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Air Passive Dosing of Toluene Increases Accessibility of PAHs for Microbial Degradation



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Figure 1: Illustration of Air Passive Dosing

Introduction

Polycyclic Aromatic Hydrocarbons (PAHs) adsorbed to soil constituents such as black carbon are inaccessible for microbial degradation. Competitive sorption can be used to release

inaccessible PAHs from high affinity sorption sites¹. In this study a novel air passive dosing setup was used to introduce toluene into soil as a biodegradable competitive sorbent for PAHs.

Hypothesis

π - π electron donor-acceptor interactions are the primary sorptive force for the adsorption of aromatic pollutants to high affinity sites². As adsorption to such sites is subject to competition,

the addition of excessive amounts of a competitor will enhance the release of retained organic pollutants so making them accessible for biodegradation.

Method & materials

Soil: Prior to Air Passive Dosing of toluene, industrially contaminated soil was exposed to microbiological degradation. The residual PAH concentration of so pretreated soil amounted to $325 \pm 6 \text{ mg kg}^{-1}$ (Σ 16 US EPA PAH).

Accessibility: The share of desorption resistant PAHs in this soil was quantified using the Contaminant Trap³, which captures desorbing PAHs in an 'infinite' sorption sink formed out of silicone and activated carbon.

Air Passive Dosing: Silicone rods out of Polydimethylsiloxane (PDMS) were loaded with toluene. They served as source for the partitioning of toluene into the gas phase and subsequently into soil slurry, leading to competitive sorption to soil constituents.

Microbial Activity: Microbiological activity was verified before and after air passive dosing of toluene by the detection of the 16S ribosomal RNA.

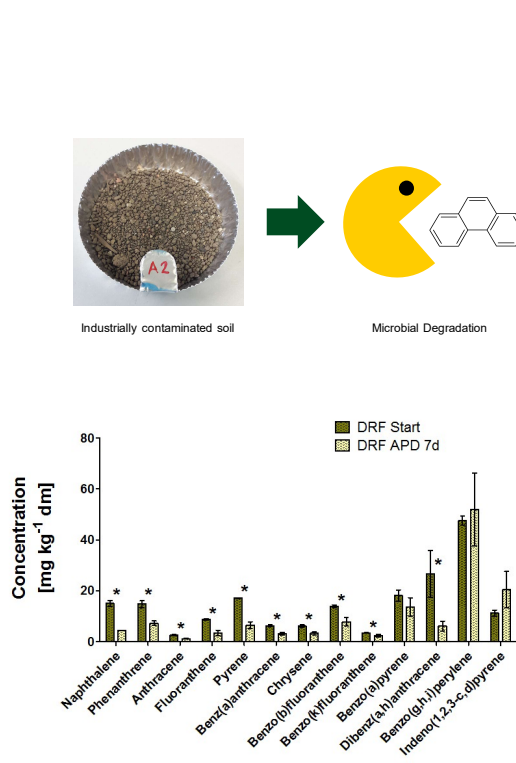


Figure 4: Desorption resistant fractions (DRF) of individual PAHs before and after air passive dosing (APD) of toluene for 7 days.

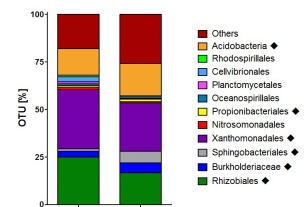
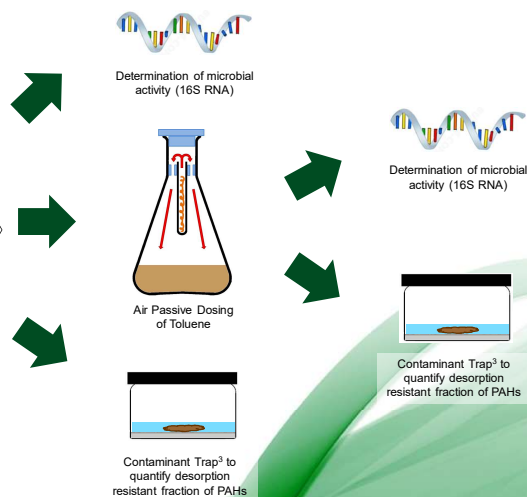


Figure 2: Microbial Activity before and after air passive dosing (APD) of toluene for 7 days. A black rhombus indicates a bacterial class with potential PAH degrading microorganisms⁴.

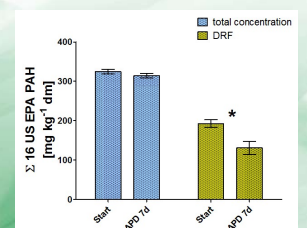


Figure 3: Total PAH concentrations (Σ 16 US EPA PAHs) and desorption resistant fraction (DRF) in microbially pretreated soil before and after air passive dosing (APD) of toluene for 7 days.

Results & Conclusions

- High concentrations of toluene as a competitive sorbate can be maintained in soil slurry by passive dosing via the gas phase (Figure 1)
- Competitive sorption of toluene significantly reduced the desorption resistant fraction of PAHs in soil (Figure 3 & Figure 4)
- The presence of active PAH degraders (16S RNA) after toluene exposure indicates ongoing biodegradation of PAHs (Figure 2)

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