

Biodegradation of chlorinated hydrocarbons in aerobic groundwater

Pümpel, E.; Jussel, B.; Schwind, S.; Bunge, M. and Pümpel, T.

Institute of Microbiology, Leopold-Franzens-University Innsbruck, Austria

The project MULTIBARDEM aims at the field demonstration of the MULTIBARRIER concept. „Altlast O24“ in Austria is one of the project sites, where the aerobic aquifer (3 mg/L O₂) is contaminated with low concentrations of chlorinated aliphatic hydrocarbons: tetrachloroethene (TeCE), trichloroethene (TCE), 1,2-cis-dichloroethene (DCE), 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA).

The goal of the presented lab-study was to test the indigenous aquifer organisms for their degradation potential under anaerobic and under initially aerobic conditions (1 mg/L and 8 mg/L initial O₂) with several nutrient amendments.

Batch conditions

- medium: yeast extract (20 mg/L), NH₄NO₃ (16 mg/L), K₂HPO₄ (9 mg/L) and pollutant-mixture (Figs. 1-3) in groundwater from the site; initial pH 7.2
- addition of different nutrients (Tab. 1)
- controls: no additional nutrients and sterile control
- inoculum: aquifer material (225 µL/vial)
- 10 mL medium in 20 mL headspace vials with Teflon-coated butyl rubber septa with N₂-, air- or with 2.4%-O₂-headspace. Six parallels for each tested nutrient and corresponding controls.
- agitation at 20°C till GC/ECD-analysis

Tab. 1: Nutrients in degradation experiments.

Substance group	Nutrient	Conc. [mM]	Stimulation of
organic acids (sodium salts)	acetate	2	heterotrophs
	lactate	1.33	
	propionate	1.33	
	fumarate	1	
complex organic material	humic acids (sodium salts)	2 mg/L	heterotrophs
salts	ammonium chloride	4.5	nitrifying bacteria
sugars	glucose	1.32	heterotrophs and O ₂ -reduction
alkanes	natural gas	1 mL/vial	methanotrophs

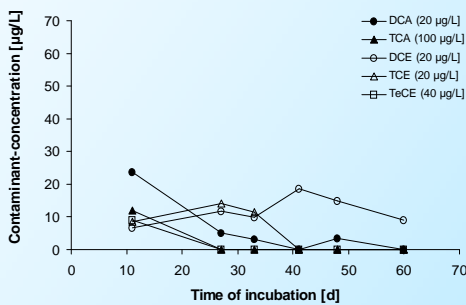


Fig. 1: Anaerobic conditions with lactate (start-concentrations in brackets)

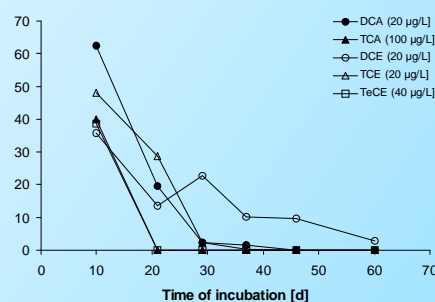


Fig. 2: Initially aerobic conditions (1 mg/L O₂) with glucose (start-conc. in brackets)

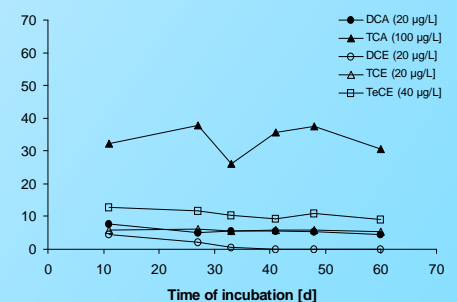


Fig. 3: Aerobic conditions (8 mg/L initial O₂) with ammonium chloride (start-conc. in brackets)

Results and Conclusions

Pollutant-transformation by indigenous aquifer organisms was enhanced or stimulated by different nutrients:

- each of the short chain organic acids enhanced biodegradation under anaerobic conditions (Fig. 1)
- glucose helped to create anaerobic conditions and stimulated the contaminant transformation at initially aerobic conditions (Fig. 2): at least 90% of the pollutants were degraded within 60 days
- ammonium and natural gas stimulated DCE degradation only under strict aerobic conditions (Fig. 3)
- humic acids did not affect the degradation activity of the aquifer organisms

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