Oil Waste Processing Using Combination of Physical Pre-treatment and Bioremediation: Case Study

Petra Najmanova (najmanova@dekonta.cz)
(DEKONTA, Inc., Prague, CZ; University of Chemistry and Technology, Prague; CZ) and
Robert Raschman (raschman@dekonta.cz) (DEKONTA, Inc., Prague, CZ)

Background. Waste emerging from upstream oil industry usually contains a mixture of contaminated soil, drilling muds and oil in various states of weathering. A massive contamination level of 10% petroleum hydrocarbons, excludes direct processing by bioremediation technology. A new technology for the removal of petroleum hydrocarbons from oil waste was used at the historical oilfield in Kazakhstan. This technology is based on the combination of physical pre-treatment (gravity separation in heavy suspensions), followed by bioremediation.

Activities. Based on the promising results obtained during the bioremediation lab test, a pilot-scale test was suggested and performed on site (an oil waste deposit in Kazakhstan) with approximately 150 m^3 of contaminated soil from an oil waste deposit in Kazakhstan, within 5 months. The contaminated soil was divided into two piles. The first one was treated using a BIOTECH bacterial solution (called “bioaugmentation”). The biodegradation of the second pile, (called “biostimulation”), was enhanced by using an organic substrate (50% vol. of camel dung), to improve material characterization and an addition of the nutrients. Because of insufficient bioremediation efficiency of achieved results caused by the high initial concentration over 500 g/kg of TPH in the case of bioaugmentation, and nearly 300 g/kg for biostimulation, the test of physical pre-treatment, based on separating of highly contaminated parts of sludge and soil with lower contamination, was performed. About 20 m^3 of contaminated material was processed. The separation technology consisted of two steps: (i) screening (vibrating screen), when removal of fine fractions below 5mm was ensured and (ii) heavy media separation, where the removal of tar balls was achieved. With respect to the specific gravity of tar (approximately 1.1 g/cm^3) and the specific gravity of sand (2.7 g/cm^3), the solution of sodium silicate (water glass), with a specific gravity 1.5 g/cm^3, was used as a dense medium in the separation process. Based on the results from the pilot-scale tests on an oilfield site, the new technology for full-scale application of dense media separation was developed.

Results. The significant decrease of TPH concentration in soil samples treated by bioremediation was achieved during lab test duration of approximately 3 months. From the initial value over 80 g/kg the contamination was reduced to approximately 15 g/kg TPH, which represents an efficiency of approx. 81%. Despite a promising efficiency of the bioremediation pilot scale test (around 80%), the output concentrations (approximately 6 to 7 g/kg) were still very high and achievement of target limits (2% of TPH) would be costly, even if possible. An alternative method of physical pre-treatment followed by bioremediation was suggested and performed on site. After separation test the yield of floating part (bitumen) was 25% (w/w) with approximately 80% content of TPH and was supposed to be used as an alternative fuel in a local cement plant. The soil was separated as a sinking part with higher density and with TPH content less than 10%. This part is supposed to be treated using bioremediation technology as shown above. In that case, we can ensure achievement of target limit under 2% w/w of TPH.