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Demonstration Bulletin

New York State Multi-Vendor Bioremediation

R.E. Wright Environmental, Inc.'s In-Situ Bioremediation Treatment System

Technology Description: The R.E. Wright Environmental, Inc.'s (REWEI) In-situ Bioremediation Treatment System is an in-situ bioremediation technology for the treatment of soils contaminated with organic compounds. According to the Developer, contaminated soils are remediated in-situ by stimulating the activity of indigenous soil microbes through the introduction of essential nutrients, an easily oxidized co-substrate and an electron acceptor. The technology's primary nutrient amendment, essential for microorganism growth, is nitrogen in the form of gaseous anhydrous ammonia. The technology uses methane as the easily oxidized co-substrate. Methane stimulates the growth of methanotrophic organisms and induces the production of an enzyme (methane monoxygenase) capable of degrading low molecular weight chlorinated alkanes and alkenes. The electron acceptor for the aerobic methanotrophic enzyme system is oxygen. Oxygen is distributed throughout the treatment zone at atmospheric concentrations by use of an air injection system. Depending on the contaminants' phase and volatility, and particularly during the early stages of remediation when the microbial consortium has not had adequate time to become established, a certain portion of the contaminant mass is removed from the soil by vapor extraction/air stripping. The Developer maximizes biodegradation as the principal mechanism for contaminant reduction by limiting vapor extraction to only the level necessary to meet biological oxygen demand.

The technology consists of networks of small-diameter bioventing (extraction) and injection wells which are used to aerate and introduce amendments into the treatment zone. The bioventing wells are manifolded together and connected to the vacuum port of a blower system. Each bioventing well head is equipped with a valve to control air flow across the treatment zone. The amendment injection wells are manifolded together and connected to the pressure port of the blower system. An anhydrous ammonia tank and a methane tank are connected in-line downstream from the injection port. Ammonia vapor is introduced into the subsurface at concentrations well below those considered toxic to microorganisms. Application frequency and the amounts of nitrogen added (as ammonia) are periodically adjusted based upon monitoring. Methane injection into the soil is limited in order to prevent excess methane from inhibiting oxidation of the target contaminants. The methane content measured in the extracted off-gas and periodic monitoring of methane-degrading microorganisms in the soil are used to determine methane optimum application rates.

The blower system is equipped with a moisture separating tank. Moisture collected in the tank is pumped through two water-phase carbon drums before it is discharged. The blower system is designed to be fully automated and controlled by a blower unit timer. Vacuum extraction off-gases are treated with activated carbon before being exhausted to the atmosphere.

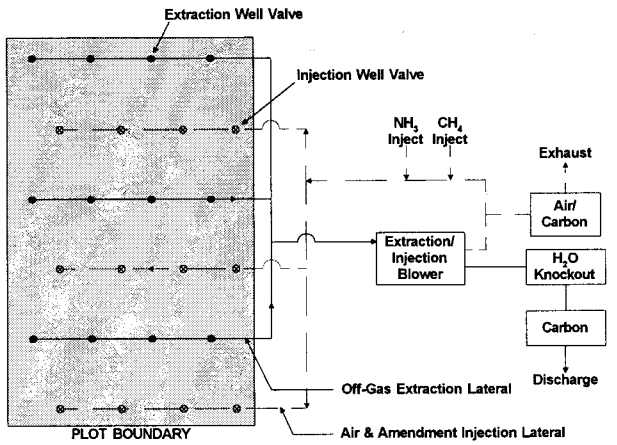

Figure 1. Schematic of R.E. Wright's In-Situ Bioremediation Treatment System

Waste Applicability: According to the Developer, the In-situ Bioremediation Treatment system is applicable to soils contaminated with VOCs and semivolatile compounds, including those comprising various fuels, hydrocarbons, and solvents. The use of methane as an easily oxidized cometabolite makes the technology amenable to treating soils contaminated with halogenated hydrocarbons.

Demonstration Results: Pilot-scale testing of the In-situ Bioremediation Treatment system was conducted at the Sweden-3 Chapman Site in Sweden, New York 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). Studies conducted after the drums were removed 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,

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contained soils contaminated with TCE, PCE, acetone, MEK, MIBK, toluene, and xylenes.

The In-situ Bioremediation Treatment system constructed at the site consisted of 3 adjacent plots. Each plot measured 36 feet by 40 feet and consisted of several separately valved rows of extraction and injection wells arranged in an alternating fashion. Each well is valved independently for optimal system flexibility and air flow control.

A primary objective of the Demonstration was to determine the effectiveness of the In-situ Bioremediation Treatment system in reducing VOC contamination in the soil. Based on this objective, it was claimed that 90% of the final samples collected from each plotafter 6 months of continuous operation would be below New York State Cleanup Objectives for six target VOCs (acetone, 2-butanone [MEK], 4-methyl-2-pentanone [MIBK], trichloroethene [TCE], tetrachloroethene [PCE] and 1,2-dichloroethene [DCE]). The Developer claimed that biodegradation would be the dominant mechanism of contaminant removal. A second objective of this study was to assess the biological contribution to contaminant removal. Additional analytes from the soil, knockout water, and extracted air streams were collected to further assess performance and effectiveness of the technology.

The first primary objective was evaluated by measuring the remaining concentrations of the selected VOCs from 9 subplots of each plot at the completion of the test period. Soil sampling was conducted initially to determine baseline conditions at the start of the treatment. Excessive soil moisture and surface water prevented the collection of intermediate samples at the end of 3 months of operation.

The second primary objective, determination of biodegradation contribution, was estimated by determining the difference between the initial mass of each VOC in each plot and the sum of the VOC masses removed in the extracted air stream and knockout water to the specified time, and that remaining in soil samples after 6 months. Coupled with other observations and analyses, the difference between the total mass reduction and mass reduction by abiotic mechanisms was considered the maximum mass destroyed by biological processes.

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

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