St. Lawrence TECHNOLOGIES

INDUSTRIAL WASTEWATER

RECOVERY OF HEAVY METALS FROM INDUSTRIAL EFFLUENTS USING THE THERMONIC TECHNOLOGY

ABSTRACT

Metal finishing and metal processing industry effluents contain toxic metals. Removing these metals using conventional treatment units generates large amounts of sludges classified as hazardous waste, for which disposal costs are high. The firm Thermonic Inc. demonstrated the applicability of a technology designed to remove the heavy metals from the effluents of a variety of plants.

Results show that recovered zinc, copper, nickel and chromium can be recycled. However, the presence of oils, greases and soap in the effluent to be treated reduces the efficiency of metals recovery. Also, sufficient quantities of metallic sludges must be available to sustain recycling plant operations.

MAIN FEATURES

- **Technology**
  - Physico-chemical effluent treatment process
  - Metals recovery by electrolysis or by concentration.
- **Environment**
  - Removal of heavy metals (Zn, Pb, Ni, Cr, Cd, CN, Al, Fe) from the industrial effluents
  - Reduction of quantity and toxicity of sludges generated
  - Recovery and recycling of metals.
- **Cost**
  - Treatment costs comparable to those of conventional physico-chemical processes
  - Economic success of metals recycling dependent on three factors: sludge supply, demand for recovered metals, and the declassification of residual sludge.

ST. LAWRENCE ACTION PLAN

Environment Canada
Protection
Québec Region

Environnement Canada
Protection
Région du Québec

THERMONIC
Assainissement des eaux industrielles
Industrial Wastewater Treatment Co.

PROJECT OBJECTIVES

The project objectives were to verify the pilot-scale performance of the Thermonic technology, with respect to:

1. Removal of metals from certain plant effluents;
2. Recovery of heavy metals contained in the residual sludge of effluent treatment processes;
3. Its economic benefits compared to a conventional physico-chemical treatment process.

PHASE I

FEASIBILITY STUDIES

Laboratory feasibility studies conducted on effluents from eight metal processing and finishing plants, namely: Acralum Paint Inc., ICI Explosives Canada Inc., Pratt & Whitney Canada Inc., Canzip Industries Inc., Sidbec-Dosco Canada Inc., Sivaco Québec Inc., Stelfil Ltd., and Wolverine Tube Canada Inc.

PHASE II

PILOT TESTS

Pilot testing of water treatment units at three industrial plants (ICI Explosives Canada Inc., Stelfil Ltd., and Wolverine Tube Canada Inc.); and recovery of the metals present in sludges resulting from precipitation treatment.

The project was carried out between 1990 and 1993.

BACKGROUND

A number of plants, especially those involved in metal processing and surface treatment, discharge heavy metals in their effluents. Such metals can concentrate in living organisms or precipitate as residual contaminants in receiving waters.

The removal of heavy metals in effluent by conventional physico-chemical treatment generates metallic sludges. These sludges are classified as hazardous waste and their disposal costs are high.

For this reason, the Thermonic firm undertook to demonstrate its own technology, which removes toxic metals from sludges while reducing the risks of future contamination often associated with sludge landfill sites.

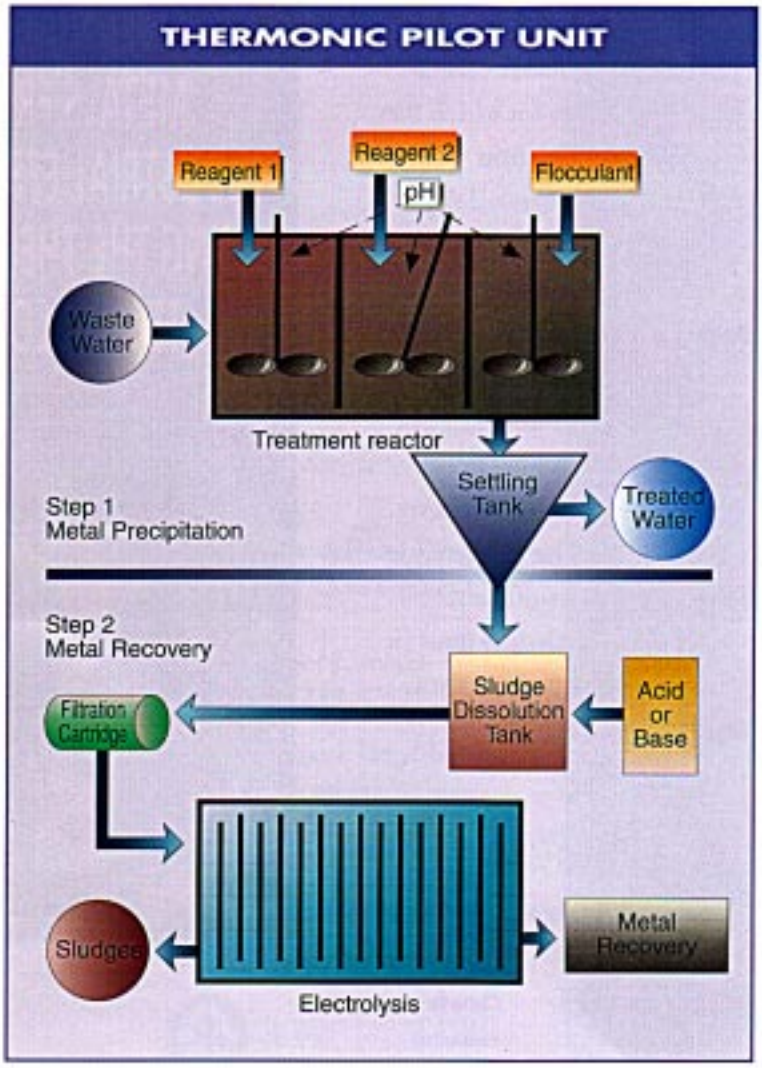
This approach may lead to the market availability of some recovered metals, and to a reduction in the amount of sludge that must be landfilled. In some cases, it may also lead to the declassification of this sludge, thereby reducing disposal costs appreciably.

TECHNOLOGY

The technology developed by Thermonic Inc. involves two principal phases, as shown in the schematic diagram below.

First, a physico-chemical precipitation is carried out in a compartmented reactor, using active reagents chosen according to the metals to be removed. Afterwards, the water is separated from the resulting metallic sludges by settling.

The second phase, the most innovative part of the treatment, involves dissolving the previously obtained sludges using either an acid or a base solution, depending on the characteristics of the sludges and metals. This allows the metals to be recovered by electrolysis or, in the case of spent chromium solutions, by concentration (evaporation) or any other physical or chemical way.



RESULTS

PHASE I
Feasibility studies

Heavy metals removal tests were first conducted on effluent from eight different plants. Testing of sludge dissolution was then carried out, as was the recovery of metals by electrolysis and by concentration. Finally, a preliminary evaluation of the economic potential of the process was carried out by comparing conventional treatment to the Thermonic technology and taking into account their main associated costs.

PHASE II
Pilot tests

Only three of the industries involved in Phase I of the project participated in the pilot tests: that is, ICI Explosives Canada Inc., Stelfil Ltd. and Wolverine Tube Canada Inc. Testing was thereby limited to three main metals: lead, zinc and copper.

As in Phase I, the process was tested for its efficiency in removing heavy metals in effluent, in dissolving sludge, and in recovering metals by electrolysis or any other approved technology. An economic evaluation was also undertaken for Stelfil Ltd. and for Wolverine Tube Canada Inc.; as for ICI Explosives Canada Inc., conditions were such that lead recovery was inefficient, and no sludge dissolution tests were performed.

The table below presents the main results and the economic analyses for each phase:

PHASES	REMOVAL OF METALS IN EFFLUENTS	RECOVERY OF METALS IN SLUDGES	ECONOMIC BENEFIT
I Feasibility studies [Zn, Fe, Pb, Ni, Cr, Cd, Cu, CN, Al] (8 plants)	1. Metals removal results greater than 98%, if concentration in effluent > 10 mg/litre. 2. Results similar to those of conventional technologies. 3. Chromium and cyanide treatments faster and simpler with Thermonic technology's active reagents. 4. Effluent solid-liquid separation easier with the Thermonic technology.	**Metals dissolution** 1. Greater than 90% for zinc, copper, nickel and chromium. 2. This stage is very limited by the presence of impurities. **Metals concentration** 1. Yields greater than 99% for zinc, copper, nickel, lead, chromium and spent plating solutions. 2. Efficiently eliminates strong cyanide concentrations.	Based on a preliminary evaluation, a metals recycling plant could be profitable for six of the eight industries studied compared to sludge disposal at an authorized site.
II Pilot tests [Pb, Zn, Fe, Cu,] (3 plants)	1. Removal efficiency confirmed for iron, zinc, copper and lead, with results above 96%. 2. Better lead removal performances with Thermonic technology on effluent from the ICI Explosives Canada Inc. plant.	**Metals dissolution** 1. Dissolution efficiency of 92% for copper and 98% for zinc. 2. No testing done on lead due to high level of impurities. **Metals concentration** Recovery rate of over 98% for metallic zinc and copper.	1. Due to high levels of impurities, recovery of lead from ICI Explosives Canada Inc. sludge is not profitable. 2. A copper and zinc recycling plant could be profitable where sufficient supplies of sludge exist.

POTENTIAL AND LIMITATIONS

POTENTIAL

The process appears to offer good economic and environmental advantages, especially where effluent impurities are few, where sufficient quantities of sludges justify the operation of a recycling plant, and where the metals recovered have, like chromium, zinc, aluminum and nickel, a good resale value.

LIMITATIONS

Just as for conventional treatments, the metal precipitation capacity of the Thermonic process is hindered by traces of soap, oils or greases in the effluent. Other compounds, whether organic matter, phosphates or calcium, in turn increase consumption of the active reagents of precipitation and hinder dissolution of the metals in the sludge during the recovery stage.

For zinc and copper, Thermonic Inc. has determined that a monthly minimum of 15 to 25 tonnes of sludges are needed to justify operating a metals recycling plant. In a number of cases, plants will have to be regrouped by Thermonic to ensure a sufficient supply of sludge for recycling plant operations.

In the end, there remain a few unanswered questions regarding recycling plant operating methods; the resale value of certain metals; and the development opportunities for metals such as iron, cadmium, and lead. However, Thermonic is working to find markets for these other metals.

INFORMATION

This data sheet is based on the results of a technology development and demonstration project carried out by Thermonic Inc., with financial support from Environment Canada and Industry Canada.

Eight industrial plants also collaborated:
Acralum Paint Inc.
Canzip Industries Inc.
ICI Explosives Canada Inc.
Pratt & Whitney Canada Inc.
Sidbec Dosco Canada Inc.
Sivaco Québec Inc.
Stelfil Ltd.
Wolverine Tube Canada Inc.

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Canada