Environmental risk assessment of poorly soluble substances: Improved tools for assessing biodegradation, (de)sorption, and modeling (project RABIT)

Müller, M. E.; Stibany, F.; Polesel, Fabio; Smith, K. E. C.; Schulte, C. ; Trapp, Stefan; Schäffer, A.

Publication date:
2017

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

Environmental risk assessment of poorly soluble substances:

Improved tools for assessing biodegradation, (de)sorption, and modeling (project RABIT)

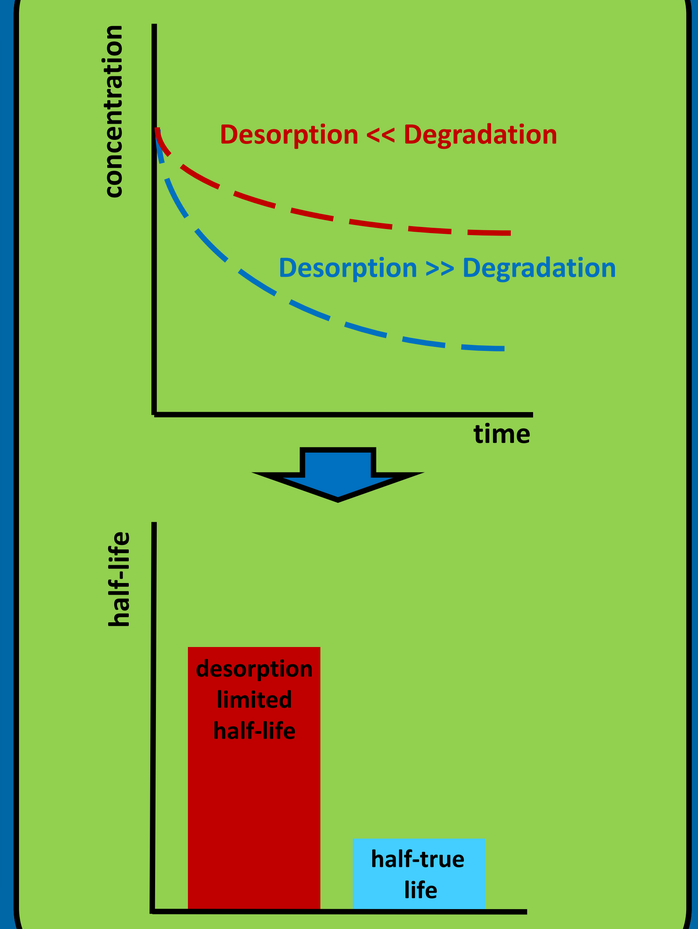
Maximilian E. Müller[1], F. Stibany[1], F. Polesel[2], K.E.C. Smith[1], C. Schulte[3], S. Trapp[2], and A. Schäffer[1] **Correspondence: maximilian.eckhard.mueller@rwth-aachen.de**

[1] RWTH Aachen University, Institute for Environmental Research (Bio V), Worringerweg 1, 52074 Aachen, Germany
[2] Department of Environmental Engineering, Technical University of Denmark, Miljøvej bd. 113, DK-2800 Kongens Lyngby, Denmark
[3] German Federal Environment Agency, Wörlitzer Platz 1, 06844 Dessau-Roßlau, Germany

Introduction

- Currently there are more than 850 substances with a log K_{ow} ≥ 5.5 registered at the European Chemicals Agency (ECHA) in Helsinki.
- High production volumes and consumer application (e.g., cosmetics) may promote the potential release of substantial amounts of these chemicals into the wastewater and the aquatic environment. Thus, investigations on environmental fate and toxicity of highly hydrophobic chemicals are urgently needed but by no means straightforward.
- As biodegradation is an important environmental removal process it needs to be assessed by adequate experimental setups.
- The strong sorption behavior onto solid matrices of poorly soluble organic substances can lead to a slow biodegradation rate limited by the desorption rate rather than its inherent biodegradability.

→ This can easily lead to false negative results



Scope & Objectives

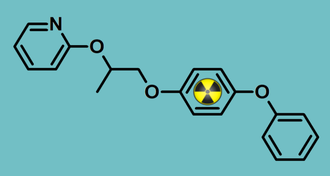
The aim of this project (RABIT) is to develop a new experimental setups that can adequately decouple desorption effects from the actual biodegradation process and is to be realized in three stages:

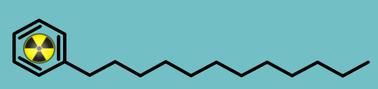
1) **Measurement of aqueous phase biodegradation without desorption effects**
2) **Measurement of abiotic desorption over time**
3) **Combination of both in a unified model**

This poster presents the actual status of the project (stage 1).

Materials & Methods

Pyriproxyfen (log K_{ow} = 5.55)





Dodecylbenzene (log K_{ow} = 8.65)

- Ether ^{14}C-Pyriproxyfen or ^{14}C-Dodecylbenze was loaded onto PDMS (100mg and 1mg, resp.) casted into a 250 mL Schott-bottle (Figure 1)
- The desorption of both compounds from the PDMS into 100mL standard mineral salt medium (Delft) was measured over time by means of liquid scintillation counting (LSC)
- Biodegradation was performed using a *Pseudomonas putida KT2440* strain in the same passive dosing system, additionally equipped with a CO_2-trap (NaOH, 2M), see Figure 1, and determined by LSC as well.

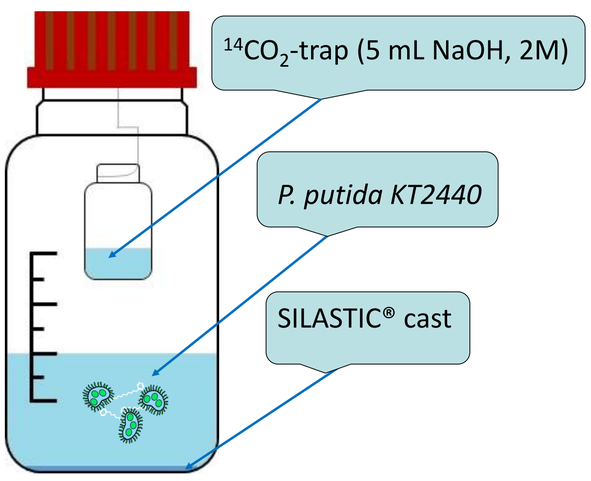


Figure 1: Passive dosing device. SILASTIC® cast on the base of a 250 mL Schott-bottle. Complete mineralization is determined by the captured amount of $^{14}CO_2$.

Results

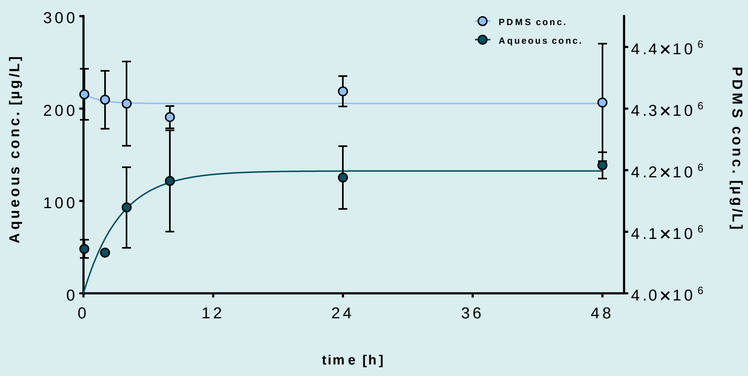


Figure 2: Desorption of Pyriproxyfen over time. Log K was accounted for 4.40 after 48 h and $t_{95\%}$ = 10.12 h.

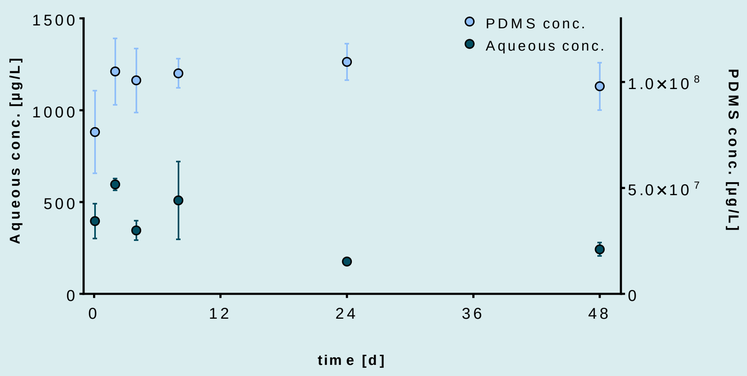


Figure 3: Desorption of Dodecylbenzene over time. Log K was accounted for 5.61 after 48 h. No desorption rate was determined as no reasonable fitting is possible.

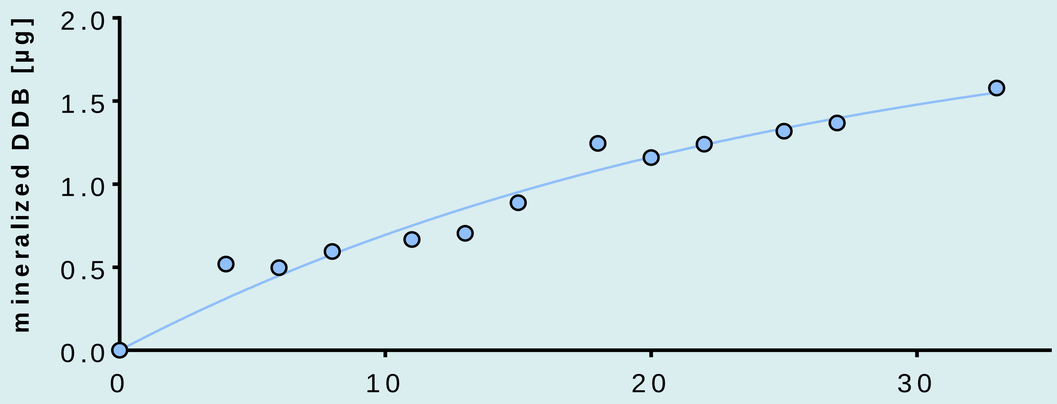


Figure 4: Pre-experimental determined mineralization of Dodecylbenzene over time. In order to confirm *P. putida KT 2440* being capable of degrading Dodecylbenzene the strain was exposed to the compound in three replicates. The captured CO_2 of each run was analysed alternating ever 2 to 3 days. After a duration of 33 days 1.58 µg (0.16 % of total amount) Dodecylbenzene were mineralized

Conclusion

- The established passive dosing device is a suitable method for maintaining constant substrate concentrations during biodegradation testing, for Pyriproxyfen (Figure 2).
- *P. putida KT2440* is capable of degrading Dodecylbenzene.