In-Situ Bioremediation
of
Hydrocarbon Contaminated
Drill Cuttings With ACCEL™

Introduction

Drill cuttings generated during oil and gas drilling operations, in particular those from the oil based drilling mud system, are contaminated with hydrocarbons. Disposal of this material is regulated. The current industry practice is to haul them away to a land farm for bio-treatment. While the land farm is an attractive method, transportation and disposal expenses for such practice adds to operational costs. With landowner approvals, in-situ treatment of the waste material at the site is an attractive option to operators.

The method of remediation discussed in this paper is based on the in-situ bio-treatment of drill cutting wastes, utilizing ACCEL™.

Principles of In-Situ Bioremediation

- Land treatment has been used successfully for the biodegradation of hydrocarbons in soil (Loehr, 1984), converting the hydrocarbon to carbon, water, biomass (bacterial cells), and humic materials (Huesemann, 1994). Biodegradation of hydrocarbons takes place in an aerobic environment, in which proteins and enzymes generated by the microorganisms function as catalysts (Shorthouse, 1990/1991).

- The success of bioremediation depends on various factors, such as physical and chemical characteristics of the waste, indigenous microbial environment, and nutrient (e.g. nitrogen, phosphorus and potassium) source for the microorganisms. As bacteria and fungi do not grow in hydrocarbons, hydrocarbons are only degraded in an aquatic environment. Consequently, moisture content of the hydrocarbon contaminated soil plays an important role in the bioremediation process.

- Other factors such as soil pH, temperature and aeration affect the rate of biodegradation and the extent of hydrocarbon removal (Dibble and Bartha, 1979).

- There is a direct relationship between the rate of microbial growth and the rate of decay in the hydrocarbon content of the soil (King et al., 1998). It should, however, be noted that an individual group of microorganisms is unable to degrade all of the possible hydrocarbon molecules of the crude oil at the same rate, if at all.

- Each organism group may have a different spectrum of activity. While inoculation of microbial culture into the material being treated can improve the rate of biodegradation, in most cases, with the aid of suitable nutrients, indigenous microbes are capable of effectively remediating the site.

<u>**Remediation of the Site**</u>

Site Characterization:

- The average size of most drill cutting pits are 100 ft x 150 ft. These pits are divided into two sections, separating the oil based from the water-based drill cuttings by a 20-ft divider constructed from the native soil. The proportionate respective size of the areas for water and oil based drill cuttings is generally of 70:30.

- The depth of most drill cuttings deposited in the pits varies, ranging between 2.5 ft to 5 ft.

- Samples from the individual sections of the pit are analyzed for TPH, nutrients, toxic metal and microbial contents. While the TPH levels of the oil based drill cuttings range between 15 to 20 wt.%, the nutrient contents and the microbe count varies significantly between the pit locations. In some cases, the microbial counts for the deposited oil based drill cuttings can be in the order of only a few thousands per gram.

- Most of these sites have water available from the on-site water wells.

Treatment Schedule:

There are two treatment schedules discussed in this paper. One for the existing reserve pits with limited additional working areas; and the other for those pits with sufficient areas available for out of pit treatment of drill cuttings.

Schedule for the Reserve Pits with Limited Working Areas:

- In this case, the water based drill cuttings are removed from the pit and held at an adjacent pad. The oil based drilling cuttings are blended with the clean soil of the pit divider and spread out evenly throughout the entire pit. The average depth of the drill-cutting soil blend is about 18 inches.

- The blending and spreading has the following objectives:

  To reduce the hydrocarbon content of the soil being treated to the level lower than 5 wt.% (regulatory requirement); to import the source of microbes to the contaminated material from the native surroundings; and to reduce the depth of the material being treated to improve the oxygen supply to microbes at depth during biodegradation process.

- The blended contaminated material is then sprayed with ACCEL™, as a source of nutrients for the microbes. The rates of application depend on the TPH content of the final drill cuttings – native soil blends (range between 4 to 5 wt.%).

- At an average size site, the initial application rate can vary from as little as 25 gal/acre to 300 gal/acre with a minimum 30:1 dilution with fresh water.(mostly available at the site.) In some cases, water has to be brought in from an outside source. The contaminated area is disked to ensure mixing of ACCEL™ in the material being treated.

- During the remediation period, to keep the material moist, the treatment area is sprinkled with fresh water on a demand basis. However, the site is disked frequently, at least once a week, to ensure adequate aeration of the contaminated material.

- Once the TPH level of the treated soil drops down to less than 1 wt. %, the water based drill cuttings which were set aside on the adjacent pad are moved back to the pit. The surface is leveled and the site ready to be closed.

Schedule for the Reserve Pits with Adequate Working Area:

- In this case, adjacent to the existing reserve pit, a bermed area (about 150 ft. x 150 ft., with a berm height of 24 in.) is constructed. (Usually during location construction) Additionally, during drilling operations the oil-based cuttings are spread across this area.

- After the completion of the drilling operation, cuttings are already spread across the area to improve the microbial counts of some native soil, which was excavated during the pit construction. The depth of the drill cuttings-soil blend is maintained at about 18 in.

- The tilled drill cutting material is then sprayed with ACCEL™ The rates of application depend on the TPH level of the tilled drill cuttings-soil compositions, which range between 4 and 5 wt.%.

- Similar to aforementioned schedule, to keep the material moist, the treatment sites are sprinkled with fresh water as required. The site is tilled periodically, at least once a week.

- Once the TPH level of the drill cuttings drop below 1 wt.%, all the materials are moved to the pit, surface leveled and closed.

Results and Discussion:

- The microbial count of the blended water based cuttings, oil based drill cuttings, and native soils from the dike walls and pit dividers varies with the locations. The average microbial content of most area native soils are noted to be about 500,000 counts/g.

- During the remediation process, the microbial growth will reach a level of several hundred million counts/g within a period of 30 days.

- In most cases, the TPH level of the sites will drop to less than 1 wt.% within 90 to 120 days. This allows the pits to be closed within the regulatory period.

Concluding Remarks

- The in-situ bioremediation process described in this paper allows the pits to be closed within the regulatory closure period, with no future liabilities.

- These treatment schedules allow the use of the existing pit design for the disposal of drill cuttings generated by the operators.

- The treatment cost of this process is in the range of 50-75% less than the currently practiced haulage and disposal option.

- No regulatory permit is required for onsite remediation.

References:

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