Evaluation of Locally-Available Substrates for Degradation of Complex Chlorinated Solvents in South America

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Background/Objectives. Past operations at an industrial facility in South America have resulted in a complex mixture of chlorinated solvents present in soil and groundwater. In Area A, dense, non-aqueous phase liquid (DNAPL) has been detected in monitoring wells. The constituents of concern (COCs) include chlorinated ethanes (tetrachloroethane [TeCA], trichloroethane [TCA] and ethylene dichloride [EDC] at over 100 milligrams per liter [mg/L]) and chlorinated ethenes (tetrachloroethene, trichloroethene, dichloroethene [DCE] and vinyl chloride [VC] up to 65 mg/L). For Area A, DNAPL-impacted soils will be excavated and backfilled with media to treat groundwater that passively flows through the backfilled zone. In Area B, COCs are primarily EDC and VC at concentrations up to 250 mg/L. In this area, substrate injections may be performed to enhance COC degradation. Treatability studies were conducted using soil and groundwater from both areas of the site to evaluate the ability of locally-available substrates to support sustainable remediation.

Approach/Activities. Sacrificial microcosms were prepared for each area. The Area A testing program consisted of two phases: a screening phase (Phase 1) and an optimization phase (Phase 2). During Phase 1, high and low concentrations of different substrates (chicken compost/emulsified vegetable oil [EVO]; Daramend; and EVO with KB-1® Plus) were tested, and groundwater was analyzed after 84 days. Based on the Phase 1 results, two sets of sacrificial microcosms were established for Phase 2 (chicken compost [20%]/ EVO [0.5% wt.]/ KB-1® Plus; and Daramend [1% wt.]). Phase 2 microcosms were analyzed 1 hour and 14, 28, 56, and 84 days after set-up to establish degradation kinetics. For Area B, non-bioaugmented and KB-1® Plus bioaugmented microcosms were prepared using (1) emulsified zero valent iron (EZVI) with a methane inhibitor (dosed at 5% of the microcosms pore fluid), (2) dilute [1%] beet molasses in 33% of the pore volume, and (3) EVO (5% wt). Area B sacrificial microcosms were analyzed 1, 30, 60, 120, and 180 days after set-up for COCs and various biogeochemical parameters. In addition, after 180 days, two Area B microcosms were selected for microbial testing via qPCR.

Results/Lessons Learned. Area A results showed that the chicken compost/ EVO/ KB-1® Plus microcosms performed the best, with complete degradation of all COCs by day 84; the Daramend microcosms showed quick degradation of TeCA, TCA, and EDC, but significant concentrations of DCE and VC remained after 84 days. Based on the results, the excavation area will be backfilled with a mixture of clean backfill, chicken compost, EVO and KB-1® Plus.

In Area B, the EZVI/ KB-1® Plus and beet molasses/ KB-1® Plus microcosms performed the best. The non-bioaugmented EZVI and molasses microcosms also performed well, but degradation of the VC took longer. There was no significant degradation of COCs in the EVO microcosms, even when KB-1® Plus was included. Zero-order kinetics were observed (vs. first-order kinetics), likely due to the high COC concentrations. The EDC half-life was ~15 days and the VC half-life was ~30 days. A pilot test is being implemented to evaluate direct injection versus injection wells using beet molasses/ KB-1® Plus.