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Expertise

BIOVERSAL Application for Accelerated Pollutant Degradation in Samples Collected at Petrol Hydrocarbon Contaminated Sites

According to the DECHEMA guideline 'Labormethoden zur Beurteilung der biologischen Bodensanierung' (Laboratory methods for the evaluation of feasible bioremediation of contaminated soil) biodegradation experiments in shaking flask were accomplished. To evaluate the biodegradation enhancement of BIOVERSAL, results of BIOVERSAL amended tests were compared to non amended controls for two crude oil-contaminated soil materials (Soil A, Soil B) from oil pumping sites.

Characterization of soils

Characterization of contaminated soils was carried out according to the DECHEMA guideline 'Labormethoden zur Beurteilung der biologischen Bodensanierung', including additional important soil parameters as shown in table 1.

Tab. 1: Characterization of test soils

	Soil A	Soil B
TPH [mg/kg]	34540	4651
TS [%]:	78,0	97,6
C org. [%]	7,6	4,4
basic respiration mg CO ₂ /gTS*24h		29,0
gluc. ind. respiration mg CO ₂ /gTS*24h		10,4
TVS [%]:	10,9	7,0
N [%]		
C anorg. [%]	0,6	0,9
pH	6,7	7,6

	Soil A	Soil B
Sedimentation [%]		
Sand (2mm-63µm):		28
Silt (63µm-2µm):		46
63-20µm		24
20-10µm		3
10-6µm		12
6-2µm		6
Clay (<2µm):		26
Metals [mg/kg]		
Hg	0,1	0
Cd	4,6	4,4
Cr	108,0	13,6
Cu	23,3	13,9
Mn	268,8	634,5
Ni	32,2	35,3
Pb	234,5	21,8
Zn	70,4	38,5
As	7,79	
Fe		20397
Bioluminescence		
GL ₂₀		8
EC ₅₀		102

Biodegradation experiments in suspensions cultures

Nutrients (DECHEMA guideline 'Labormethoden zur Beurteilung der biologischen Bodensanierung') were added to the soil samples using a buffered solution. Flasks were incubated at constant degradation conditions (20°C, darkness). Activated sludge (2 % TS) was used for inoculation in order to speed up the experiments.

Results and discussion

In Soil A (Fig. 1) the amendment with BIOVERSAL caused an immediate decrease of TPH (degradation after 15 days: BIOVERSAL 63 %, no BIOVERSAL 23 %) as well as a reduced residual concentration of pollutants in soil (TPH after 86 days: BIOVERSAL 8274 mg/kg, no BIOVERSAL 14489 mg/kg). Although a rather high heavy metal pollution of Soil A has been observed, the addition of BIOVERSAL resulted in enhanced degradation rates.

Soil B was collected from a mineral oil contaminated site as well, but due to the chromatographic pattern of peaks and the low bioluminescence inhibition (see appendix) a reasonable biodegradation rate has been expected. However, this only could be achieved by addition of BIOVERSAL (Fig. 2: BIOVERSAL 50 % biodegradation, no BIOVERSAL 6 % biodegradation).

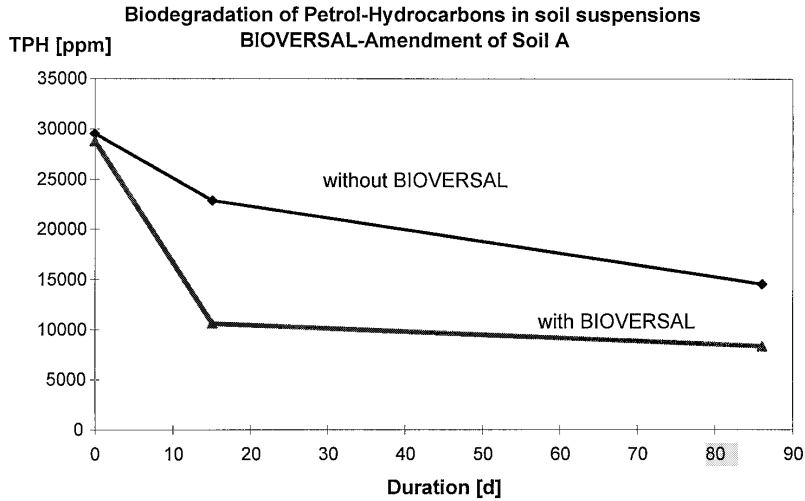


Fig. 1: Biodegradation of petrol hydrocarbons in Soil A. BIOVERSAL has introduced an initial acceleration of the biodegradation, moreover, a reduced residual TPH concentration has been achieved at the end of the experiment.

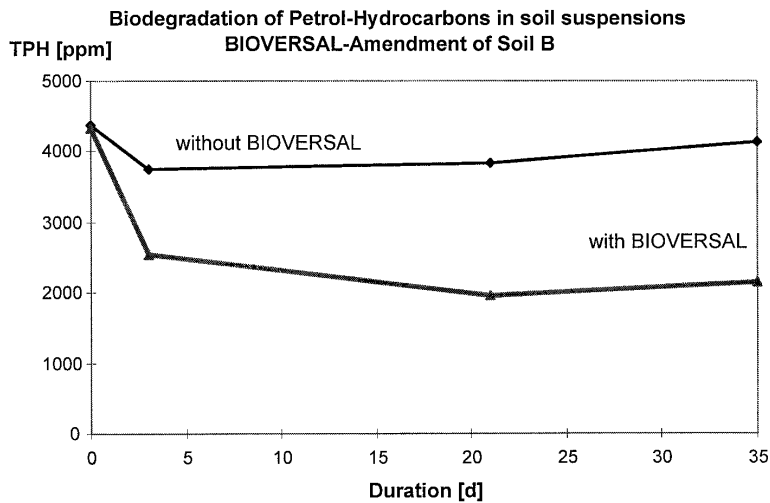
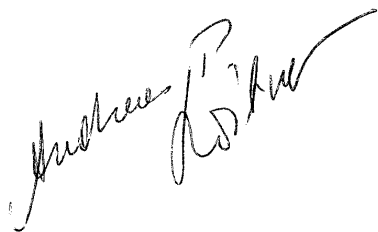


Fig. 2: An immediate biodegradation has occurred in Soil B when using BIOVERSAL. No biodegradation has been achieved without BIOVERSAL.

Summary

Biodegradation of hydrocarbons as mixture of various compounds in a complex matrix like soil is dependent on numerous factors. Even at optimum biodegradation conditions (temperature, moisture, pH, electron acceptor, nutrients, ...) the major prerequisite for biodegradation of pollutants in soil is their bioavailability which is limited in most practical situations. In particular, if high molecular weight hydrocarbons are present, if the soil contains a lot of organic matter and clay and if the contaminants have been aged in soil, the bioavailability is reduced tremendously.

Microbial activity in soil is related to the presence of moisture. In general, cellular pollutant uptake will only be possible after desorption from soil and partitioning of the respective contaminant in the aqueous phase of the soil matrix. This will be achieved by application of BIOVERSAL and results in increased biodegradation rates for the tested soils. According to the conducted experiments, BIOVERSAL enhances the biodegradation of mineral oil hydrocarbons and enables the microbial decay, respectively. In Soil A degradation increase was found to be at 40 % within 15 days. In Soil B the degradation was initiated by addition of BIOVERSAL, whereas no biodegradation occurred without this additive.



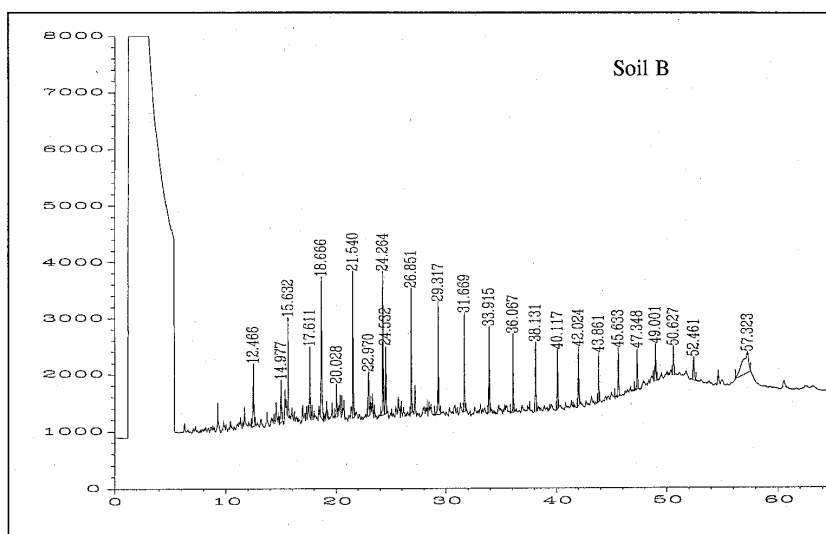
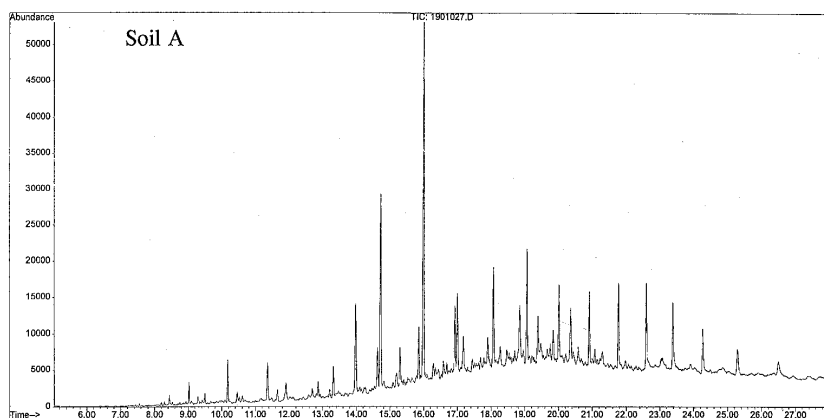
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APPENDIX

Gaschromatograms of petrol hydrocarbon contaminations



Bioluminescence inhibition

Bioluminescence inhibition of Soil B: a GL_{20} of 8 and an EC_{50} of 102 (percent of leachate in test solution, value extrapolated) have been detected, what indicates a low inhibition range.

