

Crude oil degradation in contaminated soil



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Crude Oil Degradation in Contaminated Soil Comparing Land-Farming, Surface Heating and Enhanced Biodegradation Ahmed Mahdia, Dar El Tarbia American School, Cairo, Egypt

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6 Abstract

One of the most destructive pollutants known today is oil contamination.

For decades people have been trying to find the cheapest and most efficient cleanup ways of oil contaminated soil. Many solutions were found and put to use. The purpose of this research is to compare Land-Farming, Surface Heating, and Enhanced Biodegradation of oil contaminated soil to find out which of these methods is the cheapest and most efficient. The experiments were designed by forming models of the three processes.

Fifty gram soil samples each contaminated with 10ml of crude oil passed through each process. In Land-Farming and Enhanced Biodegradation, the samples were left in a 30oC incubator for five days. Then the oil was extracted. As for Surface Heating, the remaining oil was extracted from the soil after passing hot vapor and filtration of the vapor. The extracted oil was passed through an HPLC (High Performance Liquid Chromatograph) and the amount of contaminants left was measured. The Land-Farming model was

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only able to degrade less than 1% of the oil contamination after the 5 day incubation period. Enhanced Biodegradation by *Pseudomonas* sp. was able to degrade about 35% of the oil in the same period.

As for Surface Heating, more than 50% of the contaminants were removed, with the consumption of 15.75 Kcal of heat. Land-Farming proved to be the most time consuming method, compared to Enhanced Biodegradation and Surface Heating. Surface Heating had the most purification capacity and least time, but needs high amount of funding and energy.

Enhanced Biodegradation combined both an average purification capability and average time consumption. Plus, Enhanced Biodegradation is the cheapest of the three methods. Bacteria could prove very useful if it acts well under field trial test and survived for a reasonable period sufficient for oil biodegradation.

IntroductionAs we dig deeper into the modern industrial age of technologies, several aspects of human life change. People benefit largely from life development and many live in prosperity, but prosperity has a price. This price is paid by our environment that suffers daily from all kinds of pollutants and destruction. People now have to find ways to cure this destruction. Oil contamination is one of the most dangerous pollution factors known today. It can cause a threat to the environment.

It is very feared by environmentalists and its very hard to control if it gets out of hand. Oil contamination can be either at sea or in soil. Sea oil contamination poses a threat on marine life and the death of hundreds of marine organisms. Soil contamination on the other hand is slow and lethal. It

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acts over a long period of time by poisoning food crops, water supplies, etc. Oil contamination in soil results in an imbalance in the carbon-nitrogen ratio at the spill site, because crude oil is essentially a mixture of carbon and hydrogen. This causes a nitrogen deficiency in oil soaked soil, which retards the growth of bacteria and the utilization of carbon sources.

Furthermore, large concentrations of biodegradable organics in the top layer deplete oxygen reserves in the soil and slow down the rates of oxygen diffusion into deeper layers. Soil contamination can be cured by several ways. Many methods have been used for the degradation of crude oil. Some of these methods include; Land-Farming: It is a full scale bioremediation technology in which contaminated soils, sediments or sludge are turned over, or tilled and allowed to interact with the soil and climate in the site (Fig 1). The waste, soil, climate, and biological activity interact dynamically as a system to degrade, transform, and immobilize waste constituents. Wastes are periodically tilled to aerate the waste.

Soil conditions are often controlled to optimize the rate of contaminant degradation. A Land Treatment site must be managed properly to prevent both onsite and off-site problems with ground water, surface water, air, or food chain contamination. Adequate monitoring and environmental safeguards are required.

Factors that may limit the applicability and effectiveness of the process include: ??? A large amount of space is required. ??? Conditions affecting biological degradation of contaminants is largely uncontrolled which greatly increases the length of time needed to complete the process. ??? Inorganic

contaminants will not be biodegraded. ??? Dust control is very important especially during tilling. ??? Runoff collection facilities must be constructed at site and monitored. Surface Heating Hot air or steam is injected below the contaminated zone to heat up the contaminated zone (Fig 2). The heating enhances the release of contaminants from soil matrix. The contaminants are stripped from contaminated zone and brought to the surface through soil vapor extraction.

The following factors may limit the applicability and effectiveness of the process: ??? Debris or other large objects buried in the media can cause operating difficulties. ??? Performance in extracting certain contaminants varies depending upon the maximum temperature achieved in the process selected. ??? Air emissions may be needed to be regulated to eliminate possible harm and injury to the environment. ??? A hot air injection has limitations due to low heat capacity of air. Enhanced Biodegradation It is a process in which indigenous or inoculated micro-organisms (e. g., fungi, bacteria, and other microbes) degrade (metabolize).

Organic contaminants found in soil and/or ground water, converting them to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials. Factors that may limit the applicability and effectiveness of the process include: ??? Cleanup goals may not be attained if the soil matrix prohibits contaminant microorganism contact. ???

Preferential colonization by microbes may occur causing clogging of nutrient and water injection wells. ??? Bioremediation slows at low temperatures. ??? High concentrations of heavy metals, highly chlorinated organics, long chain

hydrocarbons, or inorganic salts are likely to be toxic to microorganisms.

What I am trying to do is to find out which of the methods discussed above is the most efficient in cost, time consumption and oil degrading capacity.

The efficiency of each method will be measured by designing models of the three methods and measuring the amounts of oil degraded. Materials and Methods The experiments were designed by making models of each method to measure the capability of each process. The soil used was desert sandy soil, provided by MSA University, Faculty of Biotechnology.

The crude oil was also provided by the Faculty. 5ml of crude oil was added to each of the three 50g soil samples. The oil was stirred and mixed thoroughly into the soil.

Each contaminated was simulated into each of the three processes. Land-Farming Experimental Methods: The sample was placed in a Petri dish. Water was added to keep the mixture moist. The dish was left in a 30°C incubator and left for five days. Water was added on a daily basis and the mixture was also tilled daily. After the incubation period the crude oil was extracted from the soil by acidification with concentrated HCl to pH 4.0.

Two twenty five ml of methylene chloride were added to each sample. The methylene chloride phase was washed with acidified distilled water of 4 pH value. After phase separation, the organic extracts were combined, dried with anhydrous Na₂SO₄, and the methylene chloride evaporated to dryness through aspiration of 40°C. After extraction, the residual oil was transferred in a small volume of carbon disulfide (1 ? µl to 0.6 ml) to the HPLC (High Performance Liquid Chromatograph). Surface Heating Experimental Methods:

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An apparatus was designed to simulate the real life process. 150 ml of sterile water of temperature 20°C were placed in a beaker and heated to a maximum temperature of 125°C.

The steam resulting from heating was passed through the soil sample to remove the oily contaminants. The resulting mixture of steam and contaminants was collected and condensed. The remaining oil was extracted from the mixture by the same process mentioned above and transferred to the HPLC. Enhanced Biodegradation Experimental Methods: The soil sample was placed in a Petri dish. The active strain of the bacteria *Pseudomonas* sp., provided by the Faculty of Biotechnology, MSA University was selected for the process. The bacterial cells were added to an initial cell density of 10⁸CFU/ml.

The dish was incubated at 30°C. After five days, the remaining oil was extracted and transferred to the HPLC for analysis. The three methods were then compared with regards to time consumption, energy/money consumption and percentage of contamination removed. Supervising my work and experimentations was Dr. Mohamed Hadidi, Teaching Assistant at the Faculty of Biotechnology, MSA University, Egypt and Dr.

Mariam El Shafei Teaching Assistant at the Faculty of Biotechnology, MSA University, Egypt. Results and Discussion The degrading methods I chose for the experiments were only three out of many other methods put to test by scientists. In our experiments, all of the methods were able to start oil utilization and degradation. The degradation capacity time and cost varied from one method to the other. Effect of Land-Farming Method on Crude

The land-Farming model was controlled for humidity and aeration factors, to simulate the real life method. The only factor that remained constant was temperature, which was constant at 30°C. After incubating the mixture for 5 days, and with continuous aeration and humidity, the Land-Farming method was only able to degrade less than 1% of the crude oil in the soil sample.

This proves that a very long period of time is needed for the process to start working efficiently. I think that if the temperature factor was controlled as in nature, high temperatures at day and low temperatures at night, the amount of degraded oil would be much less, because at a constant high temperature, the bacteria in the soil are more active than in changeable and low temperatures. Effect of Surface Heating Method on Crude Oil The Surface Heating method was far more successful than Land-Farming.

The model that was designed was very close to the real life model, so all the factors were pretty much controlled. The method was able to remove about 55% of the contaminants. A total of 15.75 Kcal of heat were required to heat the water to the required temperature. Effect of Enhanced Biodegradation Method on Crude Oil Enhanced Biodegradation with *Pseudomonas* sp. was able to degrade about 35% of the total oily contaminants in the soil sample. The bacteria started the degradation after two days of incubation and went on for another three days until the oil was extracted for HPLC analysis.

There is some dispute about the incubation period. If the sample was left for more time, the amount of oil degraded might have changed. Also temperature variations and using another strain of bacteria other than *Pseudomonas* sp.

might have also affected the degrading capacity. Conclusions ??? Land-Farming proved to be the most time consuming method, degrading a very minute amount of oil after the period of incubation. ??? Surface Heating removed the most amounts of contaminants but requires setting up the model and a lot of heat for vaporizing the water.

??? Pseudomonas sp. proved its ability to degrade oil in soil. It proved cheaper than Surface Heating and has a higherReferences Abdel Alim El Sayed; A. M. Shibl and M.

A. Ramadan LABORATORY STUDY OF MICROBIAL CLEANING OF OIL SPILLS UNDER SAUDI ENVIRONMENTAL CONDITIONS J. A. Sorensen, J. R. Gallagher, Energy & Environmental Research Center, D. Chollak, Canadian Occidental Petroleum, Ltd.

, and J. A. Harju, Gas Research Institute REMEDIATION STRATEGIES FOR SOILS CONTAMINATED WITH AMINE-BASED GAS SWEETENING WASTES G. L. Stegemeier, GLS Engineering Inc., Houston, Texas; H. J.

Wnegar, Shell Development Company, Houston Texas SOIL REMEDIATION BY SURFACE HEATING AND VACUUM EXTRACTION FRTR (REMEDICATION TECHNOLOGIES SCREENING MATRIX AND REFERENCE GUIDE, VERSION 4. 0)

URL: http://www.frtr.gov/matrix2/top_page.html [pic] Percentage of Oil Degraded By Each Process [pic] Amount of Heat Used [pic] Efficiency Comparison ————— Fig 1. Tilling the Soil in Land-Farming Fig 2.

Surface Heating Method