CHARACTERIZATION OF PETROLEUM CONTAMINATED SOILS IN WYOMING[1]

by

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Abstract. Soils contaminated with petroleum and associated distillation products often have low pH values (e.g., <4.00). The low pH presents a number of problems for reclamation of these soils. The objective of this study was to assess acidity of petroleum-contaminated soils in an effort to initiate a phytoremediation process. Surface soil samples (0-10 cm) from a contaminated site were collected. Soil samples were crushed and passed through a 2mm sieve; resulting soils were homogenized and subjected to pH and Total Petroleum Hydrocarbon (TPH) analyses. From these measurements, calcium oxide requirement was calculated to increase pH to a range of 7-8. A discussion of acidity in petroleum-contaminated soils is presented.

Additional Key Words: reclamation, plant growth, biological activity.

Introduction

Since the first commercial use of Carbon Oil, the distillation of petroleum and the petrochemical industry has expanded to become a principal source of fuels and materials to meet the needs of a growing population (Giddens, 1948). High consumer demand for petroleum products has led to the development of a large petrochemical production and transport complex (Meo, 1989). The necessity of this transport and production has the effect of increasing the potential for release of petroleum materials into the environment through deteriorating storage tanks or accidental release (Dowd, 1984). Traditional methods of soil remediation center around the use of engineering controls to remove contaminants by soil lifting, followed by incineration of the affected soils. Incinerated materials are then replaced with clean topsoil and/or overburden materials. Although effective, these technologies may cause further disturbance to the site and can be cost-prohibitive (Cunningham and Berti, 1993).

In-situ remediation offers several advantages over engineering controls. These methods center on the use of technical control measures to increase convective transport and biological activity in these petroleum contaminated soils (Van Eyk, 1997). Phytoremediation processes offer several economic and technical advantages over other remediation techniques as a means of increasing biomass in soils and providing habitat for soil microorganisms (Chambers, 1991; Henderson, 1988). Microbiological processes in soil systems are of interest because they often drive or control certain soil reactions. Microbial processes often control the pH in a soil system by the utilization or production of acid by the microorganisms. In petroleum-contaminated systems, microorganisms may utilize hydrocarbons as energy sources and increase the rate of degradation of contaminants (Evangelou, 1988).

Objectives

The objectives of this study were to 1) assess the pH of soils contaminated with differing levels of Total Petroleum Hydrocarbons (TPH), 2) build a database into the Global Information System (GIS) to examine contamination patterns and 3) to determine suitability of these soils for phytoremediation processes.

Methods and Materials

Soil samples were obtained from an abandoned petroleum tank farm in Natrona County, WY, using

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Global Positioning Satellite (GPS) to identify sample sites. All sites were entered into the GIS database system. Sampling depths were restricted to the uppermost 10cm of the soil profile. Samples were stored in doubled plastic bags until analysis. TPH measurements were performed by an independent EPA certified laboratory using Gas Chromatography-Mass Spectroscopy (GC-MS) and EPA methodology. All samples were crushed and passed through a 2mm sieve and homogenized prior to preparation of soil pastes. Determinations of pH were made in the saturated paste and measurements were performed by use of an Orion pH electrode and a Fischer AccuMet 50 pH meter. The pH electrode was calibrated with a three-point calibration using buffer solutions of 4.00, 7.00, and 10.00.

Adjustments to pH prior to greenhouse studies were made by addition of calcium oxide, with further pH analysis to ensure stability of the adjusted pH. Soils were adjusted to pH values of 7-8 as determined by the soil paste method.

Results and Discussion

Saturated soil pastes prepared from samples taken at the study site were found to have pH values in the range of 2.5-8. TPH values from samples at the site were in the range of 25-47,500mg kg^{-1}. Soils from the study site are classified as coarse and fine loamy sands, with 0-2% organic matter. Soils in some portions of the study site are entombed under a layer of consolidated organic sludge at the surface.

The pH values of contaminated soils are reduced by the presence of hydrocarbon contamination and presents difficulties in establishing sustainable plant and microbial communities. To initiate a successful phytoremediation protocol, it is necessary to increase the pH value to a range of 7-8. Calcium oxide was used to increase the pH of these soils, which has the effect of increasing carbonates in the soil system and buffering the pH in the desired range, resulting in a soil system with a higher potential for sustainable plant and microbial communities. Increases in plant and microbial communities may have the effect of increasing rates of microbial decomposition and phytoextraction or stabilization of the hydrocarbon contaminants, as well as decreasing the soil erosion potential of the site.

Conclusions

Increasing pH in the contaminated soils by the addition of calcium oxide can effectively stabilize soil pH values and may prove to have some economic advantage over other soil amendments. Preliminary greenhouse studies indicate that plant communities can be established in soils where pH has been stabilized by addition of calcium oxide.

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