Removal of acute toxicity in treated effluent.
- **Cost**
  - Capital and operating costs minimized by optimizing design criteria.

ST. LAWRENCE ACTION PLAN

Environment Canada Protection Québec Region

Environnement Canada Protection Région du Québec

Cascades inc.

PROJECT OBJECTIVES

I To assess and develop an activated sludge or aerated lagoon treatment strategy for reducing conventional pollutants and removing acute toxicity in de-inking mill effluent;

II To define design and optimization criteria for these secondary treatment processes and introduce them at three Cascades Inc. plants;

III To apply the activated sludge pilot plant test results to the operation of C.M.D.'s wastewater treatment plant at Cap-de-la-Madeleine.

TESTS

The pilot tests were conducted over an eight-month period at the Centre de Recherche en Pâtes et Papiers of the UQTR in Trois-Rivières, using wastewater from the Kingsey-Falls and Breakeyville de-inking plants. Following primary treatment, the Kingsey-Falls effluent had an average BOD_5 of 4.4 t/d with SS averaging 0.5 t/d, for a mean flow rate of 7000 m^3/d. The Breakeyville aerated lagoon effluent had an average BOD_5 of 0.5 t/d, an SS load of 0.3 t/d, and a mean flow rate of 1300 m^3/d.

Treatment tests on Kingsey-Falls effluent were conducted using an activated sludge pilot system. Testing of Breakeyville effluent necessitated both an activated sludge system and an activated sludge system coupled with an aerated lagoon.

BACKGROUND

For some ten years now, more and more waste papers are recovered and de-inked to be reused in the manufacture of pulp and paper products. This practice has developed in reaction to the growing scarcity of virgin wood furnish; to meet the recent requirement for higher recycled fiber content in newsprint imported into the United States; and also to help protect the environment.

De-inking processes remove ink and all other non-fibrous materials (glue, pigments, solvents, etc.) from waste papers and paperboards. Process wastewaters also contain recycled fibres which have deteriorated during de-inking, as well as residue from the chemical agents used. The composition of resulting effluents is different from that of conventional pulp and paper mills. The treatment of these effluents constitutes a new challenge to the protection of the environment.

TECHNOLOGY

Relatively small amounts of fresh water (10-20 m^3/m.t.) are required by waste paper de-inking processes. This results in effluents that are more toxic and concentrated, but nonetheless treatable by secondary treatment stations.

Activated sludge and aerated lagoon treatment are aerobic processes used to biodegrade organic compounds. The activated sludge treatment system seems to be the most appropriate to treat the Kingsey-Falls plant effluent. For Breakeyville effluent, the performance of the existing aerated lagoon is not sufficient to meet the new standards: tests are thus required with an activated sludge system (more effective than the lagoon), or with a reduced volume activated sludge system combined with an aerated lagoon system.

The activated sludge technology was adopted at the start-up of the new Cap-de-la-Madeleine plant in March, 1993. An activated sludge pilot unit was simultaneously operated at the UQTR in order to compare and optimize full-scale in-plant operation of the system.

ACTIVATED SLUDGE — PILOT UNITS

RESULTS

Process efficiency

Pilot testing involved the operation of activated sludge systems under a variety of experimental conditions. Results indicate that for the Kingsey-Falls and Breakeyville plants, removal rates remained higher than 98% for BOD_5, and at greater than 80% for SS: removal rates for resin and fatty acids ranged from 12% to 65%, and the resulting effluents were not toxic. Excellent removal rates and better sludge sedimentation were obtained by adding an aerated lagoon to a reduced volume activated sludge unit (12-hour HRT), for the Breakeyville mill effluent.

Design and operating criteria

Based on the pilot test results, the following design criteria were adopted for the activated sludge unit at the new Cap-de-la-Madeleine plant:

- 48-hour HRT
- 15-day-old sludge
- 0.7 to 0.95 kg/m^3 BOD_5 load
- 0.2 to 0.4 F/M
- 3500 mg/L mixed liquor (MLSS)
- Sludge production assessed at between 0.5 and 0.7 g/g BOD_5 removed.

Full-scale performance (Cap-de-la-Madeleine plant)

The full-scale activated sludge unit start-up took place in November, 1992. After a five-month breaking-in period, performance results already exceeded discharge standards. After one year of operation, at the end of 1993, BOD_5 discharge levels are at 0.1 kg/t; SS are at 0.3 kg/t; and the effluent is not toxic to trout and daphnia. Sludges extracted from the final settling tank are mixed with primary de-inking sludge and will be burned in a boiler, producing vapour at a rate of between 25 000 and 50 000 pounds per hour.

Process costs

Capital costs of installing the activated sludge process at the Cap-de-la-Madeleine plant were set at some $870/kg of BOD_5 removed, based on a flow rate of 4800 m^3/d and a daily BOD_5 loading of 8000 kg. This estimate is for a Cascades Inc. installation, and includes the purchase of flotation cells; the purchase and adaptation of old oil tanks as secondary reactors; the construction of a secondary clarifier and an emergency buffer tank; the installation of high-pressure pumping units; mechanical equipment; control instruments; plumbing; chemical product preparation systems; and complete sludge treatment systems for energy recovery (including sludge conditioning, drying and combustion in the new plant's modified boiler). Operating costs (including labour, chemical products, electricity, replacement parts, sludge removal, and control analyses) amount to some $0.35/kg of BOD_5 removed.

PILOT TESTS RESULTS

Parameters		Kinsey-Falls plant				Breakeyville plant				
		Activated sludge				Activated sludge				A.s. + lagoon*
HRT (h)		24	18	18	12	48	36	36	24	12 + 168
θ (age of sludge, in days)		10	15	10	10	10	15	10	10	10 + 7
BOD_5 (mg/L)	influent	722	572	722	722	1167	1380	1167	1167	1442
	effluent	9.2	10.4	12.4	12.9	12.2	13.9	11.1	7.3	10.8
	removal percentage	98.9	98.1	98.3	98.3	98.9	98.9	99.1	99.2	99.2
COD (mg/L)	influent	1140	1120	1142	1142	2409	2815	2390	2440	2641
	effluent	133	126	120	120	251	246	203	223	171
	removal percentage	88.1	88.6	89.3	89.3	89.6	91.2	91.3	90.0	93.5
RFA (mg/L)	influent	0.91	1.39	0.91	0.91	1.13	2.36	1.13	1.13	1.93
	effluent	0.61	1.19	0.32	0.73	0.72	1.06	0.78	0.69	0.87
	removal percentage	33.7	12.2	65.2	20.5	36.1	55.4	30.7	38.7	55
SS (mg/L)	influent	108	89	111	114	180	221	182	182	149
	effluent	11.2	5.1	14.1	19.8	19.6	15.6	21.1	16.1	14.1
	removal percentage	89.6	94.3	87.3	82.6	89.1	92.9	88.4	91.1	90.5
Toxicity** (% v/v)	trout (LC_{50}-96 hr)	100	-	100	100	100	-	100	100	100
	daphnia (LC_{50}-96hr)	100	-	100	100	100	-	100	100	100

* A.s. + lagoon = Activated sludge and aerated lagoon.

** To meet government standards, effluent from the Kingsey-Falls plant must be less than 225 mg/L for BOD_5, less than 408 mg/L for SS and must not be toxic for trout and daphnia.
To meet government standards, effluent from the Breakeyville plant must be less than 315 mg/L for BOD_5, less thant 505 mg/L for SS and must not be toxic for trout and daphnia.

POTENTIAL AND LIMITATIONS

Operating results at the effluent treatment station of the Désencrage C.M.D. Inc. plant have been exceptional. The station was designed to treat effluent from a plant that produces 500 tonnes of de-inked wood pulp daily. The treatment system limit is encountered at the secondary clarifier, where the following steps must be taken to ensure optimal settling:

- Avoid wide flow variations to the secondary clarifier by using an emergency buffer tank;
- Operate at a F/M that promotes the development of microorganisms forming biological flocs with good settleability. The addition of a small amount of ferric chloride helps the development of these microorganisms.

INFORMATION

This data sheet is based on the results of a technology development and demonstration project conducted by the firm Cascades Inc. and the Centre de Recherche en Pâtes et Papiers of the Université du Québec à Trois-Rivières, with the technical and financial assistance of Environment Canada.

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