View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Online Research Database In Technology

DTU Library

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

Humel, Stefan; Zaknun, Cathrine ; Mayer, Philipp; Loibner, Andreas P.

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Humel, S., Zaknun, C., Mayer, P., & Loibner, A. P. (2018). Air Passive Dosing of Toluene Increases Accessibility of PAHs for Microbial Degradation. Poster session presented at 7th European Bioremediation Conference (EBC-VII) and the 11th International Society for Environmental Biotechnology conference (ISEB 2018), Chania, Greece.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

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

Stefan Humel[1], Cathrine Zaknun[1], Philipp Mayer[2] and Andreas P. Loibner[1]

1 BOKU - University of Natural Resources and Life Sciences, Vienna
IFA-Tulln - Department of Agrobiotechnology, 3430 Tulln, Austria
2 DTU Environment, Miljoevej, Building 113, 2800 Kgs. Lyngby, Denmark

contact: andreas.loibner@boku.ac.at

University of Natural Resources and Life Sciences, Vienna, AT
Department IFA-Tulln
Geobiotechnology & Environmental Chemistry

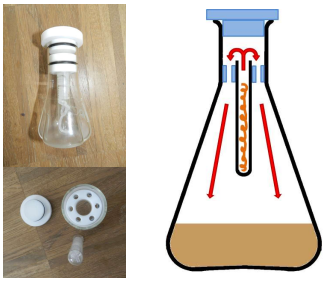


Figure 1: Illustration of Air Passive Dosing

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 sites[1]. 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 sites[2]. 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.

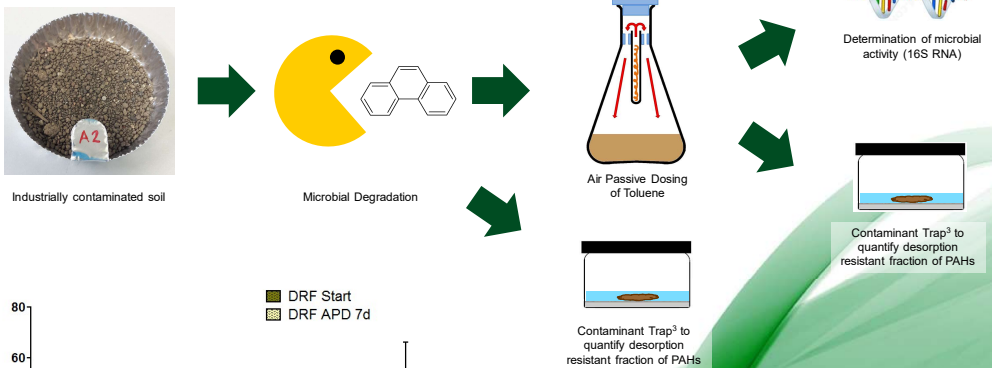
Method & materials

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 ± 6 mg kg^{-1} (Σ 16 US EPA PAH).

Accessibility: The share of desorption resistant PAHs in this soil was quantified using the Contaminant Trap[3], 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.



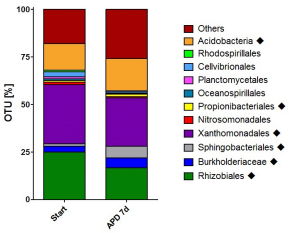


Figure 2: Microbial Activity before and after air passive dosing (APD) of toluene for 7 days. A black rhombus indicates a bacterial class with potential PAH degrading microorganisms[4].

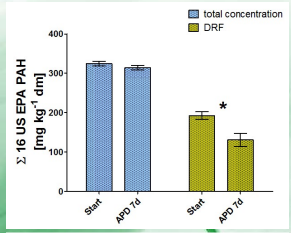


Figure 3: Total PAH concentrations (Σ 16 US EPA PAHs) and desorption resistant fraction (DRF) in microbiologically pretreated soil before and after air passive dosing (APD) of toluene for 7 days.

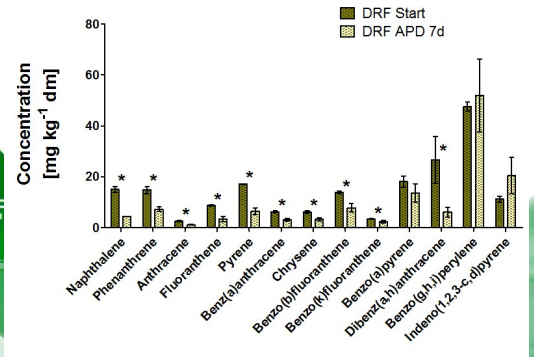


Figure 4: Desorption resistant fractions (DRF) of individual PAHs before and after air passive dosing (APD) of toluene for 7 days.

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)

References

[1] Humel, S., Schmidt, S.N., Sumetzberger-Hasinger, M., Mayer, P., Loibner, A.P., 2017. Enhanced Accessibility of Polycyclic Aromatic Hydrocarbons (PAHs) and Heterocyclic PAHs in Industrially Contaminated Soil after Passive Dosing of a Competitive Sorbate. Environ. Sci. Technol. 51, 8017–8026.
[2] Kelluweit, M. & Kleber, M., 2009. Molecular-Level Interactions in Soils and Sediments: The Role of Aromatic π-Systems. Environ. Sci. Technol. 43, 3421–3429.
[3] Mayer, P., Olsen, J. L., Gouliarmou, V., Hasinger, M., Kendler, R., Loibner, A. P., 2011. A Contaminant Trap as a Tool for Isolating and Measuring the Desorption Resistant Fraction of Soil Pollutants. Environ. Sci. Technol. 45, 2932–2937.
[4] Ghosal, D., GhoshS., Dutta T.K., Ahn Y., 2016. Current State of Knowledge in Microbial Degradation of Polycyclic Aromatic Hydrocarbons (PAHs): A Review, Front Microbiol. 7 1369.

Acknowledgements - This work was financially supported by the European Regional Development Fund (ERDF) together with the Government of Lower Austria (Project MACATA, WST3-T-95/017-2012 and WST3-T-95/025-2014).