TechData Sheet

Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4370

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Biocell Technology

Remediation of Petroleum-Contaminated Soils

Problem

Many Navy installations have to dispose of small quantities of petroleum hydrocarbon contaminated soils. These soils are generated at facilities that have fuel stored in underground or aboveground storage tanks, maintenance and vehicle wash areas, and training areas where fuel has been spilled on the ground. Private industry also faces similar problems at service stations, maintenance garages, and other facilities where fuels are used. Off-site disposal is traditionally used to dispose of these small quantities of contaminated soil. However, off-site disposal can be very expensive.

Solution

As a solution to expensive off-site disposal, biocell technology provides an innovative method for treating small quantities of soils contaminated with low to intermediate concentrations of petroleum hydrocarbons. The technology involves loading petroleum-contaminated soils into a commercially available 40-yd^3 dumpster or any other container similar in size, and stimulating aerobic microbial activity within the soils through aeration. Soil can be treated in amounts ranging from a small quantity, by simply filling a portion of the container, to a large quantity, by using multiple containers (modular approach). Adding moisture and nutrients such as nitrogen and phosphorus can enhance microbial activity. The microbial activity degrades the petroleum-based constituents adsorbed to soil particles, thus reducing the concentrations of these contaminants. Clean soil can then be returned to the original excavation site or used as fill where needed.

Demonstration

The ability of biocell technology to reduce the concentration of petroleum constituents in excavated soils through the use of aerobic biodegradation has been successfully demonstrated. The Army's Waterways Experiment Station (WES) developed a 10-yd^3 biocell. A significant portion of the WES research was aimed at simplifying the technology so that an activity could build a 40-yd^3 system using readily available commercial materials. A 10-yd^3 biocell was tested at the Naval Construction Battalion Center's Hydrocarbon National Test Site in Port Hueneme, California in October 1996 (Figure 1). After 105 days of biocell operation, the total petroleum hydrocarbons (TPH) concentrations in the soil decreased from 736 ppm to 147 ppm.

Figure 1. The 10-yd^3 biocell at Port Hueneme, California.

Technical Description

Biocells use naturally occurring microbes to degrade fuels and oils into carbon dioxide and water. Under optimum nutrient, moisture, oxygen, and temperature conditions, native bacteria in the contaminated soil use the TPH as a food source. Clean soil can then be returned to the original excavation site or used as fill where needed. Volatile organic compounds (VOCs) produced during operation of the biocell are treated by using a granulated activated carbon (GAC) adsorption system. Biocells are capable of treating soils contaminated with petroleum-based fuels and lubricants, including diesel fuel, jet fuel, and lubricating and hydraulic oils. The microbes use the contaminants as a food source and thus destroy them. By carefully controlling air flow and moisture levels, the treatment time can be reduced.

The biocell system consists of commercial roll-off dumpsters or containers converted into fully contained bioremediation units. Individual units can treat contaminated soil ranging in quantities from 20 to 40 yd^3 at a time, and several units may be combined at one site for larger soil volumes. Biocell containers have an impermeable liner to reduce the potential migration of leachate to the subsurface environment. A leachate collection system is installed at the bottom of the container to capture excessive moisture in the system. Perforated pipes, installed under the contaminated soil, are connected to a blower that facilitates the aeration of the soil. The blower should pull air through the soil and GAC canisters versus blowing the air as demonstrated by WES to eliminate the potential for VOCs to escape through the cover. If off-gas treatment is not required, blowing air through the soil is recommended. The container is covered with an impermeable liner to prevent the release of contaminants and/or contaminated soil to the environment, and to protect the soil from wind and precipitation (Figure 2). Biocells operate very effectively in temperate climates such as California and Hawaii. They will also operate effectively in the colder climates of Alaska and Iceland; however, the treatment duration will be longer.

Benefits

Biocell technology offers the following benefits:

- Biocell systems are relatively easy to design and construct.
- At most Navy sites, treatment can be completed in a relatively short period of 3 to 6 months.
- Biocells may be cost-competitive with off-site disposal.
- Biocells are applicable to a wide range of site conditions and petroleum-based contamination.
- Soil volumes to be treated range between 20 to 200 yd^3 per year.

Cost Analysis

Based on WES's design and the successful demonstration of a 10-yd^3 biocell, the Naval Facilities Engineering Center (NFESC) has developed a document entitled "Biocell Application Guidance" TR-2092-ENV to provide Navy installations a general overview of the biocell technology, design, operation and maintenance procedures, and economics. The document lists the basic materials and parts required to build a biocell. It also details the cost effectivness of operating a biocell.

The unit cost per yd^3, amortized over 5 years with three operations per year, is \$40.83/yd^3 for one biocell, \$36.75/yd^3 for two biocells, and \$34.56/yd^3 for three biocells, respectively. When the container is not at full capacity the costs per yd^3 are significantly higher. Therefore, soil should be stockpiled until the biocell can be operated at 100 percent capacity. When compared to off-site disposal costs, which range between \$40.00/yd^3 and \$480.00/yd^3, biocell technology could be a very cost-effective option.

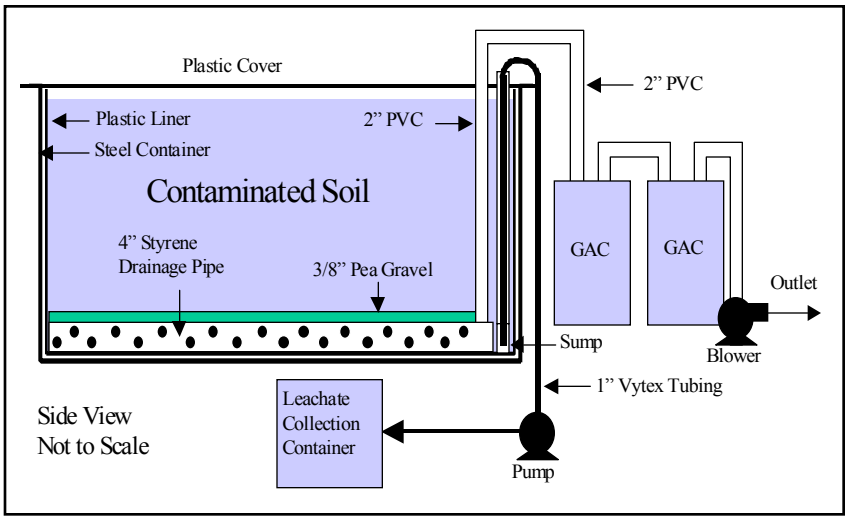

Figure 2. Schematic of a 40-yd^3 biocell.

For more information about biocell technology and a copy of "Biocell Application Guidance" TR-2092-ENV, contact:

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