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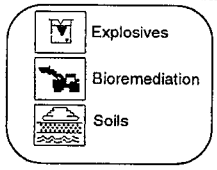
EPA

TECH TRENDS

The Applied Technologies Journal for Superfund Removals & Remedial Actions & RCRA Corrective Actions

THE COMPOSTING ALTERNATIVE TO INCINERATION OF EXPLOSIVES CONTAMINATED SOILS



By Harry Craig, EPA Region 10 and Wayne Sisk, U.S. Army Environmental Center

EPA's Region 10 has evaluated composting as an ex-situ solid phase biological treatment technology to degrade nitroaromatic and nitramine compounds in soils. Treatability studies at two National priority List sites -- the Umatilla Army Depot Activity site in Hermiston, Oregon and the U.S. Naval Submarine Base site in Bangor, Washington -- demonstrate that composting is a treatment alternative to incineration for remediating these compounds. Composting has been selected as the Record of Decision treatment for 14,800 tons of TNT (2,4,6-trinitrotoluene), RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) and HMX (octahydro-1, 3, 5, 7-tetranitro-1, 3, 5, 7-tetrazocine) contaminated soils at Umatilla and for 2,200 tons of TNT contaminated soils at Bangor. Previously, composting has been used primarily to treat municipal solid waste, but not hazardous wastes.

Composting mixes natural organic amendments, such as manure, wood chips, alfalfa and vegetable processing wastes with 30% contaminated soil and adds water to 50% of moisture holding capacity. The process utilizes native aerobic thermophilic microorganisms and requires no inoculation. Composting operates under mesophilic [30-35 degrees Centigrade (C)] and thermophilic (50-55 degrees C) conditions, with thermophilic conditions being optimum. Amendments serve as a source of carbon and nitrogen for thermophiles, which degrade explosives under co-metabolic conditions. Composting produces no chemical air emissions and no leachate; and, it does not require dewatering upon completion of treatment.

Composting residues will support the growth of vegetation after treatment, unlike incineration ash or soils treated by solidification/stabilization. The final volume increase in soil is approximately 50% to 100%, similar to stabilization/solidification technologies.

At the Umatilla site, the soils were contaminated from the discharge of 85 million gallons of explosives' wastewater into unlined lagoons from 1950 to 1965. During the pilot-scale treatability study, 30 cubic yards of soil were treated in each of two windrow configurations, one with forced aeration and the other unaerated. After 40 days of treatment, composting reduced initial average contaminant concentrations of 1,574 parts per million (ppm) TNT to 4 ppm; 944 ppm RDX to 2 ppm; and 159 ppm HMX to

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IT'S TIME

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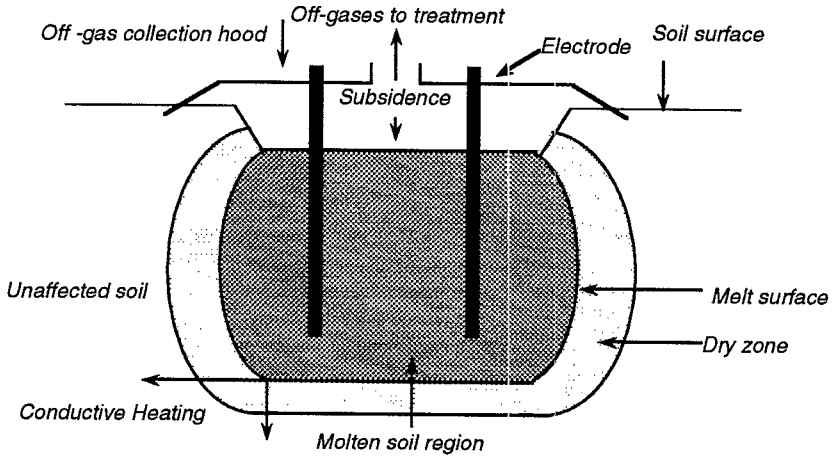
The second special insert describes new technology information that you may want to order.

ISV TREATMENT MELT

(Not to scale)

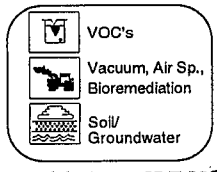


(See Article on page 2)

SITE Subjects

VACUUM EXTRACTION/AIR SPARGING WITH BIOREMEDIATION FOR ORGANICS

By Paul dePercin, Risk Reduction Engineering Laboratory



The Subsurface Volatilization and Ventilation System (SVVS®) is an in situ vacuum extraction/air sparging and bioremediation technology for the treatment of subsurface organic contamination in soil and ground water. The primary objective of the SITE (Superfund Innovative Technology Evaluation) Program evaluation of SVVS® at the Electro-Voice, Incorporated (EV) facility in Buchanan, Michigan was to determine the effectiveness of SVVS® in reducing volatile organic contamination in the vadose zone. The demonstration met the objective.

Historical activities at the EV facility included painting, electroplating and assembling of components associated with the manufacture of audio equipment. In 1964 EV implemented an automated painting system; and, a dry well was installed to handle some of the liquid wastes generated from the paint shop. A remedial investigation discovered a sludge-like material beneath the dry well area contaminated with aromatic hydrocarbons and halogenated and non-halogenated volatile and semi-volatile compounds. Some of these organic contaminants have migrated to underlying strata. The SITE chose seven of these contaminants to demonstrate the effectiveness of the SVVS® system. These contaminants and their initial average concentrations were the BTEX compounds -- benzene at 0.01 parts per million (ppm), toluene at 92 ppm, ethylbenzene at 37.4 ppm and xylenes at 205 ppm -- and tetrachloroethene at 5.4 ppm, trichlorethene at 0.36 ppm and 1,1-dichloroethene at 0.01 ppm. The overall reductions in contaminants ranged from 71% to over 99%, which greatly exceed the developer's claim of a projected 30% reduction.

The SVVS® technology, developed by Billings and Associates, Inc., and operated under a licensing agreement by Brown & Root Environmental, utilizes vapor extraction and biostimulation to remove and destroy organic contaminants from the subsurface. Vapor extraction removes the easily strippable volatile components from the soil and/or ground water. This removal mechanism is dominant during the early phases of the remediation. Biostimulation processes dominate the later phases of the remediation and are used to accelerate the in situ destruction or organic compounds in the soil and ground water. The developer claims that remediation using the combination of vapor extraction and biostimulation is more rapid than the use of biostimulation alone. The SITE demonstration tests indicate that the technology stimulated biodegradative processes at the site and that the early phase of the remediation was characterized by higher concentrations of volatile organics in the extracted vapor stream. In addition, SVVS® can remediate contaminants that would not be remediated by vapor extraction alone (chemicals with lower volatilities and/or chemicals that are tightly sorbed). These benefits translate into lower costs and faster remediations.

The technology consists of a network of injection and extraction wells plumbed to one or more compressors or vacuum pumps, respectively. The vacuum pumps create negative pressure to extract contaminant vapors. Air compressors simultaneously create positive pressures across the treatment area to deliver oxygen for enhanced aerobic biodegradation. The system is maintained at a vapor control unit that houses pumps, control valves, gauges and other process control hardware. The operation of SVVS® is custom designed to meet specific site conditions. The number and spacing of the wells depends upon the results of a model, as well as the physical, chemical and biological characteristics of the site.

According to the developer, the SVVS® is applicable to sites contaminated with gasoline, diesel fuels and other hydrocarbons, including halogenated compounds. The developer claims that the SVVS® is very effective in treating soils contaminated with virtually any material that exhibits some volatility or is biodegradable. The technology

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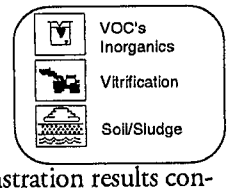
IN SITU VITRIFICATION TREATS ORGANICS AND INORGANICS

By Teri Richardson, Risk Reduction Engineering Laboratory



The Geosafe Corporation's in situ vitrification (ISV) technology is designed to treat soils, sludges, sediments and mine tailings contaminated with organic, inorganic and radioactive compounds. EPA's SITE (Superfund Innovative Technology Evaluation) Program evaluated the technology at the Parsons Chemical site in Grand Ledge, Michigan; soil at the site was contaminated with low levels of pesticides and mercury. The SITE demonstration results concluded that the cleanup levels were met. The process uses electrical current to heat (melt) and vitrify the soil in place. Organic contaminants are

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EPA Technology Innovation Office

Please send me the innovative technology information I have indicated below:

_____ **Vendor Information System for Innovative Treatment Technologies (VISITT) Version 3.0.** VISITT is a diskette-based system containing information on 277 innovative remediation technologies offered by 177 vendors. The system captures current information on the availability, performance, and cost supplied to EPA by technology companies. VISITT 3.0 is available on diskette, with a user manual, and requires a personal computer with DOS Version 3.3 or higher, 640K of RAM, and 10MB hard disk space.

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_____ **Innovative Treatment Technologies: Annual Status Report (Sixth Edition) (EPA-542-R-94-005).** This report documents and analyzes the selection and use of innovative treatment technologies in the U.S.EPA Superfund Program and at some non-Superfund sites under the Departments of Defense and Energy. The report contains site-specific information on 350 projects, including soil vapor extraction, soil washing, bioremediation, solvent extraction, and other innovative technologies for treating ground water in place and soil.

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_____ **Innovative Hazardous Waste Treatment Technologies: A Developer's Guide to Support Services (Third Edition) (EPA-542-B-94-012).** This booklet provides information on sources of assistance and support in bringing technologies from the proof-of-concept stage to the commercialization stage. It includes information on sources of grant funding and technical assistance, and identifies incubators, test and evaluation facilities, and university-affiliated research centers that can provide a range of technology development and evaluation services.

_____ **Remediation Technologies Screening Matrix and Reference Guide (EPA-542-B-93-005).** This document is designed to help Federal site managers identify potentially applicable technologies for more detailed evaluation prior to remedy selection. It summarizes the strengths and limitations of 48 innovative and conventional technologies for remediation of soils, sediments, and sludges; groundwater; and air emissions/off-gases. Technologies covered include treatment, containment, waste separation and enhanced recovery.

Technology Resource Guides. Each of these guides contains information on resource documents, databases, hotlines, and dockets pertaining to the subject technology. They also identify regulatory mechanisms that have the potential to ease implementation of the technology at hazardous waste sites. Each guide contains a Resource Matrix, which identifies the technology, media, and contaminants covered in each abstracted document.

_____ **Bioremediation Resource Guide (EPA-542-B-93-004)**
_____ **Soil Vapor Extraction Treatment Technology Resource Guide (EPA-542-B-94-007)**
_____ **Physical/Chemical Treatment Technology Resource Guide (EPA-542-B-94-008)**
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NORTH OF THE BORDER

The "Proceedings of the Fourth Annual Symposium on Groundwater and Soil Remediation" are now available. The symposium was sponsored by several Canadian agencies (Environment Canada; Alberta Environmental Protection; the Biotechnology Research Institute -National Research Council Canada; and the DESRT Program) and the Members of GASReP, the Canadian Association of Petroleum Producers and the Canadian Petroleum Products Institute. The Symposium presented results and fostered discussion on current research, development and demonstration projects dealing with ground water and soil remediation. The cost, including shipping and handling, is $35 Canadian currency.

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THE STATES

EPA's Technology Innovation Office has several publications on innovative treatment technologies and a vendor information system database now available. For more information on these publications, as well as a handy order form, see the special insert in this issue of TECH TRENDS.

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decomposed by the extreme heat into simple gases, which then rise through and escape from the molten soil. Inorganic contaminants are trapped within the molten soil, which cools and solidifies into a glassy monolith. The ISV technology operates by means of four graphite electrodes, arranged in a square and inserted into the soil to be treated. A pattern of electrically conductive graphite containing glass frit is placed on the soil in paths between the electrodes. When power is fed to the electrodes, the graphite and glass frit conducts the current through the soil, heating the surrounding area and melting directly adjacent soil. Molten soil is electrically conductive and can continue to carry the current which heats and melts soil downward and outward. The electrodes are allowed to progress down into the soil as it becomes molten, continuing the melting process to the desired treatment depth. As treatment progresses, a "cold cap" of solidified material forms at the surface. When all of the soil in the treatment area becomes molten, the power to the electrodes is discontinued and the molten mass begins to cool. The electrodes are cut near the soil surface and are allowed to settle into the molten soil to become part of the melt.

The organic contaminants in the soil are pyrolyzed (heated to decomposition without oxygen) and are generally reduced to simple gases. The gases migrate through the molten soil and/or the adjacent dry zone to the surface, where they are collected in a stainless steel hood placed over the area being treated. Gases from the hood are treated in an off-gas treatment system. (See page 1 of this issue for a graph of the system.)

Inorganic contaminants in the soil are generally encapsulated in the molten soil which hardens to a vitrified mass that is dense and hard, which significantly reduces the possibility of leaching from the mass over the long term. Since the vitrification process removes most of the void space in the soil, as well as destroys the organic contamination, there is a volume reduction of 20 to 50%.

Prior to the SITE evaluation demonstration, treatment at the Parsons site had been ongoing for several months in open concrete trenches designed for nine treatment cell settings. The SITE demonstration focused on cell 8, which was the most contaminated cell. The ISV technology treated the soil as expected, completing the melt in 10 days. The cleanup levels specified by EPA Region V for chlordane, 4,4-DDT; dieldrin; and mercury were met. Pesticide concentrations were reduced to non-detectable levels in the vitrified soil, from initial concentrations of 13,050 micrograms per kilogram (µg/kg) for 4,4-DDT to less than 16 µg/kg and from 4,620 µg/kg dieldrin to less than 16 µg/kg. The solid vitrified material collected was subjected to TCLP for mercury and pesticides. The test results indicated that leachable mercury was well below the regulatory guidelines of 40 CFR Part 261.24; and, no target pesticides were detected in the leachate. There were no target pesticides detected in the stack gas samples; metal emissions were below regulatory requirements; and, total hydrocarbon and carbon monoxide emissions were in compliance with EPA Region V limits.

For more information, call Teri Richardson at EPA's Risk Reduction Engineering Laboratory at 513-569-7949. Key findings from the demonstration will be published in an Innovative Technology Evaluation Report which will be available February 1995. Those involved in cleaning up similar sites across the country will be able to use this report to evaluate the Geosafe ISV technology as a potential alternative technology for their sites. A SITE Technology Capsule and videotape will also be available by January 1995. To get on the mailing list for these reports, contact Peggy Heimbrock at 513-569-7472 by phone or by FAX at 513-569-7566.

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5 ppm. Destruction and removal efficiencies (DRE) were: 99.7% for TNT; 99.8% for RDX; and 96.9% for HMX. The treatment process also degraded key bio-degradation intermediates of TNT -- 2A-4,6-DNT (2-amino, 4-6 dinitrotoluene) and 4A-2, 6-DNT (4-amino-2,6-dinitrotoluene).

At Umatilla, toxicology and leachability tests also were performed to compare toxicity and mobility effects of compost residues to those in untreated soils. Toxicity results showed 87% to 92% reduction of leachate toxicity to **Ceriodaphnia dubia**, and 99.3% to 99.6% reduction in mutagenicity for Ames assays using strains TA-98 and TA-100. A brief oral rat feeding study did not produce mortality from consumption of compost residues. Leachable concentrations were greater than 99.6% for TNT, 98.6% for RDX and 97.3% for HMX, using the EPA Synthetic Precipitation Leach Procedure (SPLP)(SW-846 Method 1312).

At Bangor, soils have been contaminated from open-burn/open-detonation (OB/OD disposal of munitions from 1946 to 1965. Region 10 conducted bench scale treatability studies to evaluate composting treatment of TNT contaminated soils from three areas of the base -- one wastewater disposal lagoon and two ordnance OB/OD sites. Composting reduced the concentration of TNT in one kilogram of soil from 822 ppm to 8 ppm after 60 days of treatment, with a DRE of 99.5%. A pilot scale treatability study of 60 cubic yards of soil is currently in progress. Results will be available in March 1995.

For the treatability studies at both sites, an asphalt liner in a temporary building was used to house the biotreatment system. Site specific factors should determine what containment system, if any, should be used.

The treatabilit[illegible]. Umatilla and Bangor indicate that composting is capable of achieving risk-based cleanup levels of 30 to 33 ppm for TNT and 9 ppm to 30 ppm RDX after 40 days of treatment. The Feasibility Study estimates treatment costs of $206 to $766 per ton, which is 40% to 50% less than on-site incineration for quantities from 1,200 to 30,000 tons. Actual costs will be refined during full-scale remediation, which is scheduled to begin in 1995.

Composting is suitable for soils and sludges. Composting does not appear to be particularly sensitive to soil type. Umatilla soils are sands/gravel; and, Bangor soils are loams and glacial till. A moderate amount of contaminated wastewater can be treated with soil, since the process consumes water at a rate of approximately one gallon per cubic yard per day of treatment. Contaminated rocks and debris can be crushed or shredded and treated with soils.

For more information, call Harry Craig at EPA's Region 10 Oregon Operations Office at 503-326-3689.

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can be applied to contaminated soil, sludges, free-phase hydrocarbon product and ground water.

A one-year time frame was chosen for SITE testing purposes at the EV site. However, other sites may require longer or shorter remedial cleanup time.

For more information, call Paul dePercin at EPA's Risk Reduction Engineering Laboratory at 513-569-7797. An Innovative Technology Evaluation Report describing the complete demonstration will be available in early 1995.

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