Factors Affecting the Bioavailability of Tetrachloroethene Sorbed to Municipal Solid Waste Components

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Low-level contamination of groundwater by hydrophobic organic compounds, e.g. tetrachloroethylene (PCE) and toluene, has been found down gradient of unlined municipal landfills. Biodegradation of these contaminants is affected by sorption/desorption, sorbent decomposition, contaminant aging, and association with humic matter. The overall objective of this research is to study factors controlling PCE bioavailability in the presence of (1) humic substances in solid matrices and (2) acid-phase and methanogenic-phase leachate. Given the heterogeneity and complexity of solid waste, work is being conducted with the major organic municipal solid waste (MSW) components, including office paper, newsprint, rabbit food as a model food and yard waste, high density polyethylene and polyvinyl chloride. Each material (in fresh and anaerobically decomposed form if applicable) will be aged abiotically with a mixture of ^{14}C- and cold-PCE for periods ranging from 1 to 360 days and thereafter tested to measure the effects of waste decomposition and aging on contaminant desorption and bioavailability. To study PCE bioavailability, a strictly anaerobic gram-negative bacterium, *Dehalospirillum Multivorans,* was selected. This organism can convert PCE to *cis*-1,2-dichloroethene (DCE) while using pyruvate as electron donor, and it is easy to grow relative to dehalogenating organisms that convert chlorinated aliphatics to ethylene. DCE is monitored over time in triplicate reactors containing sorbent and in sorbent-free positive controls. At the end of the bioavailability experiments, the solid will be extracted to quantify sequestration of PCE in all major forms of humic substances (i.e., humic acid, fulvic acid, and humin). High-pressure size exclusion chromatography (HPSEC) will be utilized to analyze the apparent molecular weight distribution of ^{14}C in humic and fulvic acid fractions.

Preliminary experiments have been conducted to study the behavior of *Dehalospirillum Multivorans* under the conditions of a bioavailability test, in which the dissolved PCE concentration is expected to be low relative to the high level of PCE, at which the organism is maintained in culture. With an initial PCE concentration of 1000 ppb (~ 6 μM), dechlorination was completed in 72 hours. Although the dechlorination rate was dependent on the initial PCE concentration, DCE production was readily observed at PCE concentrations of 1000 – 3000 ppb, which is acceptable. To obtain a high optical density (OD) for the bioavailability test inoculum, cells were first grown in fumarate-containing medium, and a maximum OD of 0.80 was achieved. To eliminate the influence of fumarate as a competitive electron acceptor and the accumulation of *cis*-DCE in the inoculum, the fumarate-grown culture was washed prior to use in a bioavailability test.

References

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