Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 1104

Anaerobic Biodegradability of Phenolic Compounds in Microcosms Derived from a Highly Contaminated Aquifer

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Phenolic compounds are the major constituents of many industrial processes such as coal conversion, coke preparation, petroleum refineries, pulp and paper, and photo-processing (Patterson, 1975). Entering the environment as a result of uncontrolled discharges or accidental spills, they are listed among the 25 most frequently detected groundwater contaminants at hazardous waste sites. Phenols are toxic not only to human beings, but also to animal, plants, and micro-organisms (Dean-Ross and Rahimi, 1995). Phenolic compounds present in many industrial effluents are currently removed by costly and inefficient physical or chemical methods. Contaminated groundwater and soil are more difficult and costly to be treated engineeredly. Intrinsic bioremediation (Natural attenuation) has recently been studied as an alternative, due to the low cost associated with this option, as well as the possibility of complete mineralization of the xenobiotic (Singleton, 1994).

Natural attenuation of phenols in soils and groundwater has not been well documented although many efforts have been made to investigate phenolic degradation by various microbial processes. Inhibitory effects of these compounds on the methanogenic processes in groundwater and subsurface sediments have not been systematically studied. This report compared the methanogenic activities and anaerobic phenolic biodegradability at high phenolic concentrations derived from a phenolic contaminated aquifer in middle England. Batch microcosms were set up with highly contaminated groundwater from boreholes 8D (17 g/l phenols) and 9 M (1 g/l phenols), and inoculated with rock core that had been sampled anaerobically using clean field techniques (Thornton et al., 1998). The experiments were carried out in laboratory microcosms derived from a phenolic contaminated aquifer, England. In the microcosm containing 17 g/l of phenols, methane and hydrogen was found accumulated in headspace, but no phenolic degradation was achieved either in original microcosm or diluted one. Higher methane but lower hydrogen produced in the microcosms containing 1 g/l of phenols. No phenolic degradation was tested in original microcosm, but phenols degraded under nitrate, sulphate reduction, and methanogenic processes after dilution. PCR and 16SrDNA sequencing analysis showed there are similar populations of methanogens active in both of two original microcosms and in the some zone at the field site. It seems methanogens could adapt themselves to highly contaminated subsurface conditions although their activity could be inhibited by high phenols concentration. Phenols can be degraded after dilution by groundwater flow and dispersion under anaerobic conditions. These results suggest that natural attenuation of phenolic compounds could occur throughout the whole plume, but would be most rapid at lower concentrations. However, further efforts need to understand the inhibitory effects of mixed phenols on phenolic anaerobic biodegradation in groundwater.

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