Laboratory and Field Evaluation of Bioaugmented Granular Activated Carbon for Treatment of Chlorobenzenes and PCBs in Sediment

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Background/Objectives. Granular activated carbon (GAC) bioaugmented with contaminant-degrading cultures is a potential method to treat, rather than contain, organic contaminants in sediments in sediments. Biodegradation of chlorinated organic contaminants such as chlorinated benzenes (CBs) and polychlorinated biphenyls (PCBs) can be achieved most completely by using a combination of anaerobic and aerobic cultures, respectively, to promote reductive dechlorination of highly chlorinated compounds and oxidation of less chlorinated compounds. As part of study funded by the National Institute of Environmental Health Sciences and EPA, we are using laboratory treatability studies, field pilot tests, and in situ microcosms to evaluate a reactive barrier containing bioaugmented GAC for treatment of CBs and PCBs at the Standard Chlorine of Delaware Superfund site. Wetland, tributary, and creek sediments at the site were impacted by past spills and continue to be impacted by discharging groundwater plumes.

Approach/Activities. Initial testing focused on CBs as the more widespread contaminants at the site. Bioaugmented GAC, sand, and chitin was mixed into wetland sediment to form a reactive barrier matrix in laboratory batch and column tests. Treatments compared GAC bioaugmented only with an anaerobic, dechlorinating culture (WBC-2) and GAC bioaugmented with both WBC-2 and an aerobic CB oxidizing consortium (15B) enriched from the site. For field pilot tests, the reactive barrier matrix containing bioaugmented GAC was mixed into the upper 25 centimeters of wetland sediment in two plots (1 m2 area each) in the wetland. Samples were collected prior to installation and at 0.5, 5, 9, and 19 months post-installation of the test plots. At 19 months, in situ microcosms with ^{13}C-labeled chlorobenzene were initiated to provide data on CB removal rates and mechanisms in the test plots and control areas. Treatability studies with WBC-2 and bioaugmented GAC were initiated to evaluate their effectiveness for PCB removal.

Results/Lessons Learned. Growth and activity of CB-degrading species were stimulated in the WBC-2 and 15B cultures when bioaugmented on GAC in batch tests, but CB removal was not significantly different between columns with WBC-2 only or both cultures bioaugmented on the GAC. Field test plots containing GAC bioaugmented with both cultures showed 80 to 95 percent removal in total CB mass in sediment samples and 50 to 99 percent decline in groundwater concentrations in the 25 cm-thick reactive zone compared to controls. Groundwater concentrations were below detection in the upper 10 cm of reactive zones. Mass removal was maintained through 19 months, or 1,900 pore volumes of groundwater discharge. Substantial increases in chloride concentrations provided evidence that CB mass removal was due to biodegradation. Although redox constituents indicated that anaerobic conditions were predominant, both anaerobic and aerobic CB-degrading populations were prevalent. Uptake of ^{13}C-labeled chlorobenzene into the microbial biomass conclusively demonstrated mineralization (aerobic degradation) of monochlorobenzene in the reactive barriers and was

highest in the reactive barrier at a site close to the creek. Initial PCB treatability tests demonstrated degradation by WBC-2. Ongoing PCB mesocosms with reactive barrier matrix will assist in quantifying degradation processes and applicability of the technology for both chlorobenzenes and PCBs.