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Remediation of oil-contaminated soil in Arctic Climate

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Oil spill is a problem in towns in Greenland, where oil is used for heating and transport. The problem may increase in the future with expected oil exploitation in Greenlandic marine areas and related terrestrial activities. Oil undergoes natural microbial degradation in which nutrients, temperature, water content, pE and pH are important factors for the degradation rate. In particular temperature and nutrient availability are challenges in the Arctic, and alternative solutions must be sought if biodegradation is to be implemented as a low-cost and low-tech solution in this region. Experiments have been made with excavated oil-contaminated soil from the Greenlandic town Sisimiut to study different low-tech and low-cost solutions for remediation of oil-contamination.

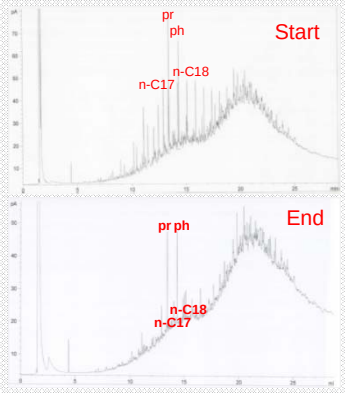
First approach

Soil polluted by light oil was treated with two different nutrient sources (substrate and N:P:K), stabilizer (crab shells) and heating (room temperature).

The results showed:

- Reduction in oil-contamination during the treatment period of 1.5 months.
- No difference in reduction between the nutrient sources, and of crab shells.
- The reduction proceeded further at raised temperature.
- 99-100% of the oil was removed after one year independently of treatment.
- In-situ the pollution was decreased significantly during a period of 13 years.

First approach set-up. The excavated soil was placed in the blue "tent" (top picture) in different wooden boxes (bottom picture). Heat was generated by solar energy.



Second approach set-up. Boxes with excavated soil and aeration system (top picture). Examples of a GC-FID chromatogram from the start and end of the experiments.

Second approach

A nutrient rich soil highly polluted by weathered heavy oil was aerated by insertion of air-channels, and heated to 20°C during a few days.

The results showed:

- 19 - 34 % of the pollution was removed after 2.6 month.
- Microbial degradation were the primary reason for the removal of the pollution.
- Water content and aeration had a significant effect on degradation rate.
- Heating to 20°C had no effect on degradation rate.

Third approach

In the third still on-going approach the oil-contaminated soil is sequential treated including:

- Evaporation of light compounds by turning the soil.
- Supply of oxygen and heat (10-40 °C) for biodegradation of middle size alkanes.
- Vapor extraction of heavier oil components (PAH) at temperatures up to 90°C supplied by surplus heat from the local waste incineration plant.

Third approach set-up: Boxes with oil-contaminated soil and different additions. The addition of sphagnum includes both sphagnum moss and chalk .

Third approach set-up: The heating set-up and temperature measurement system.

Concluding remarks

These results suggest that remediation of oil-contaminated soil is possible in the Arctic with low-tech and low-cost solutions.

Depending on oil type, weathering state of the oil and composition of the soil different solutions should be chosen to secure the best conditions for enhanced natural degradation of the oil-contamination.

Example of oil-contamination in an Greenlandic environment