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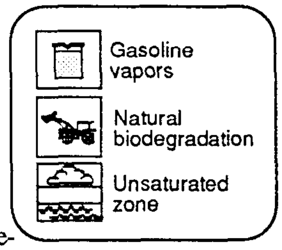
TECH TRENDS

The applied technologies journal for Superfund removals and remedial actions and RCRA corrective actions

Natural Biodegradation of Fuel Vapors in Unsaturated Zone

by Don H. Kampbell, R.S. Kerr Environmental Research Laboratory



Volatilization of gasoline and the aerobic biodegradation of the vapors is a major process for removing gasoline from subsurface material above the water table. EPA's Robert S. Kerr Environmental Research Laboratory (RSKERL) has documented the role of aerobic biodegradation of gasoline vapors in the unsaturated zone above a leak from an underground storage tank. The field studies, conducted at the Coast Guard's Traverse City, Michigan, site, established that natural aerobic biodegradation consumed gasoline vapors that volatilized from the gasoline spill before they could reach ground surface. In this process, oxygen was consumed and carbon dioxide was produced. By measuring the concentrations of oxygen, carbon dioxide and gasoline vapors, one can determine when natural biodegradation of fuels is occurring at a site. Here's what the Traverse City experience tells us.

At Traverse City, approximately 36,000 gallons of aviation gasoline had spilled about 20 years ago. The material was trapped as oily phase residue just above the water table. Over the 20-year history of the spill, approximately 39% of the original mass has volatilized and biodegraded aerobically. Gasoline volatilizes and moves upward in the unsaturated zone as a vapor. Oxygen from the atmosphere moves downward. Microbes in the intermediate area of the unsaturated zone consume the oxygen and the gasoline vapors. As a result, oxygen concentrations decrease with depth, and oxygen disappears at the water table. Gasoline vapors are undetected just below the soil surface and increase with depth. Thus, the carbon dioxide concentrations increase with depth as a mirror image of the decrease of oxygen as the gasoline vapors are biodegraded.

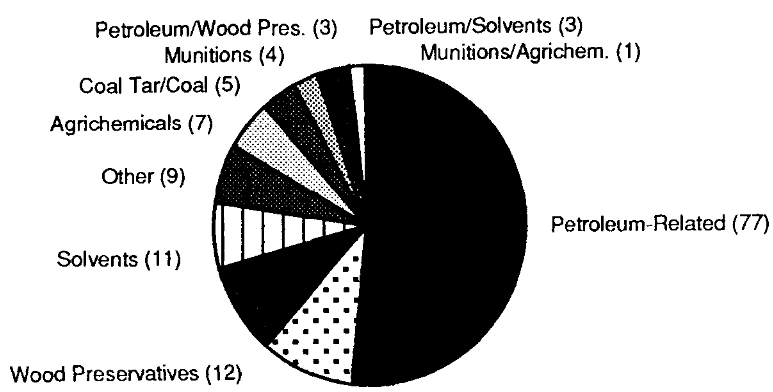
Carbon dioxide levels were measured at both contaminated and uncontaminated areas of the site. The contaminated area showed higher carbon dioxide levels, higher microbial cell counts and a depletion of oxygen levels when compared to the uncontaminated area. For example, at a depth of 3 meters, carbon dioxide levels comprised 2.2% of

(see **Biodegradation** page 2)

Treatability Study News

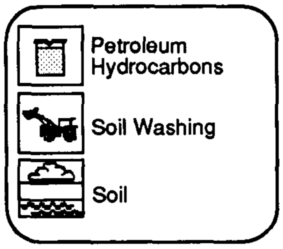
In this issue of *Tech Trends we* have an article on Resource Conservation and Recovery Act (RCRA) opportunities to do treatability studies. Don't miss this news on page 3.

New ATTIC Bioremediation Case Studies



132 bioremediation case studies provided by Bioremediation Action Committee

Soil Washing Technology Demo at Toronto Harbour



by Teri Richardson
Risk Reduction Engineering Laboratory

EPA's Superfund Innovative Technology Evaluation (SITE) program recently evaluated the Bergmann soil washing technology in conjunction with the Toronto Harbour Commissioners Soil Recycling Demonstration Facility. The SITE evaluation concluded that this soil washing technology is effective. The soil washing unit produces clean coarse soil fractions and concentrates the contaminants in a fine slurry so that the slurry can be treated by other treatment technologies. The Bergmann technology has also proved effective in another SITE demonstration at Saginaw Bay.

The SITE demonstration at Toronto consisted of a pilot unit that processed soil from a site that had been used for metals finishing and as a refinery and petroleum storage facility. The soil was contaminated with oil and grease/ petroleum hydrocarbons, naphthalene, phenanthrene, pyrene, benzo(a)pyrene and heavy metals. Since the metals contamination was very low in the excavated soil, there was no need to process the soil to remove inorganic compounds. During the soil washing, the coarse soil fractions were separated from the soil by mineral processing equipment; the separated gravel was washed to remove and concentrate the contaminants in a fine slurry. Hydrocyclones (similar to centrifuge devices) were used to separate the contaminated finer soil from the uncontaminated soil; and, an attrition scrubber then freed the organic contaminants from the sand particles. Additionally, a density separator removed coal and peat from the sand fractions. All the contaminants removed by the processes described above remained concentrated in the fine slurry to be treated by additional treatment methods. Initial concentrations of the contaminants and concentrations in clean sand (particle size 0.063 ml to 6 ml) after soil washing were: oil and grease from 8,233 mg/kg to 2,183 mg/kg; total recoverable petroleum hydrocarbons from 2,542 mg/k to 621 mg/kg; naphthalene from 11.15 mg/kg to 2.05 mg/kg; phenanthrene from 6.91 mg/kg to 1.77 mg/kg; pyrene from 5.06 mg/kg to 1.43 mg/kg; and benzo(a)pyrene from 1.91 mg/kg to 0.53 mg/kg.

The soil washing technology is intended to be used in conjunction with other techniques to treat the slurry, such as chemical pretreatment and biological treatment to remove organics, metals chelation to remove inorganic compounds or incineration. This "treatment train" approach is most useful when sites have been contaminated as a result of multiple uses over a period of time. Typical sites where the process train might be used include refinery and petroleum storage facilities, metal processing and metal recycling sites and manufactured gas and coal/coke processing and storage sites. The process is less suited for soils with undesirable high organic constituents that result from the inherent mineralogy of the soils.

For more information on the Toronto Harbour Commissioners SITE evaluation of the Bergmann soil washing system

*(see **Soil Washing** page 3)*

Biodegradation

(from page 1)

the soil gas in the contaminated area as compared to 0.03% in the uncontaminated area; and oxygen levels were 1.6% compared *to 20.8%* in the uncontaminated area.

The Coast Guard and RSKERL accidently discovered that biodegradation occurs at a higher rate when grass is planted, fertilized and watered, than when the top soil is not managed for turf grass. Two contaminated areas of the site were studied. One area had preexisting turf that had been fertilized. The other area was barren. In both areas, nine soil gas probe clusters were placed into the subsurface at 0.5 meter intervals, ranging from a depth of 0.5 meters to 5 meters (just above the water table). The subsurface biodegradation of both areas was compared. Measurements in both areas showed that natural biodegradation was occurring. However, biodegradation in the enhanced turf area occurred at a higher activity level compared to the barren am. Microbial cell counts were approximately two times greater in the fertilized turfarea.

Natural biodegradation augmented by soil venting technology and turf enhancement has been chosen to remediate the entire contaminated plume at Traverse City. For a brief description of in situ biosparging and bioventing remediation technologies at Traverse City, see page one of the June 1992 issue of *Tech Trends* (EPA Document No. EPA/542/N-92/003), *"In Situ* Biosparging with Bioventing Cleans Both Saturated and Unsaturated Zones."

For more information on carbon dioxide and oxygen as indicators of natural biodegradation and for more detailed information on biosparging/bioventing (referenced in preceding paragraph), call Don Kampbell at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, at 405-332-8800. Additionally, for a detailed analysis of the kinetics of biodegradation of gasoline vapors in the unsaturated zone, see "Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone," by David W. Ostendorf and Don H. Kampbell, *Water Resources Research,* Vol. 27, No. 4, April 1991, pp. 453-462.

RCRA Treatability Study Opportunities

By Michael Forlini, Technology Innovation Office

EPA's Resource Conservation and Recovery Program (RCRA) program provides different opportunities to do treatability studies pertaining to treatment technologies. They range from bench scale studies to pilot scale treatability demonstrations. Below is a brief description of some provisions of the regulations pertaining to treatability studies.

Treatability Studies Exemption Rule. The Treatability Studies Exemption Rule (40 CFR 261.4(e)-(f)) applies to the generation or collection of samples and standards for treatability studies (as defined at 40 CFR 261.10) for no more than one kilogram (kg) of acute hazardous waste, 250 kg of soils, water or debris contaminated with acute hazardous waste and 1,000 kg of non-acute hazardous waste. EPA's Regional Administrator or, in the case of an authorized State, the State Director, may grant a request for additional collection samples. When operating within the exemption rule, compliance is not required for the RCRA regulatory requirements pertaining to identifying, listing, generating and transporting hazardous waste (40 CFR 261-263) and the notification requirements of Section 3010.

Research Development and Demonstration Permits. RCRA Research Development and Demonstration (RD&D) Permits (40 CFR 270.65) can apply to a pilot scale study. RD&D permits were created to facilitate the development and demonstration of treatment technologies. The RD&D permit provides for the construction of the facility and its operation for no longer than one year unless the permit is renewed. A permit may not be renewed more than three times. The one year timeframe pertains to days of operation.

Subpart X Permits. Subpart X ("Miscellaneous Units" 40 CFR 264.600) provides another avenue for issuing RCRA permits to the diverse universe of innovative technology developers. Subpart X can be used as a complement to the RD&D permit program. The preamble to the Subpart X regulations (52 FR 46961) discusses acceptable permitting options for a multi-stage demonstration project, where the outcome of one stage may radically change the subsequent stage, as is common in testing an innovative technology.

Corrective Action. In the Corrective Action Program, the facility and EPA, in collaboration with the State, can use a treatability variance for on-site demonstrations through such mechanisms as permit modifications at permitted facilities or enforcement orders [3008(h) orders for interim status facilities] [40 CFR 268.44(h)]. Treatability variances may be granted to a facility for those wastes that cannot achieve the Land Disposal Restrictions' Best Demonstration Available Technologies standards. Regions have the authority to grant a site specific treatability variance for contaminated soils. These variances may prove to be extremely useful in implementing alternative treatment technologies in the RCRA Corrective Action Program.

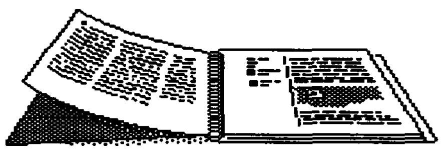
For a more detailed description of all the provisions discussed here, we refer you to the Code of Federal Regulations (specific CFR citations noted above) and to the RCRA/Superfund Hotline at 800-424-9346 or 703-920-9810.

Soil Washing

(from page 2)

(and the other two "treatment train" technologies used there in conjunction with soil washing), call Teri Richardson at 513-569-7949. For information on the Saginaw Bay SITE demonstration of the Bergmann soil washing technology, call Jack Hubbard at 513-569-7507. An Application Analysis Report and a Technical Evaluation Report that describes the complete demonstration at the Toronto Harbour Commissioners Soil Recycling Demonstration Facility will be available in the Spring of 1993.

Also, an upcoming issue of *Tech Trends* feature a special insert on developments in soil washing.



New for the Bookshelf

Recent EPA publications are available from the National Center for Environmental Publications and Information (NCEPI). You can order them by sending a fax request to NCEPI at (513) 891-6685, or sending a mail request to NCEPI, 11029 Kenwood Road, Building 5, Cincinnati OH 45242. You must have the document number or the exact title to order a document.

The Technology Innovation Office has recently updated three publications:

Federal Publications on Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation, Second Edition.
EPA/542/B-92/001

Accessing Federal Databases for Contaminated Site Cleanup Technologies, Second Edition.
EPAI542/B-92/002

Synopses of Federal Demonstrations of Innovative Site Remediation Technologies, Second Edition.
EPA/542/B-92/003

Out of the ATTIC

ATTIC Yields Abundant Bioremediation Information

Online clearinghouses, databases and electronic bulletin-boards are not new to Andy Autry, a Project Scientist for ENSITE, Inc., responsible for developing and improving bioremediation technologies for site restoration.

Dr. Autry routinely checks many EPA computerized information sources such as the Clean-Up Information (CLU-IN) and Office of Research and Development electronic bulletin boards, and the Alternative Treatment Technology Information Center (ATTIC) database. It was from a bulletin in ATTIC that he earned about the Vendor Information System for Innovative Treatment Technologies (VISITT) database and was able o contribute information about his company's technology for removing petroleum hydrocarbons from contaminated soils. Dr. Autry also uses ATTIC to download the latest meeting notes from he Bioremediation Action Committee BAC) and to get the latest news bulletins on bioremediation.

He recently accessed ATTIC to check new information on remediation of soil contaminated with polyaromatic hydrocarbons (PAHs) and phenols. He found 228 reports using those three parameters. He narrowed that list down by including bioremediation in the criteria. This search resulted in 24 reports. One, entitled "Slurry-Phase Bioremediation: Case Studies and Cost Comparisons," is an overview of available bioremediation technologies for the cleanup of contaminated soils, sludges and water. Slurry-phase bioremediation, a relatively new adaptation to remediation technology, is described in the abstract; and, results from selected case studies are presented. Slurry- phase bioremediation generally provides more rapid treatment and requires less area than solid-phase, soil-heaping or composting biological treatment processes. Slurry-phase processes are being used more often at sites where time and space, rather than cost, are critical.

Another abstract from this search describes ECOVA Corporation's bioslurry reactor which was demonstrated under EPA's Superfund Innovative Technology Evaluation (SITE) Program and was featured in the March 1992 issue of *Tech Trends* (EPA Document No. EPA/542/N-92/001). This Reactor can treat highly contaminated creosote wastes and other concentrated contaminants that can be aerobically biodegraded. A second SITE Program technology-ENSITE, Inc.'s SafeSoil™ Biotreatment System-was included in the search results.

Dr. Autry also found 132 new case studies on bioremediation that were recently provided to ATTIC by the BAC. These reports contain data on bioremediation of 12 different categories of contaminants from studies that were conducted by vendors in 3 1 states.

Information on ATTIC is available from the system operator at 301-670-6294 or Joyce Perdek of EPA's Risk Reduction Engineering Laboratory at 908-321-4380. CLU-IN may be accessed online at 301-589-8366 or by voice at 301-589-8368. The ORD electronic bulletin board may be accessed at 513-569-7610 or by voice at 513-569-7345. VISITT may be ordered by calling 800-245-4505.

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