GREAT LAKES ACTION PLAN

Great Lakes Environment Office
Environment Canada
Ontario Region

CLEANUP FUND
FACT SHEET

CONTAMINATED SEDIMENT TREATMENT TECHNOLOGY DEMONSTRATION SERIES

NUMBER 3

AOSTRA Taciuk Process Treatability Tests

Contaminated Sediment Treatment Technology Program

The Great Lakes Cleanup Fund is a $55 million component of the Federal Great Lakes Action Plan. Started in 1991, the Cleanup Fund focuses on the development and implementation of cleanup technologies for contaminated sediments, urban runoff and rehabilitation of fish and wildlife habitats. The Cleanup Fund also focuses on Canada's 17 Areas of Concern identified by the International Joint Commission for priority clean-up.

The Contaminated Sediment Treatment Technology Program (COSTTEP) was set up to demonstrate new and innovative technologies for treating contaminated sediments. It is also COSTTEP's mandate to communicate results of demonstrations to the Canada/Ontario Remedial Action Plan (RAP) teams and other agencies involved in RAP implementation. The initial focus of the contaminated sediment treatment program has been on demonstrating technologies at laboratory or bench scale. Future priorities will centre on pilot and full scale demonstrations.

This series of Fact Sheets is intended to summarize the demonstration work of COSTTEP. Fact Sheet Number 1 gives an overview of the Great Lakes Cleanup Fund, COSTTEP and the sediment contamination problems in the Great Lakes. All other Fact Sheets are specific to a technology demonstration project. Fact Sheets are available from Environment Canada's Great Lakes Environment Office, Toronto, Ontario.

Taciuk Technology

The AOSTRA Taciuk Process (ATP) technology is owned by the Alberta Oil Sands Technology and Research Authority (AOSTRA) and licensed to UMATAC Industrial Processes for waste treatment applications. The ATP was originally developed to produce oil from Athabasca oil sands (Alberta) and later applied similarly to Australian oil shale. The ATP has been tested more recently on a range of contaminated wastes, primarily associated with the oil industry. Separation of the hydrocarbons (i.e. oil, PAHs, & PCBs) from the solids to generate "clean" solids is the key process in contaminated waste applications.

The Processor of the ATP system is a rotating thermal processing unit which separates the soil, hydrocarbon and water fractions of contaminated soil or sediment (a simplified process schematic is displayed in *Figure 1)*. Slurried waste enters a preheat zone where pyrolytic vaporization of water and light hydrocarbons occurs as the waste is

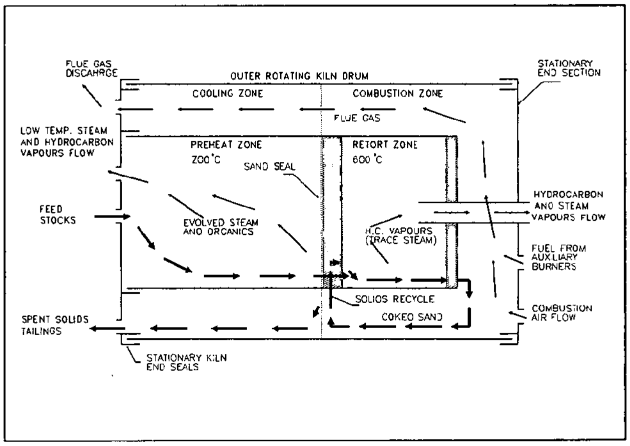

FIGURE 1: Schematic for the AOSTRA Taciuk Processor showing internal process flow streams.

heated to approximately 200°C. The remaining organics and solids pass to the retort zone where pyrolytic vaporization and thermal cracking of heavy hydrocarbons occurs. The temperature in this zone is 500°C to 600°C. The coked solids then pass to a combustion zone where residual carbon from the thermal cracking phase is burned for process heat make up, and the residual solids are heated to be used for heat transfer to incoming feed. Separation of the three stages of the process within a single unit is made possible by patented seals which use free flowing sand.

Canada

Laboratory Scale Demonstration Project

The treatability studies were performed at the UMATAC facilities in Calgary, Alberta. Two batch units were used, simulating the retort zone and the combustion zone of the process as illustrated in *Figure 1.* Tests were performed on sediments from Thunder Bay and Hamilton Harbour.

The batch pyrolysis unit tests for distillation and pyrolysis extraction of organics, the processes relevant to the retort zone of the ATP. The unit is a 12" diameter, 4" long, electrically heated, insulated steel drum. Parameters varied were the pyrolysis temperature, solids residence time (run length) and for the Thunder Bay sediment only, vapour residence time (N_2 purge gas volume). "Ramp" tests in the pyrolysis unit, during which temperature was raised from ambient to approximately 650°C, were used to establish the range of parameters required for the ensuing tests.

The batch combustion unit, which is similar in design to the pyrolysis unit (the main difference is that combustion air is added to the combustion unit) was used to test one solids sample from a pyrolysis test of each sediment. The sample was added and run until extinction of the coke. The test was to ascertain the combustion characteristics of the coked solids, the major requirements of a flue gas treatment system in a pilot/full scale ATP unit and the physical and environmental characteristics of the combusted solids.

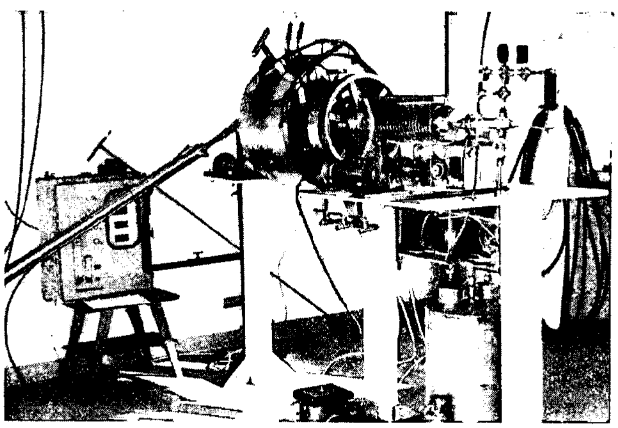

FIGURE 2: Photograph of 1991 laboratory unit.

After performing simple characterization analysis and "Ramp" tests, 4 pyrolysis tests were run using the Hamilton sediment, 5 pyrolysis tests using Thunder Bay sediment and a single combustion test on the coked solids from both Hamilton and Thunder Bay.

The analytical program consisted of analyses regarded as standard by UMATAC for the testing protocol they had developed, complemented for some runs by analyses requested by the Wastewater Technology Centre (WTC). This program was conducted by an independent commercial laboratory. The WTC laboratory analyzed duplicate samples of the liquid and solid products from a pyrolysis test, as well as a sample of the feed, the solids from a ramp test and the combusted solids for each sediment. *Table 1* summarizes the testing and analytical program and selected results.

Results and Discussion

The data submitted by UMATAC indicated that the combination of pyrolysis and combustion were effective in substantially reducing the organic contaminant concentrations associated with Hamilton Harbour and Thunder Bay sediment solids.

The pyrolysis stage separated more than 90% of the oil and grease from the solids, which was reflected by the reduced levels of the organic contaminants in the treated solids and high Biological Oxygen Demand and Chemical Oxygen Demand values of the liquid effluent stream (primarily water). Hence the water condensed from the pyrolysis unit would require treatment prior to discharge. Oil was condensed in significant quantities only for the Thunder Bay sediment (50 L/tonne of raw sediment). PAHs were reduced to non-detect limits for the coked solids and concentrated in the liquid stream.

After combustion, both the oil and grease and the Total Organic Carbon had been reduced by over 94% for Hamilton Harbour sediment and over 99% for the Thunder Bay sediment. The resulting solids remained contaminated to a significant degree by metals only (metals are not removed by the ATP technology). However, the metal leachate values obtained for the combusted solids were all lower than regulatory limits.

Unfortunately, in view of the apparent success of the project, the quality of the analytical data has been questioned by the WTC. The PAH concentration reported by the laboratory contracted by UMATAC for this project for the Hamilton Harbour sediment was significantly below the historical value. Also of concern was the fact that the concentration of metals on the solids being processed appeared to decrease as the sediment underwent pyrolysis and combustion. In addition, a metal mass balance could not be obtained over the pyrolysis stage.

Metals concentration should in fact increase, as the solid mass decreases (organics are vaporised and/or combusted). As the method of analysis - Inductively Coupled Plasma - should report the total metals concentration regardless of speciation, it is conceivable that the samples submitted for analysis may in fact have been more representative of the clean recycle sand than the sediment solids. The WTC results indicate metals concentrations in the combusted solids approximate that in the clean sand.

Conclusions

In their final report UMATAC staff drew several conclusions. In summary these are:

1. The ATP technology is technically capable of treating sediments to remove contaminating organics;
2. Water derived in the process will require treatment prior to reuse or release. By dewatering sediment prior to processing, the water treatment unit would be reduced in size, and energy savings in the ATP process would be realized;
3. The combusted solids passed the USEPA TCLP leaching test; and,
4. A small quantity of oil is recovered from Thunder Bay sediment, requiring disposal as a hazardous waste.

As the auditing agency for the project, the WTC also had conclusions about the project. In summary these are:

1. The UMATAC conclusions are fundamentally true provided the laboratory data is correct;
2. The UMATAC staff are very experienced in their work, having completed over 1400 bench scale tests. All work was performed professionally and according to specifications; and,
3. The AOSTRA Taciuk process, if coupled with a pre-treatment process (dewatering, large solids removal) and a metals removal process would provide very good sediment treatment.

Future Directions

The ATP technology has been applied at full scale at Wide Beach, N.Y. and is currently operating at the Waukegan Harbour, IL Superfund site. Both applications were to remove PCBs from contaminated sediment and soil.

The UMATAC AOSTRA Taciuk Process will be rated against all other technologies demonstrated in COSTTEP and those demonstrated by other programs such as the U.S. Assessment and Remediation of Contaminated Sediments (ARCS) Program at the conclusion of the demonstration phase. This rating will be published in the final report expected in 1995.

More Information

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TABLE 1: Demonstration and analytical program and results

Run #	Sediment	Test	Initial Concentrations[1] (mg/kg dry wt.)			Destruction and Removal Efficiency (%)		
			TOC[2]	O&G[2]	PAH[3]	TOC[2]	O&G[2]	PAH[3]
1[4]	Hamilton Harbour	Ramp						
2	Hamilton Harbour	Pyrolysis						
3[5]	Hamilton Harbour	Pyrolysis	3460	134		13.3	95.8	
4[6]	Hamilton Harbour	Pyrolysis	3455	134	115	76.9	92.0	>93.4[7]
5	Hamilton Harbour	Pyrolysis	3460	134		16.2	>96.3	
6[4]	Thunder Bay	Ramp						
7	Thunder Bay	Ramp						
8	Thunder Bay	Pyrolysis						
9[5]	Thunder Bay	Pyrolysis	11350	3340		55.9	>99.9	
10[6]	Thunder Bay	Pyrolysis	11270	3315	2180	96.5	>99.8	>99.6[8]
11	Thunder Bay	Pyrolysis	11380	3345		72.8	99.8	
12	Thunder Bay	Pyrolysis						
13[9]	Hamilton Harbour	Combustion				94.2	94.3	*[10]
14[9]	Thunder Bay	Combustion				>99.1	99.7	*[10]

1. Based on a single raw sediment concentration, diluted by (clean) recycle sand. Values are rounded to the nearest 10 (>10 000), 5 (>1000) or 1 (>100).
2. TOC and O&G were not targeted for removal; however they are bulk parameters which give an indication of the destruction and removal of **all** organics
3. Sum of 16 PAHs, PAHs were considered "contaminants of concern"
4. Split samples analyzed by the WTC laboratory
5. Dry solids product of this test used as feed for the combustion tests
6. WTC audited test, split samples taken for the WTC laboratory, additional analyses were performed (16 PAHs, 17 metal scan)
7. Individual PAHs analysed in the effluent were <1 ppm or at non-detect limits
8. Individual PAHs analysed in the effluent were <1 ppm or at non-detect limits except Napthalene (2.5 ppm)
9. Split samples analyzed by the WTC laboratory, additional analyses were performed (16 PAHs, 17 metal scan). DRE represents the net effect of pyrolysis and combustion
10. All PAHs analysed were at non-detect limits.