Bioscience, Inc.
Environmental Products and Services
ISO 9001:2008 CERTIFIED

Bioremediation of Hydrocarbon Contaminated Soil

Using a biopile technique and Microcat® XBS Hydrocarbon Degrader- BSE 038

Problem

Soil was contaminated by underground storage tanks leaking gasoline and a C13-C15, branched chain, aliphatic hydrocarbon solvent. The objective of this work was to biologically treat the soil contaminated by gasoline and a C13-C15, branched-chain, aliphatic hydrocarbon solvent to less than 100 ppm Total Petroleum Hydrocarbons (TPH) using a biopile technique.

Products Used

MICROCAT®-XBS, Hydrocarbon Degrader and MICROCAT®-NPN, Biodegradable Nutrients

Site History

The underground storage tanks were removed and 1,200 cubic yards of soil, containing an average of 230 mg/kg TPH were excavated. Levels of other compounds were below RCRA regulatory limits. "Hot spots" in the excavated soil showed TPH levels of greater than 600 mg/kg. The soil was placed on an impermeable liner and covered while tests were conducted to determine the feasibility of bioremediation by means of a solid-phase process. Although gasoline is readily biodegradable, little was known about the hydrocarbon solvent or

whether it could be degraded rapidly by naturally-occuring microorganisms.

Treatability Testing

Bioscience, Inc. of Bethlehem, PA performed two types of treatability studies: one using respirometry to measure the oxygen consumption of microorganisms during biodegradation of the contaminants under a variety of conditions; and, a second consisting of bench-scale simulation vessels containing composites of soil from the site, nutrients, water and bacteria**.**

Respirometry

In the respirometry tests, reactors containing the C13-C15 solvent showed lower oxygen uptake than uncontaminated controls during the first 80 hours of incubation. The reactor containing a higher concentration showed a significant lag in oxygen uptake for the first 16 hours. Between 70 and 150 hours into the experiment, oxygen uptake for both heavily and lightly contaminated reactors was similar to that of the seed blank (control). After 150 hours, both reactors began to show a consistent increase in uptake compared to the seed blank, but not enough to indicate complete biodegradation of the hydrocarbon solvent substrate. Analysis of the reactor contents after incubation indicated a greater than 90 percent reduction in TPH.

Bench-Scale Simulation

TPH reduction in the simulation reactors with indigenous microbes was only 15 percent after 14 days and 45 percent after 28 days. Where the commercial inoculum (MICROCAT-XBS) had been added, the reductions were 39 percent after 14 days and 78 percent after 28 days (Figure 1). Based on the test results, which indicated the inhibitory nature of the hydrocarbon solvent and a doubling of the biodegradation rate by bioaugmentation, the owner selected a solid-phase process using nutrients and a commercial microbial inoculum, as the most cost-effective treatment of the site. Based on the lab results, reduction of TPH levels to the target of less than 100 mg/kg was expected to take from several weeks to months, depending primarily upon soil temperature, which could not be controlled.

Full-Scale Remediation

Solid-phase remediation of the site began in mid-October. The soil was divided into three treatment cells on 10-mil plastic liners. Each cell was covered to prevent volatilization of hydrocarbons and rain infiltration. The initial soil conditioning included a commercial microbial product (MICROCAT-XBS) in a water suspension plus the required levels of nutrients (MICROCAT-NPN) for microbial growth. The first cell was spread to a depth of one foot, sprayed with nutrients and inoculum, and another foot of soil added, which was also inoculated. Since this method proved time-consuming, the remainder of the soil was inoculated using a tank sprayer as it was being spread on the liner by a track-hoe. Mechanical distribution of the soil provided sufficient mixing and aeration for microbial growth.

Results of Full-Scale Work

One month after inoculation, each cell was sampled and tested for TPH. Each cell was divided into four sections and a composite of three samples from each section mixed for analysis. Average TPH in all cells was below 100 mg/kg; however, some individual hot spots remained as a result of less than complete mixing. It was decided to leave the site without further treatment over the winter and to re-inoculate specific hot spots after the ice melted in the spring. These sections were extracted, treated and tilled-in during the ensuing

springtime.

Final analysis in April showed TPH levels well below 100 mg/kg in every section with 7 of the 12 samples below 10 mg/kg TPH. Additional analyses for benzene, toluene, ethylbenzene and xylene (BTEX) and for total organic halogens (TOX) indicated levels below detectable limits in all soil composites (Figure 2).

Static soil pile bioremediation proved a cost-effective treatment method for these hydrocarbon-contaminated soils. Bioaugmentation was shown to double the mineralization rate of hydrocarbons over the indigenous populations in laboratory pilot tests.

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FIGURE 1

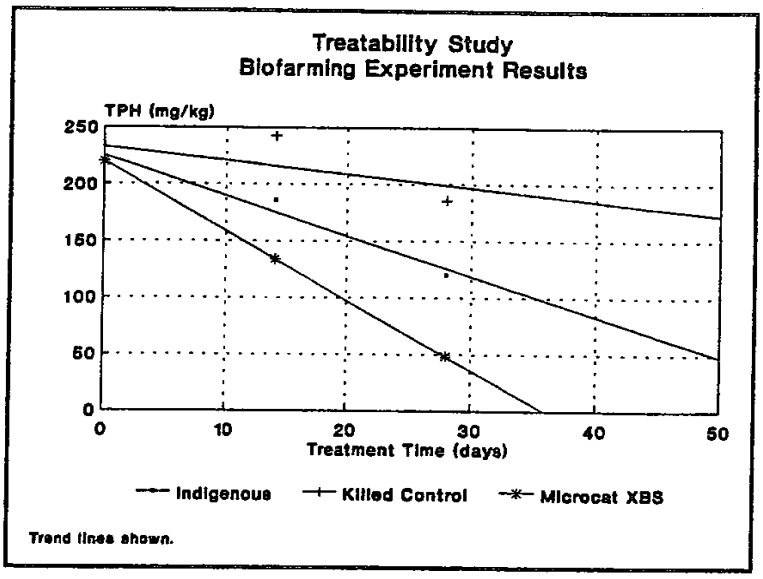

FIGURE 2