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Demonstration Bulletin

New York State Multi-Vendor Bioremediation

ENSR Consulting and Engineering/Larsen Engineers Ex-Situ Biovault

Technology Description: The ENSR Biovault Treatment Process is an ex-situ bioremediation technology for the treatment of organic contaminated soils. Contaminated soils placed in specially designed soil piles, referred to as biovaults, are remediated by stimulating the indigenous soil microbes to proliferate and metabolize the organic contaminants in the soil at an accelerated rate. Depending on contaminant phase and volatility, a certain portion of the contaminant mass is removed from the soil by vapor extraction/air stripping. Optimizing the bioremediation component of the ex-situ biovault technology involves a series of controlling factors that directly influence microbial activity, including soil pH, electron acceptor availability, moisture, and nutrients such as nitrogen and phosphorus. According to the developer, the principal products of the technology are water, carbon dioxide and inorganic salts. Some intermediates may also be formed as a consequence of metabolic activity, depending on the chemistry of the parent contaminants and mode of operation (e.g., aerobic or anaerobic). The developer claims that any intermediates that are formed will be captured and degraded by other microbes, sorbed on soil particles for later degradation, solubilized by water in the soil, or volatilized and removed by the biovault's gas management system (GMS).

The biovault is constructed of 30 mil HDPE liners placed over soil berms which support and contain the soil pile (Figure 1). The bottom of the vault consists of double lined HDPE with a leak detection system between the two liners. The vault floor slopes to one corner to a sump, which contains a pump to recover leachate. Leachate collected in the sump is pumped to storage and eventually recycled to the soil pile via a soaker hose system as part of the technology's moisture control system. The soaker hose system is also used for pH adjustment and nutrient delivery.

The vault uses a gas management system (GMS) to ventilate the soil and thereby control the availability of the electron acceptor (oxygen). Contaminated soil is sandwiched between a lower and upper air distribution system. The GMS is designed and operated to provide uniform air flow through the soil. Vault off-gases are treated by activated carbon before being released to the atmosphere.

The biovaults can be operated on a strictly aerobic basis, where the soils are periodically vented with air over the remediation period, or on an alternating anaerobic/aerobic basis, which involves extended periods when no air is delivered to the soil. The latter method of air management is believed to be better suited for biodegradation of highly halogenated contaminants.

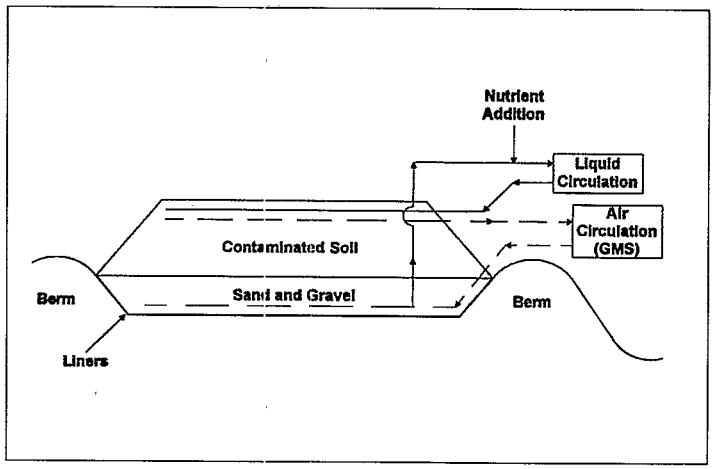

Figure 1. ENSR Biovault Section

Waste Applicability: According to the developer, the ex-situ biovault remediation technology is applicable to soils contaminated with volatile and semivolatile compounds, including various fuels, hydrocarbons, and solvents. The technology is believed to degrade halogenated compounds when operated in the anaerobic mode or as a result of cometabolic reactions while operating in the aerobic mode.

Demonstration Results: Pilot-scale testing of the Ex-Situ Biovault bioremediation process was conducted at the Sweden-3 Chapman Site in Sweden, NY as part of the Multi-Vendor Demonstration of Bioremediation Technologies over a ~5 month period between July 1994 to December 1994. The presently inactive 2-acre landfill was used to dispose of construction and demolition debris between 1970 and 1975. A state sponsored investigation of the site conducted between 1985 and 1987 revealed buried drums throughout the landfill. In 1991, over 2,300 drums were removed from the landfill under an interim remedial measure (IRM). A remedial investigation conducted after the landfill was capped identified three areas of heavily contaminated soil. The area referred to as the "Northwestern source area", the focus of the technology evaluation and the largest of the three areas, contained soils contaminated with TCE, PCE, acetone, MEK, MIBK, toluene, and xylenes.

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The demonstration involved the pilot-scale testing of two side-by-side biovaults, each about 40 ft^2. One 100 yd^3 of soil from the "Northwestern source area" was excavated and placed in each vault. One biovault was operated in a strict aerobic mode while the other alternated between the aerobic and anaerobic mode.

A primary objective of the demonstration was to determine the effectiveness of the ex-situ Biovaults in reducing VOC contamination in the soil. Based on this objective, the Developer set as a remediation objective that 90% of the final samples collected from each vault after 6 months of continuous operation would be below NYS Cleanup objectives for six target VOCs (acetone, 2-butanone [MEK], 4-methyl-2-pentanone [MIBK], trichloroethene [TCE], tetrachloroethene [PCE] and cis-1,2-dichloroethene [DCE]). In addition, the developer claimed that biodegradation would be the dominant mechanism of contaminant removal. Additional analytes from the soil, vault water, and extracted air streams were collected to further assess performance and effectiveness of the ex-situ Biovaults.

The first primary objective was evaluated by measuring the residual concentrations of the selected VOCs in nine subplots of each vault at the completion of the test period. Soil sampling was also conducted initially and at ~3 months to assess the overall efficiency of the process in reducing each contaminant. The second primary objective, determination of biodegradation contribution, was determined by estimating the difference between the initial mass of each VOC in each vault and the sum of the VOC masses removed in the extracted air stream and vault water and that remaining in the soil at 6 months. Coupled with other observations and analyses, the difference between the total contaminant mass reduction and mass reduction by abiotic mechanisms was considered the maximum mass destroyed by biological processes.

Preliminary results from the Ex-Situ Biovault technology demonstration follow:

- Significant reductions in soil VOCs occurred in both vaults over the 6-month Demonstration period, although data exhibited considerable variability.
- Preliminary data suggest that the performance of the vault operating in the alternating mode may have been adversely affected by the frequency of air venting, including that conducted during off-gas sampling of this vault.

An Innovative Technology Evaluation Report (ITER) describing the complete demonstration will be available by late 1995.

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