ifn Forschungs- und Technologiezentrum GmbH

Determination of bioremediation of oil contaminated soil

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Task

The aim is to determine the influence of the SORB®XT absorber material on the bioremediation of oil-contaminated soil. Soil contaminated with mineral oil hydrocarbons (MHC) was used as a soil sample, which shows a minimization of mineral oil contamination during storage. Defined amounts of hydrocarbons were added to this for the experiments.

Experimental procedure

The tests were carried out according to the protocol "Laboratory Methods for the Assessment of Biological Soil Remediation" of the interdisciplinary working group "Environmental Biotechnology - Soil" of DECHEMA from 1992. The evaluation of the results was carried out according to the aspects of the "Minimal Programme for the Investigation of Microbiological Remediability".

Excavated soil was taken professionally in sterile sample containers and transported cooled to the laboratory. After removing the coarse components and determining the maximum water holding capacity of the soil sample, it was adjusted to 50 % of the maximum water holding capacity and stored for 48 h at 22°C in well-ventilated containers. Subsequently, degradation tests were carried out in standing culture with the moist soil material. For this purpose, 20 g of soil material were transferred to a large-volume, sealed vessel and 30 mg NH_4Cl and 4 mg K_2HPO_4 were added. To simulate an accident (rupture of an oil-bearing pipe with leakage of different amounts of heavy oil into the soil), the individual preparations were mixed with different volumes of an additive-free engine oil. After sufficient mixing (vibrating plate, 24 h), the sample vessels were lined with moistened filter paper to prevent the soil sample from drying out. Subsequently, the vessels were incubated in the dark at room temperature (20°C - 25°C) for 28 days and finally the entire preparation was processed for chemical-physical analysis. As a control, an identically treated sample batch was stored at 4°C in an N_2-atmosphere. In addition, reference samples without added oil were incubated.

To determine the influence of the oil-binding adsorbent material SORB®XT on the bioremediation of oil-contaminated soil, a further preparation was made in each case with an additional 2 g of SORB®XT and treated according to the above protocol.

In each case, two different sample series were prepared that differed in the added oil concentration (≈ 3000 mg oil per kg soil; ≈ 10,000 mg oil per kg soil). An overview of the experiments performed can be seen in Table 1.

Table 1. overview of sample approaches.

Sample series 3000 mg/kg MHC	
Reference sample; Day 1 (soil + 3000 mg/ kg oil)	3600 mg /kg MHC
sample 1; Day 28 (soil + O_2 + RT + 3000 mg/ kg oil)	2996 mg /kg MHC
sample 2; Day 28 (soil + SORB®XT+ O_2 + RT + 3000 mg/ kg oil)	2336 mg /kg MHC
sample 3; Day 28 (soil + N_2 + 4°C + 3000 mg/ kg oil)	3307 mg /kg MHC
Sample series 10.000 mg/kg MHC	
Reference sample; Day 1 (soil + 10.000 mg/ kg oil)	7780 mg/ kg MHC
sample 4; Day 28 (soil + O_2 + RT + 10.000 mg/ kg oil)	6229 mg/ kg MHC
sample 5; Day 28 (soil + SORB®XT+ O_2 + RT + 10.000 mg/ kg oil)	6718 mg/ kg MHC
sample 6; Day 28 (soil + N_2 + 4°C + 10.000 mg/ kg oil)	7617 mg/ kg MHC

Evaluation

To determine the bioremediation capability and the influence of SORB®XT on the bioremediation of oil-contaminated soil, the individual sample preparations were analyzed for the content of mineral oil hydrocarbons (chain length C1-C40) at the beginning (day 1; reference samples) and after incubation (day 28) by means of gas chromatography. The results obtained are shown in Table 1. A graphical representation of the results is shown in Figures 1 and 2.

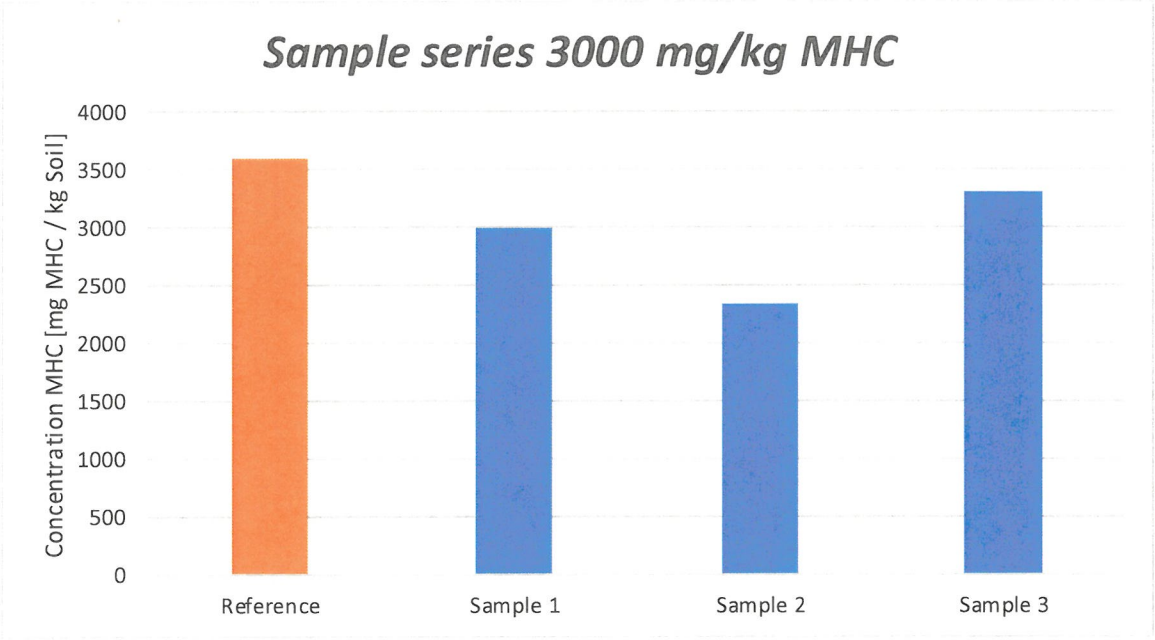

Figure 1. Graphical representation of MHC concentrations of samples 1-3 (≈ 3000 mg/kg)

The mineral oil load of the reference sample was measured without incubation time, i.e. directly after mixing of soil and oil component and provides the starting value of the investigations. Since all samples were mixed with the same amount of oil, the reference sample is to be understood as the starting value of the investigations. It has a MHC content of 3600 mg per kg of soil. Due to the incubation period of 28 days at room temperature and air atmosphere, the microbiome in samples 1 and 2 has time to metabolize and thus degrade some of the mineral oil components. The only difference between the two samples is that ten percent by mass of the absorbent material SORB®XT was added to sample 2. In sample 1, the mineral oil load decreased by approx. 17 % over the incubation period, in sample 2 by approx. 34 %. Sample 3 was incubated under nitrogen atmosphere and at 4°C for 28 days, which again inhibits the metabolism of the soil microbiome. Sample 3 thus serves as a back-up to exclude physical effects such as evaporation of the oil components, etc. Since both the reference sample and sample 3 have comparable levels of MHCs, it can be assumed that the reduction in MHC concentrations in sample 2 and 3 are due to degradation by the microbiome. Based on the results, it can be concluded that the absorbent material SORB®XT does not have a negative, rather a positive influence on the biodegradability of the soil used.

Diagram 2 shows the MHC concentrations of samples 4-6 (spiked with ≈ 10,000 mg/kg oil).

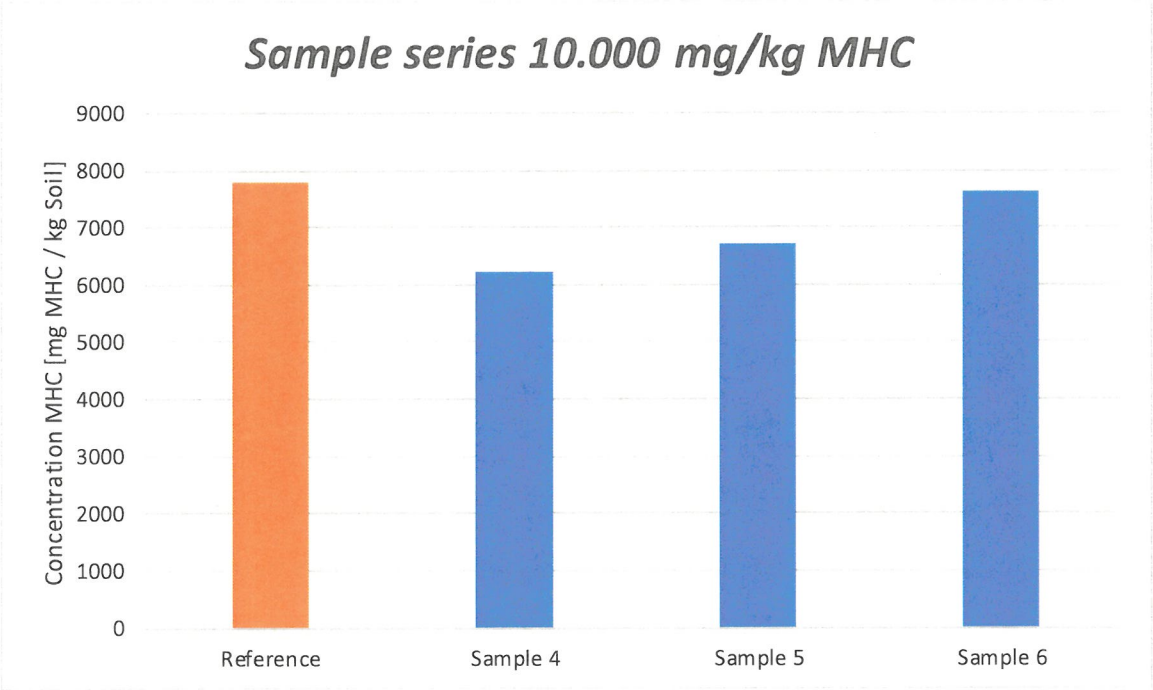

Figure 2. Graphical representation of MHC concentrations of samples 4-6 (≈ 10.000 mg/kg)

Once again, the reference batch as well as batch 6, which was incubated under nitrogen atmosphere and at low temperatures, show an almost identical load with MHC, while sample 4 and sample 5 show a reduction of the MHC load after incubation. Sample 4 shows a 20 % lower load of MHC and sample 5 a 14 % lower load of MHC compared to the reference approach. Once again, the results show that the use of the SORB®XT absorber material has no negative influence on the bioremediation capacity of the soil used.

Summary

A series of investigations were carried out on the bioremediation capability of a soil contaminated with engine oil. The aim was to work out the influence of the absorbent material SORB®XT on bioremediation. The data obtained show that the microbiome of the soil used is able to degrade the oil used. For the absorber material SORB®XT no negative influence on the bioremediation capacity of the used soil was found.