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TECH TRENDS

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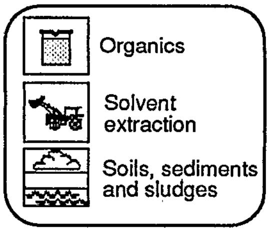
Extraction Process Separates Organics from Sludges, Soils and Sediments

by Mark Meckes, Risk Reduction Engineering Laboratory



The Basic Extractive Sludge Treatment (B.E.S.T.®) process is a solvent extraction system that uses triethylamine to separate organic contaminants from sludges, soils and sediments. The B.E.S.T.® process was pilot demonstrated under the EPA's Superfund Innovative Technology Evaluation (SITE) program in cooperation with the Great Lakes National Program Office and the U.S. Army Corps of Engineers. The demonstration treated river bottom sediment from the Grand Calumet River in Gary, Indiana, which was contaminated with oil and grease, polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs).

The key to the success of triethylamine extraction is the property of inverse miscibility. At temperatures below 60 degrees Fahrenheit, triethylamine is miscible with water; above 60 degrees Fahrenheit, triethylamine and water are only slightly miscible. A triethylamine solvent chilled below 60 degrees Fahrenheit mixes well with water, thus attracting water and contaminants from solids, resulting in a non-homogenous mixture of moisture-free solids and a solution of solvated oil, water and solvent. This is referred to as "cold extraction." Later, during the "hot extraction," the organic contaminants that remain in the dewatered solids are removed by warm triethylamine, which is heated to temperatures ranging from 70 to 160 degrees Fahrenheit and above. Triethylamine moves contaminants from moisture-free solids more effectively at these higher temperatures.

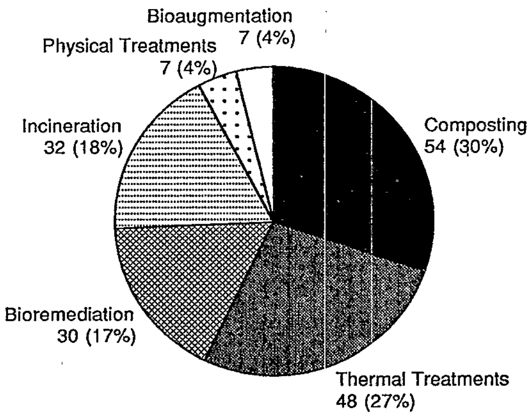
The B.E.S.T.® process operates as follows. Contaminated material is screened to less than 1/2 inch diameter (1/8 inch for this demonstration) and added to a refrigerated premix tank with a predetermined volume of 50% sodium hydroxide. After the tank is sealed and purged with nitrogen, chilled triethylamine solvent is added. The chilled mixture is agitated and then allowed to settle, creating the non-homogenous mixture of moisture-free solids and the solution of solvated oil, water and solvent. The solution is decanted from the solids and centrifuged. The solvent and water are removed from the

(see B*E*S*T® page 2)

Sediment Cleanup Featured

Innovative technologies that remediate sediments are the subject of two articles in this issue of *Tech Trends*. The B.E.S.T® process on this page addresses river bottom sediment in the Grand Calumet River in Gary, Indiana. The update on the ATP process on page 4 gives results on remediation of PCBs in sediment in Waukegan Harbor in Illinois.

ATTIC* Reports on Remediating Explosives-Contaminated Soil



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SITE Subjects

Organics Desorbed from Soil with Low Temperature Thermal Treatment

VOCs/SVOCs
Thermal desorption
Soil

by Paul R. dePercin, Risk Reduction Engineering Laboratory

The Roy F. Weston, Inc., low temperature thermal treatment system (LT^3®) thermally desorbs organic compounds from contaminated soil without treating the soil to combustion temperatures. The LT^3® can process a wide variety of soils with differing moisture and contaminant concentrations. Bench, pilot or full scale systems have been used to treat soil contaminated with coal tar, drill cuttings (oil-based mud), petroleum hydrocarbons, halogenated and nonhalogenated volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs), including polynuclear aromatic hydrocarbons. The LT^3® was demonstrated under the Superfund Innovative Technology Evaluation Program (SITE) at the Anderson Development Company (ADC) site in Adrian, Michigan, where the soil was contaminated with VOCs and SVOCs, including 4,4-methylene-bis(2-chloroaniline) (MBOCA).

The system is divided into three main areas of treatment: soil treatment, emissions control and water treatment. The thermal processor for soil treatment consists of two jacketed troughs, one above the other. Each trough houses four intermeshed screw conveyors. A front-end loader transports feed soil (or sludge) to a weigh scale and deposits the material onto a conveyor that discharges into a surge feed hopper located above the thermal processor. The surge hopper is equipped with level sensors and provides a seal over the thermal processor to minimize air infiltration and contaminant loss. Heat transfer fluid (typically hot oil) from the burner circulates through the hollow screws and trough jackets as the soil moves across the upper trough, drops to the second trough and exits the processor at the same end that it entered. Thus, each screw conveyor mixes, conveys and heats the contaminated soil during treatment. Soil is discharged from the thermal processor into a conditioner where it is sprayed with water to reduce the temperature and to minimize fugitive dust emissions. An inclined belt conveys the treated soil to a truck or pile.

The hot oil, or heat transfer fluid, used above is heated in the burner to an operating temperature of 400 to 850 F (about 100 F higher than desired soil temperature). Combustion gases released from the burner are used as sweep gas in the thermal processor, where a fan draws the sweep gases and desorbed organics from the thermal processor through a fabric filter baghouse. Exhaust gas from the filter is drawn into an air cooled condensor to remove most of the water vapor and organics and then through a second, refrigerated condensor to further lower the temperature and reduce the moisture and organic content of the off-gases. Electric resistance heaters then increase the off-gas temperature to approximately 70 F to optimize the performance of the vapor-phase activated carbon column which removes any remaining organics. The condensate stream is typically treated in a three-phase oil-water separator to remove light and heavy organics from the water, which is then treated in a carbon

(see LT^3 page 3)

B*E*S*T ®

(from page 1)

solvent/water/oil mixture by evaporation and condensation of the solvent and water. Solids with high moisture content may require more than one cold extraction. For example, for this demonstration, a sediment containing 41% moisture required two cold extractions.

Once a sufficient volume of moisture-free solids is accumulated, it is transferred to a steam jacketed extractor/dryer where warm triethylamine is added to the solids. The mixture is heated, agitated, settled and decanted to separate any of the organics not removed during the initial cold extraction. The solids remaining in the extractor/dryer contain triethylamine following decanting. A small amount of steam is injected to volatilize this remaining triethylamine. The hot extraction process can be repeated, when necessary, to further remove contaminants.

The products from the process are: (1) solids, (2) water and (3) concentrated oil containing the organic contaminants. The recovered oil fraction can be dechlorinated or incinerated to destroy the organics. The triethylamine is recovered and reused in further extractions.

Two sediment samples were treated for this SITE demonstration. Sediment A contained 41% moisture, 6,900 milligrams oil and grease per kilogram of sediment (mg/kg), 12 mg/kg PCBs and 550 mg/kg PAHs. The process removed greater than 98% of the oil and grease, 99% of the PCBs and greater than 96% of the PAHs. Sediment B contained 64% moisture, 127,000 mg/kg oil and grease, 430 mg/kg PCBs and 73,000 mg/kg PAHs. The process removed greater than 98% of the oil and grease and greater than 99% of the PCBs and PAHs. The residual solvent in the process' products of solids, water and oil (Sediment B) was 103 mg/kg, less than 1 mg per liter and 730 kg, respectively.

For more information, call Mark Meckes at EPA's Risk Reduction Engineering Laboratory at 513-569-7348. A Technical Evaluation Report and an Applications Analysis Report describing the complete demonstration will be available in the summer of 1993.

Evaporation/Oxidation System Treats A Variety of Wastewater Contaminants

Organics, metals, pesticides, radiowastes

Evaporation and oxidation

Waste water, ground water

by Randy Parker, Risk Reduction Engineering Laboratory

The PO*WW*ER™ Process treats a variety of wastewaters by reducing the volume of aqueous waste and catalytically oxidizing volatile contaminants. The technology, developed in 1988 by Chemical Waste Management, Inc., was evaluated under the Superfund Innovative Technology Evaluation (SITE) program at the Lake Charles Treatment Center, Lake Charles, Louisiana. PO*WW*ER™ can treat landfill leachate, contaminated ground water, process wastewater and low-level radioactive mixed waste. The system can also treat wastewater containing volatile and semivolatile organic compounds (VOCs and SVOCs), pesticides, herbicides, solvents, heavy metals, cyanide, ammonia, nitrate, chloride, sulfide, plutonium, americium, uranium, technetium, thorium and radium.

The major components of the PO*WW*ER™ are: (1) an evaporator that reduces influent wastewater volume, (2) a catalytic oxidizer that oxidizes the volatile contaminants in the vapor stream from the evaporator, (3) a scrubber that removes acid gases produced during oxidation and (4) a condenser that condenses the vapor stream leaving the scrubber. The waste feed enters the evaporator from a stainless steel feed tank where the waste had been prepared by additives to control foaming and pH. The evaporator has three main components: the heat exchanger, the vapor body and an entrainment separator. The waste is first heated in a heat exchanger before it passes into the vapor body where the waste reaches a boiling point and separates into a vapor phase and a brine phase. Some of the brine is collected by gravity into a waste brine drum while the remaining brine is recirculated in the vapor body. The vapor exits to an entrainment separator where it passes through a mesh pad that entrains droplets and particles.

The vapor that passed through the entrainment mesh enters the catalytic oxidizer where it is further heated and then passed through a catalyst bed which oxidizes the VOCs and inorganic contaminants. After oxidation, the vapor stream exits the oxidizer into the scrubber where it passes through a packed bed containing a caustic solution that neutralizes the acid gases. The vapor is cooled and condensed. The product condensate can either be reused as boiler or cooling tower water or discharged to surface water, if appropriate (*i.e.*, if the condensate meets National Pollution Elimination Discharge System requirements). The noncondensible gases can be vented to the atmosphere if they meet permit requirements as they did at Lake Charles.

No VOCs, SVOCs, ammonia or cyanide were detected in the condensate. The original feed waste had contained concentrations of VOCs ranging from 270 to 110,000 micrograms per liter (µg/L), SVOCs ranging from 320 to 29,000 µg/L; ammonia ranging from 140 to 160 milligrams per liter (mg/L); and cyanide ranging from 24 to 35 mg/L. The PO*WW*ER™ system effectively reduced the volume of aqueous wastes and concentrated the contaminants in the waste feed to be treated.

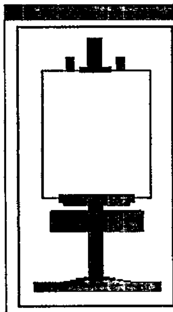
For more information, call Randy Parker at EPA's Risk Reduction Engineering Laboratory at 513-569-7271. Also call Randy to get on the mailing list for the Applications Analysis Report and Technology Evaluation Report on the SITE demonstration.

LT³ *(from page 2)*

adsorption system to remove residual organic contaminants.

At the ADC SITE demonstration, the LT³® removed VOCs to below method detection limits (less than 0.060 milligrams per kilogram [mg/kg]) for most compounds, from initial concentrations of about 50 mg/kg. MBOCA removal efficiency was greater than 88%; concentrations in the treated sludge ranged from 3.0 to 9.6 mg/kg gas opposed to 43.6 to 860 mg/kg in untreated sludge. All SVOCs, with two exceptions, decreased in concentration in the sludge.

Low levels of dioxins and furans were formed in the LT³® system. The majority of these were recovered or treated by the gas and liquid residuals treatment system. The sampling results will be discussed in the Technical Evaluation Report and the Application Analysis Report which will be available in early 1993. For more information, contact Paul dePercin at EPA's Risk Reduction Engineering Laboratory at 513-569-7797.



Conference Alert

Look for EPA at AIChE Conference

March 30, 1993

EPA will present sessions on hazardous waste remediation technologies at the American Institute of Chemical Engineers' (AIChE) conference in Houston, Texas, on March 30, 1993. The AIChE conference will be held in conjunction with Petrochemical Expo '93.

One of the EPA sessions (Session # 99) will address technology trends, including biological treatment processes for polyaromatic hydrocarbons and results from recently completed Superfund Innovative Technology Evaluation (SITE) projects utilizing soil washing and thermal technologies. Another session (# 100) will include interactive demonstrations of computer databases that contain extensive information on treatment technologies. For further information, call Denise DeLuca at 212-705-7344.

Update

Anaerobic Thermal Processor Completes Second PCB Remediation

In the December 1991 issue of *Tech Trends* we told you about the anaerobic thermal processor (ATP) that had removed polychlorinated biphenyls (PCBs) from contaminated soils during cleanup activities at the Wide Beach Development site in Brant, New York. The ATP, which was evaluated at Wide Beach under EPA's Superfund Innovative Technology Evaluation (SITE) program, has been the subject of a second successful SITE evaluation conducted on sediments and soils at the Outboard Marine Corporation (OMC) site in Waukegan, Illinois. The ATP, which involves a physical separation process that thermally desorbs organics such as PCBs from soil, sediments and sludge, is also designed to treat wastes with a nominal hydrocarbon concentration of 10%.

At both Wide Beach and OMC, the ATP unit removed PCBs in the contaminated soil to levels at and below the desired cleanup concentration levels of 2 parts per million (ppm). At Wide Beach, PCB concentrations were reduced from an average concentration of 28.2 ppm in the contaminated feed soil to an average concentration of 0.043 ppm in the treated soil. At the OMC site, PCB soil concentrations were reduced from an average of 9,761 ppm to 2 ppm. No volatile/semivolatile organic (VOC/SVOC) degradation products or leachable VOC/SVOCs were detected in the treated soil at Wide Beach; at OMC, leachable VOCs and SVOCs and metals were below Resource Conservation and Recovery Act toxicity characteristic standards. At OMC approximately 0.12 mg of PCBs per kilogram of PCBs fed to the ATP were discharged from the system's stack.

The ATP system was developed by UMATAC Industrial Processes under the sponsorship of the Alberta Oil Sands Technology and Research Authority (AOSTRA) and is licensed by SoilTech ATP Systems, Inc., a United States corporation.

For more information, call Paul dePercin at the EPA's Risk Reduction Engineering Laboratory at 513-569-7797. An Applications Analysis Report and a Technology Evaluation Report describing the SoilTech ATP SITE demonstrations will be available in the Spring of 1993.

To order additional copies of this or previous issues of *Tech Trends*, or to be included on the permanent mailing list, send a fax request to the National Center for Environmental Publications and Information (NCEPI) at 513-891-6685, or send a mail request to NCEPI, 11029 Kenwood Road, Building 5, Cincinnati OH 45242. Please refer to the document number on the cover of the issue if available.

Tech Trends welcomes readers' comments and contributions. Address correspondence to: Managing Editor, *Tech Trends* (OS-110W), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460.

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