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Microbial contaminant degradation in vertical soil filter systems: analysis by reactive transport simulations

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Different types of constructed wetlands are investigated for the ex-situ treatment of polluted groundwater from a contaminated site in eastern Germany. One type of investigated wetlands are vertical soil filter systems, which are irrigated by contaminated groundwater to enable the degradation of the contaminants - mainly benzene and MTBE. Vertical soil filters have the advantage of facilitating soil air renewal providing an oxygen-rich environment for aerobic microorganisms but also inducing volatilization of the contaminants.
A quantitative analysis of the filter system and of the relevance of individual (biotic and abiotic) processes for the overall contaminant removal is necessary to determine the efficiency of the treatment method. Therefore, experimental observations are accompanied by reactive transport simulations using numerical simulation models. Numerical models are useful tools to simulate a priori processes determining the efficiency of remediation technologies and to optimize these technologies during their implementation. The objective of the model simulations is to reproduce the physicochemical and biological processes occurring in the vertical soil filter systems. In particular, flow and transport through the unsaturated filters are coupled to reactive processes such as (aerobic and anaerobic) microbial degradation, sorption and mineral

precipitation/dissolution, as well as volatilization (using the reactive transport model MIN3P). A sensitivity analysis of changes of the air movement in the soil, degradation rate constants, water saturation and temperature was done to identify the most relevant factors and parameters controlling the degradation processes and the bioremediation efficiency.