# Biodegradation of Polynuclear Aromatic Hydrocarbons in soil using microorganisms under anaerobic conditions

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Abstract:

Polynuclear aromatic hydrocarbon (PAH) compounds are highly carcinogenic chemicals and common groundwater contaminants that are observed to persist in soils. The adherence and slow release of PAHs in soil is an obstacle to remediation and complicates the assessment of cleanup standards and risks. Biological degradation of PAHs in soil has been an area of active research because biological treatment may be less costly than conventional pumping technologies or excavation and thermal treatment. Biological degradation also offers the advantage to transform PAHs into non-toxic products such as biomass and carbon dioxide. Ample evidence exists for aerobic biodegradation of PAHs and many bacteria capable of degrading PAHs have been isolated and characterized. However, the microbial degradation of PAHs in sediments is impaired due to the anaerobic conditions that result from the typically high oxygen demand of the organic material present in the soil, the low solubility of oxygen in water, and the slow mass transfer of oxygen from overlying water to the soil environment. For these reasons, anaerobic microbial degradation technologies could help alleviate sediment PAH contamination and offer significant advantages for cost-efficient in-situ treatment. But very little is known about the potential for anaerobic degradation of PAHs in field soils. The objectives of this research were to assess: (1) the potential for biodegradation of PAH in field aged soils under denitrification conditions, (2) to assess the potential for biodegradation of naphthalene in soil

microcosms under denitrifying conditions, and (3) to assess for the existence of microorganisms in field sediments capable of degrading naphthalene via denitrification.

Two kinds of soils were used in this research: Harbor Point sediment (HPS-2) and Milwaukee Harbor sediment (MHS). Results presented in this seminar indicate possible degradation of PAHs in soil under denitrifying conditions. During the two months of anaerobic degradation, total PAH removal was modest probably due to both the low availability of the PAHs and competition with other more easily degradable sources of carbon in the sediments. For both Harbor Point sediment (HPS-2) and Milwaukee Harbor sediment (MHS), PAH reduction was confined to 3- and 4-ring PAHs. Comparing PAH reductions during two months of aerobic and anaerobic biotreatment of MHS, it was found that extent of PAH reduction for anaerobic treatment was compatible with that for aerobic treatment. Interestingly, removal of PAHs from sediment particle classes (by size and density) followed similar trends for aerobic and anaerobic treatment of MHS. The majority of the PAHs removed during biotreatment came from the clay/silt fraction. In an earlier study it was shown that PAHs associated with the clay/silt fraction in MHS were more available than PAHs associated with coal-derived fraction. Therefore, although total PAH reductions were small, the removal of PAHs from the more easily available sediment fraction (clay/silt) may result in a significant environmental benefit owing to a reduction in total PAH bioavailability.

By using naphthalene as a model PAH compound, biodegradation of naphthalene under denitrifying condition was assessed in microcosms containing MHS. Naphthalene spiked into MHS was degraded below detection limit within 20 days with the accompanying reduction of nitrate. With repeated addition of naphthalene and nitrate, naphthalene degradation under nitrate reducing

conditions was stable over one month. Nitrite, one of the intermediates of denitrification was detected during the incubation. Also the denitrification activity of the enrichment culture from MHS slurries was verified by monitoring the production of nitrogen gas in solid fluorescence denitrification medium. Microorganisms capable of degrading naphthalene via denitrification were isolated from this enrichment culture.