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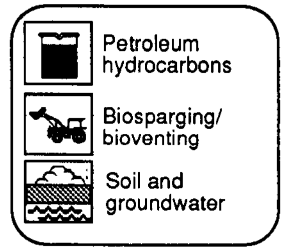
In Situ Biosparging with Bioventing Cleans Both Saturated and Unsaturated Zones

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



The technique of biosparging combined with bioventing is being Wed to remediate an aviation gasoline spill at the Coast Guard's Traverse City, Michigan, site. EPA's Robert S. Kerr Environmental Research Laboratory has already found that bioventing (injecting air into the unsaturated zone above the water table) and biosparging (injecting air into the saturated zone below the water table) promote biodegradation of petroleum hydrocarbons (TPH). The purpose of air injection is to volatilize he contaminants into a soil gas stream in both saturated and unsaturated subsurface zones so that the contaminants will be more readily biodegraded by aerobic microorganisms in the soil. This *in situ* method should perform better and should be more cost effective than above-ground soil removal treatment or groundwater pump-and-treat methods. Further, the system produces little or no air emissions of hydrocarbon contaminants.

Prior to the pilot demonstrations at Traverse City, laboratory treatability studies were performed using surface soil from the spill site. The studies demonstrated that bioremediation from venting and sparging would be feasible for this site. For the actual pilot demonstration, grass was planted on a 75' x 90' rectangular area over the plume of contamination. Next, a nutrient solution was applied for dispersion throughout the unsaturated subsurface to support enhanced microbial activity. For the bioventing part of the demonstration, two blowers in a nearby building were connected to aeration transfer piping and to screened air injection wells with adjustable depths to force air flow into the unsaturated zone just above the water table. Blower rates in the injection

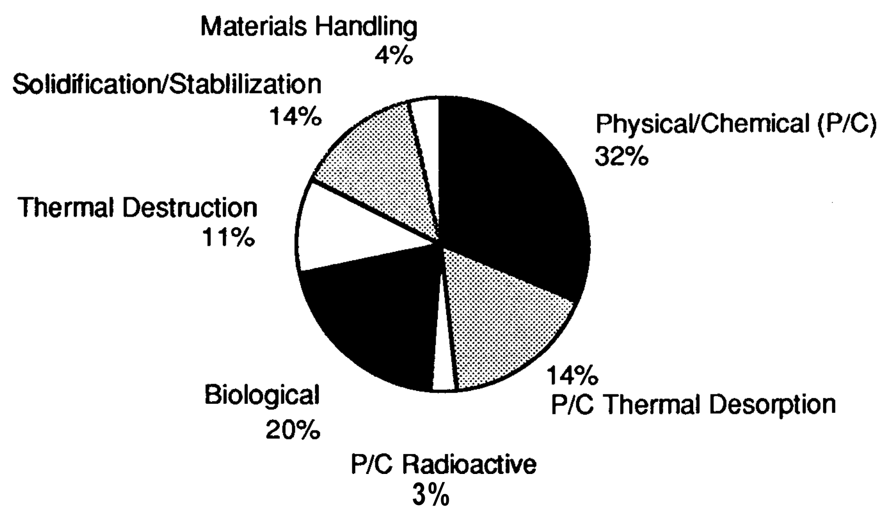
*(see **Biosparging** page 2)*

Summer SITEs

We are doing something new in this issue of *Tech Trends.* Usually we only tell you about Superfund Innovative Technology Evaluation (SITE) demonstrations *after* they happen and results are available, In this issue, we let you know about upcoming SITE demonstrations you can visit this summer. See page 3 for details.

Also, the ATTIC Database now contains all pre- and post-demonstration information from 76 SITE Demonstration Program Projects. See adjacent pie chart.

SITE Demo Program Technologies in ATTIC



76 technologies reported. Source documents include Demonstration Bulletins, Technology Profiles, Technology Evaluation Reports, and Applications Analysis Reports.

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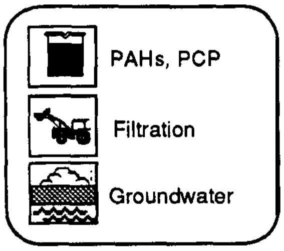
SBP Membrane Filtration Reduces Groundwater Contaminants



by Kim Kreiton,
Risk Reduction Engineering Laboratory

EPA's Superfund Innovative Technology Evaluation (SITE) Program demonstrated a membrane microfiltration process that effectively separates contaminants and concentrates them into a smaller volume of groundwater prior to treatment. The SBP Technologies, Inc., membrane technology was tested in Pensacola, Florida, at the American Creosote Works Site, where wood preserving wastes such as polyaromatic hydrocarbons (PAH) and pentachlorophenol (PCP) had seeped from capped former waste lagoons into an aquifer.

The membrane filtration unit consists of two stainless steel tubes. The outer tube acts as a shell that houses the second porous stainless steel tube. There is a space between the two tubes. On the inside of the inner tube a membrane forms and is continuously regenerated from the recirculation of an aqueous slurry of membrane formation chemicals. When feedwater enters the inner tube, the membrane functions as a hyperfiltration unit. It retains contaminants with molecular weights of 200 and higher, while allowing a large portion of the water and the chemical species that have a lower molecular weight to pass through the membrane walls where they are collected in the space between the inner and outer tubes. The heavier contaminants that cannot pass through the membrane wall are collected in a holding tank for subsequent treatment. The volume of water containing these heavier contaminants is significantly less than the initial volume of water fed into the filtration tube, since much of the water passed through the membrane into the space between the inner and outer tubes. The permeated water can be disposed of in a manner consistent with local permitting requirements. The cost of treating the reduced volume of water with the greater concentration of heavier contaminants is less than that of treating the original volume of waste water.

For the SITE demonstration, the filtration unit operated for six days. Each day, approximately 1,000 gallons of feedwater were run through the unit during a two-hour period. The concentrated contaminant water was recycled until the desired volume reduction was achieved. Average PAH concentrations in the feedwater were approximately 47 milligrams per liter (mg/L) and average PCP concentrations were 2.4 mg/L. The system concentrated the feedwater to 20% of the original volume. This contained 80% of original contaminants which represents approximately 30% of the phenolic compounds and greater than 95% of the PAHs.

Based on the SITE demonstration, the SBP system appears effective in concentrating waste streams rich in PAHs but probably would not be suitable for phenols. The system can be customized for a wide range of contaminants-for example, waste streams containing high molecular weight or non-polar organic contaminants such as polychlorinated biphenyls. The process may also be useful for separating other emulsified or dispersed organics that do not lend themselves to simple physical phase separation.

An Applications Analysis Report and a Technology Evaluation Report describing the complete SBP SITE demonstration will be available in the Fall of 1992. For more information now, and to get on the mailing list for the Report, call Kim Kreiton at the Risk Reduction Engineering Laboratory in Cincinnati, Ohio, at 513-569-7328.

Biosparging

(from page 1)

wells were adjusted to five cubic feet per minute. This low blower rate created a long air stream retention time of 24 hours so that microbes would have a chance to mineralize the pollutants. The injected air volatilized the contaminants into soil gas components. After air injection began, TPH soil gas levels were near 5,000 mg/L in the plot area. Venting and subsequent biodegradation eventually reduced soil gas levels to less than 50 mg/L.

After completion of bioventing, biosparging was started at the pilot demonstration. Aeration injection points were inserted in the saturated zone of the plot area to a depth of about ten feet below the water table. The same blower injection system that was used for the bioventing was used. The injected air removed water soluble hydrocarbons trapped in the soil capillaries and groundwater by vaporizing the contaminants as the air bubbled up through the groundwater. The contaminants, now in a vapor phase, were then further aerated upward into the unsaturated zone. Here they were biodegraded by the bioventing process described above.

The pilot demonstration showed that biosparging was effective in removing the water-solubilized hydrocarbons in the groundwater. For example, after biosparging began, soil gas contaminant concentrations in the unsaturated zone increased from 20 mg/L to 6,000 mg/L for volatile TPHs. Final benzene levels in the underlying groundwater near the water table were less than 5 micrograms per liter (µg/L) compared to initial concentrations of 133 µg/L.

We already know that biosparging can remove water-dissolved phase fuel in the groundwater. However, when fuel globules are entrapped in capillary matrices, the cap illaries act as a physical barrier that hinders or prevents the injected air from transforming the fuel into vapors. The full effectiveness of sparging is being evaluated by collection and analysis of vertical profile core samples at different times. Final results should be available by September, 1992.

For more information, call Don Kampbell at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, at 405-332-8800.

Upcoming SITE Demos

Several Superfund Innovative Technology Evaluation (SITE) program demonstrations are planned for this summer. Below is a brief description of the technologies to be demonstrated, the name of the developers and the EPA contacts to call for more information and visitor days.

Dechlorination

Region 1

Chemical Waste Management's (CWM) DeChlor/KGME process involves the dechlorination of liquid-phase halogenated compounds, particularly polychlorinated biphenyls (PCB). KGME, a CWM proprietary reagent, is the active ingredient in a nucleophilic substitution reaction in which the chlorine atoms on the halogenated compounds are replaced with fragments of the reagent. The products of the reaction are a substituted aromatic compound (no longer a PCB aroclor) and an inorganic chloride salt. For more information, contact Reinaldo Matias at 513-569-7149.

Thermal Gas Phase Reduction

Region 5

A patented process from ELI EcoLogic International, Inc., is based on the gas-phase, thermochemical reaction of hydrogen with organic and chlorinated organic compounds at elevated temperatures. At 850 degrees Celsius or higher, hydrogen reacts with organic compounds to produce smaller, lighter hydrocarbons. This reaction is enhanced by the presence of water, which can also act as a reducing agent. Because hydrogen is used to produce a reducing atmosphere devoid of free oxygen, the possibility of dioxin or furan formation is eliminated. Visitor days are projected for the week of September 8, 1992. For more information, call Gordon Evans at 513-569-7684.

In Situ Biotreatment

Region 5

The geolock and bio-drain treatment platform from International Environmental Technology is a bioremediation system that is installed in the soil or waste matrix. The technology can be adapted to soil characteristics, contaminant concentrations and geologic formations in the area. The system is composed of an *in situ* tank, an application system and a bottom water recovery system. All types and concentrations of biodegradable contaminants can be treated by this system. Through direct degradation or co-metabolism, microorganisms can degrade most organic substances. Visitor days are projected for August 1992. For more information, call Randy Parker at 513-569-7271.

Solvent Extraction

Region 1

A soil restoration unit from Terra-Kleen Corporation is a mobile solvent extraction remediation device for the on-site removal of organic contaminants from soil. Extraction of soil contaminants is performed with a mixture of organic solvents in a closed loop, counter-current process that recycles all solvents. Terra-Kleen Corporation uses a combination of up to 14 solvents, each of which can dissolve specific contaminants in the soil and can mix freely with water. None of the solvents is a listed hazardous waste, and the most commonly used solvents are approved by the Food and Drug Administration as food additives for human consumption. The solvents are typically heated to efficiently strip the contaminants from the soil. For more information, call Mark Meckes at 513-569-7348.

Solvent Extraction

Region 5

The BEST Solvent Extraction process from Resources Conservation Company is a mobile solvent extraction system that uses one or more secondary or tertiary amines [usually triethylamine (TEA)] to separate organics from soils and sludges. The BEST technology is based on the fact that TEA is completely soluble in water at temperatures below 20 degrees Celsius. For more information, call Mark Meckes at 513-569-7348.

Thermal Desorption

Region 5

The Soil Tech anaerobic thermal desorption processor heats and mixes contaminated soils, sludges and liquids in a special rotary kiln that desorbs, collects and recondenses hydrocarbons from solids. The unit can also be used in conjunction with a dehalogenation process to destroy halogenated hydrocarbons through a thermal and chemical process. For more information, call Paul dePercin at 513-569-7797.

Soil Washing

Region 10

The soil washing system from BESCORP is a gravity separation system to treat lead-contaminated soils. The advantage of the system is that it is a very simple system derived from mining technology. It is assumed that solubilized lead will partition to fine fraction and that using a density separation system will remove the dense metallic lead. For more information, call Hugh Masters at 908-321-6678.

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ATTIC **Out of the ATTIC**

Finding Cleanup Alternatives for TCE and PCE

If you are looking for alternatives for cleaning up a site containing soil and groundwater contaminated with trichloroethylene (TCE) and perchloroethylene (PCE), you should consider calling the Alternative Treatment Technology Information Center (ATTIC) database.

If you search the ATTIC database using the key word "soil" you will find over 750 reports. You could narrow this list by performing a free-text search of the Summary Paragraphs for "TCE" and "PCE". If you decide to omit the Records of Decisions you will find 3 1 reports on technologies such as biodegradation, *in situ* soil venting, radio frequency enhancement, vacuum extraction, low-temperature thermal technology, granular activated carbon, soil washing, ultraviolet oxidation and incineration. One document that might catch your eye is "Treatment Technologies for Hazardous Waste Part II: Alternative Techniques for Solvent Wastes." Another document is from the Superfund Innovative Technology Evaluation program and is called "AWD Technologies, Inc. Integrated Vapor Extraction and Steam Stripping." This second report describes a system that simultaneously treats groundwater and soil contaminated with volatile organic compounds (VOCs). The technology can effectively remove over 90 of the 110 volatile compounds listed in 40 CFR Part 261, Appendix VIII. Removal efficiencies were as high as 99.99% for VOCs in groundwater and 99.9% for VOCs in soil gas. [Note: This AWD technology was previously featured in the March 199 1 issue of Tech Trends.]

From the Bulletins section of the ATTIC system, you can download a complete text of an EPA engineering bulletin on *in situ* soil vapor extraction, a report of a demonstration of the steam injection technology in Huntington Beach, California, and an EPA engineering bulletin on granular activated carbon treatment. You can also download a technology update from EPA's Center Hill Research Facility in Cincinnati, Ohio, that describes advantages of using hydrofracturing to increase the surface area in extraction wells.

By searching ATTIC's Risk Reduction Engineering Laboratory Treatability Database for TCE and PCE, you can find information on: chemical and physical properties; environmental data including risk estimates for carcinogens and water quality criteria; and performance data of water treatment technologies, such as activated sludge, chemical assisted clarification, air stripping, trickle filtration, chemical oxidation, granular activated carbon, reverse osmosis, ultraviolet radiation and packed activated carbon.

ATTIC provides the names and phone numbers of several EPA personnel that could be contacted for more information on the technologies. There is no charge for accessing, searching or downloading information from the ATTIC system. Information on the ATTIC system is available from the system operator at 301-670-6294 or from Joyce Perdek of EPA's Risk Reduction Engineering Laboratory at 908-321-4380.

To order additional copies of this or previous issues of *Tech Trends,* call the publications unit at CERI at (513) 569-7562 and refer to the document number on the cover of the issue. **To be included on the permanent mailing list** for *Tech Trends,* call (703)308-8800.

Tech Trends welcomes readers' comments and contributions. Address correspondence to:
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