ENVIRONMENT

Technological Innovation

ABSTRACT

WR3 Technologies Inc. conducted a full-scale demonstration of an innovative technology used to treat industrial landfill leachate at the landfill site of a pulp and paper mill. This chemical-free technology is based only on physical mechanisms occurring simultaneously within multiple reactor vessels.

The main objective of the demonstration was to evaluate the overall efficiency of this technology under real industrial conditions, and demonstrate its ability to produce an effluent that complies with environmental standards, with a view to its ultimate discharge into the receiving environment.

The treated leachate complied fully with all the standards set by the Quebec Environment Ministry for direct discharge of treated water into the environment. Most treated water parameters actually tested below the detection limits of measurement devices or standard methods used for wastewater analysis. The final discharge was virtually pure water.

WASTEWATER

THE OXYCAIR™ SOLUTION FOR LEACHATE TREATMENT

HIGHLIGHTS

Technology
- Based on various physical processes
- Proven, cost-effective and efficient treatment
- Wide spectrum of potential application
- Responds to large variations in organic and hydraulic loading

Environment
- Production of nearly pure water
- No use of chemicals or bacteria
- Reduces transportation impacts
- Reduces spill risk
- Reduces liquid and solid discharge volumes

Savings
- Reduces overall costs for leachate and wastewater treatment
- Eliminates leachate transportation costs
- Reduces solid waste transportation costs
- By-product is returned to the landfill without additional disposal costs

Canada

WR3 Technologies inc.

Centre intégré en pâtes et papiers

PROJECT OBJECTIVES/ PHASES

The main objective of the project was to evaluate, under industrial conditions, the capacity and overall efficiency of this technology to produce an effluent that complies with environmental standards and, ultimately, to discharge treated leachate directly into the receiving environment.

Other objectives of the project were:

- **To maximize performance of the technology**
- **To validate the results and the technology**
- **To optimize the reliability of components**
- **To develop a modeling software to evaluate performance**
- **To define the maintenance cycle of components**
- **To evaluate operating costs and energy consumption per cubic metre of treated water.**

Standard environmental norms were the main variables by which treatment efficiency was evaluated. The physico-chemical analyses of raw and treated leachate were performed according to the standard methods of the laboratories at the Centre Intégré en Pâtes et Papiers (CIPP) of the Université du Québec à Trois-Rivières (UQTR) and at accredited commercial laboratories. Typically, the leachate and treated water were sampled three times a week.

BACKGROUND

Some North American pulp and paper mills send their solid wastes to landfill sites, thereby generating large volumes of leachate. It is difficult to treat leachate using conventional technologies for a number of reasons, including high H_2S levels and cold weather. Also, because landfill sites are usually far from urban areas, leachate is often trucked some distance to a mill's wastewater treatment plant, an expensive and hazardous option.

Because of the efficiency and potential of this new technology, the management of landfill leachate has become an important goal for WR3 Technologies.

TECHNOLOGY

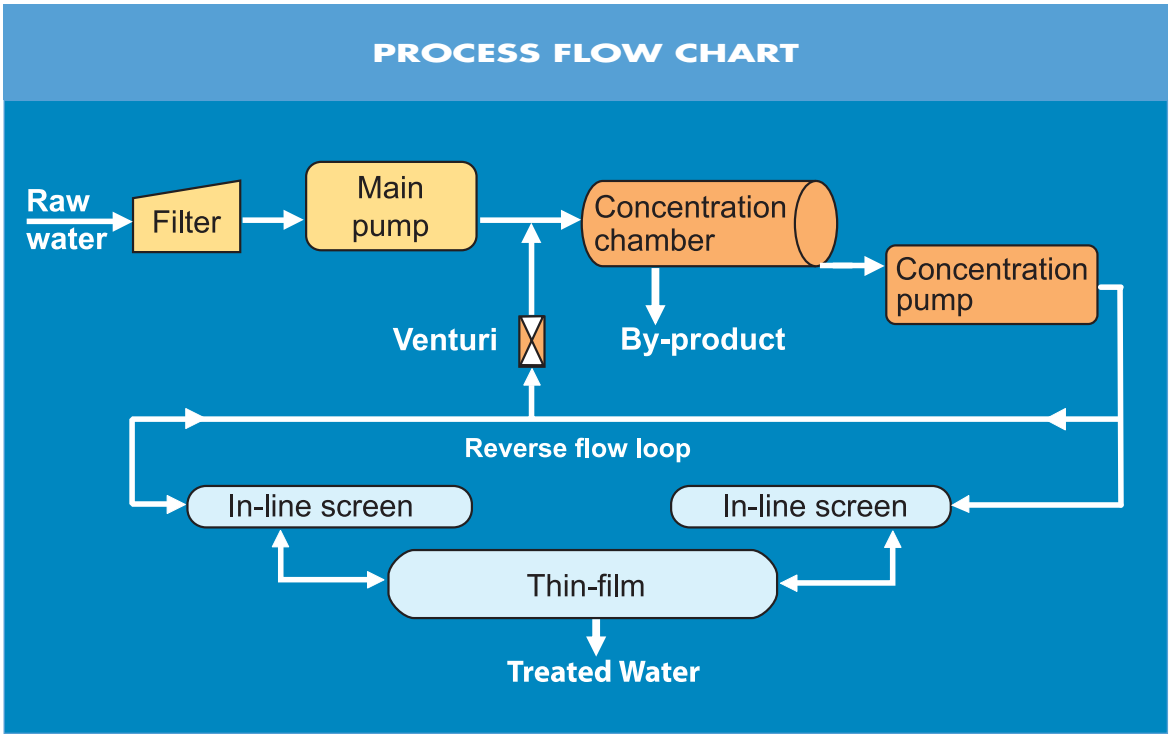
Oxycair™ technology relies on several physical processes that take place within multiple reactor vessels. At the intake, a coarse filter protects the main pump. This submersible pump increases the pressure and raises the temperature, breaks up solids, and homogenizes the raw water. The water is supersaturated with air by venturi induction and mixed with the process stream.

Once in the concentration chamber, the stream is subjected to various physical processes including: mechanical sieving and shear stress; static settling, flotation and degassing; air supersaturation and oxidation; cavitation and sonoluminescence; and pressure, salinity, temperature and velocity variations.

At the outlet of the chamber, concentration pumps boost the pressure and temperature, and salts are redissolved. Inline screens encourage the formation of crystals, enhancing filtration and protecting the thin film used for polishing. This process resolves conventional membrane limitations by eliminating plugging and blinding problems, biofouling, and the mechanical stressing of membrane elements.

The system accommodates a wide range of load, pH and temperature variations, allowing for year-round operation under all conditions. The technology maximizes treated water recovery from the effluent and minimizes by-product discharge volumes.

PROCESS FLOW CHART



RESULTS

Over the course of this project, which ran for 18 months, the Centre Intégré en Pâtes et Papiers acted as the third party in validating both the results and the technology. The main characteristics of the raw and treated leachate, system performance and environmental discharge standards are shown below.

The leachate, which was treated on site, consistently respected all the discharge standards established by the ministère de l'environnement du Québec (MENV) for release to the receiving environment. Generally speaking, the specific values of each of the standard environmental parameters actually tested below the detection limits of the measurement equipment or standard methods used for wastewater analysis.

Throughout the project, the technology demonstrated that it can run efficiently at peak flows and peak loads year-round. The reliability of the system's self-cleaning mechanisms was also tested.

The results confirm that this technology is a reliable, efficient and cost-effective alternative to conventional methods for treating landfill leachate of pulp and paper mill sites.

The demonstration and validation project contributed to the upgrade of some components; for example, the venturis had to be reconfigured to extend their life spans and increase efficiency. On the other hand, extreme-service motors and pumps were replaced by heavy-duty motors that are less expensive to operate and longer lasting. All other components demonstrated their reliability throughout the demonstration project.

LEACHATE CHARACTERISTICS, SYSTEM PERFORMANCES AND MENV DISCHARGE STANDARDS

Parameters	Maximum value (mg/L)	Minimum value (mg/L)	Reduction (%)	Treated leachate (mg/L)	Leachate discharge standards (mg/L)
Five-Day Biochemical Oxygen Demand (BOD_5)	3 515	250	99.4	5	50
Total Suspended Solids (TSS)	386	10	≥ 99.9	< 5	50
Aluminum	11.20	1.40	≥ 99.9	< 0.0018	10
Iron	17.50	2.55	≥ 99.9	< 0.0012	10
Chromium	0.15	< 0.01	≥ 99.9	< 0.0003	1
Total sulfides	645	2	≥ 99.9	< 0.0003	1
Zinc	0.25	< 0.01	≥ 99.9	< 0.0012	1
Lead	3.55	< 0.01	≥ 99.9	< 0.018	0.3
Mercury	0.40	< 0.01	≥ 99.9	< 0.0018	0.05
Resinic Fatty Acid (RFA)	210	2	≥ 99.9	< 0.0001	0.3
Phenol*	8.7	0.5	≥ 99.9	< 0.0007	0.05
Total Organic Carbon (TOC)	1 720	345	≥ 99.9	< 0.2	NR
Chemical Oxygen Demand (COD)	11 340	890	≥ 99.9	1	NR
Inorganic Carbon and Total Carbon	3 380	540	99.6	7 and 14	NR
Conductivity (µS/cm)	27 800	805	99.3	59	NR
Dissolved Solids (DS) and Total Solids (TS)	22 160	2 650	99.0	120 and 122	NR

Note: The unit had a maximum treatment capacity of 1500m^3/day
*: Phenolic compounds
NR: Not regulated

POTENTIAL AND LIMITATIONS

Potential

In addition to leachate treatment, this technology has great potential in the following sectors:

- Pulp and paper
- Laundry services
- Agrifood
- Petroleum industry

The Oxycair™ Solution makes it possible to:

- Respect the most stringent environmental standards
- Desalinate sea water
- Close the loop in industrial water processes
- Recover heat of the effluent
- Retain heat in the treated water
- Stabilize toxic compounds
- Reduce volumes of waste and liquids requiring management
- Reduce the cost of wastewater treatment
- Reduce the cost of waste management
- Reduce new or make-up water production costs
- Add remote system monitoring and control.

Limitations

Although the technology proved to be very flexible, the demonstration also showed that significant and abrupt variations in the physico-chemical composition of the leachate could require an operator's presence on a regular basis.

INFORMATION

This fact sheet is based on the results of an *in situ* industrial demonstration project conducted by WR3 Technologies Inc., and validated by the Centre Intégré en Pâtes et Papiers. The project received the financial support of Environment Canada, the Canada Revenue Agency and Revenu Québec.

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ENVIRONMENT
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Technological Innovation Data Sheets, published by Environment Canada, are intended for all firms, industries, organizations and individuals interested in new environmental technologies. Their purpose is to disseminate the results of technology development and demonstration projects carried out in the following sectors: Wastewater, atmospheric emissions, contaminated soil, waste management, hazardous waste, agri-environment and innovative tools and processes.

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