Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

Comparison of Biological, Biogeochemical and In Situ Chemical Reduction for Treatment of Mixed Chlorinated Ethenes and Methanes

Grace Su and Michael Tischuk (TEA, Inc., Moraga, CA, USA)
Audrey Sidebottom (The Dow Chemical Company, Fort Saskatchewan, AB, Canada)
Sandra Owen, Brianna Desjardins (PeroxyChem, Tonowanda, New York, USA)
Dan Leigh (PeroxyChem, Walnut Creek, CA, USA)

Background/Objectives. Soil and groundwater at a chemical manufacturing facility in Northern California have been impacted by high concentrations (>100 mg/L) of mixed organics consisting of chlorinated ethenes (CEs) and chlorinated methanes (CMs). Ongoing treatment of the site groundwater has primarily consisted of biologically mediated reductive dechlorination using propylene glycol (PG) as an electron donor. While PG has been an effective electron donor, alternate remedial approaches are being tested to optimize the remedial process.

Approach/Activities. A bench test was conducted to evaluate three remedial approaches including biological only (BIO), biogeochemical (BGC) and in situ chemical reduction (ISCR) to treat the observed contaminants. Site groundwater, with up to 44 mg/L of CEs and 70 mg/L of CMs, was added to each test and a control. In each active process (BIO, BGC and ISCR) test, a combination of 10% PG and 90% emulsified lecithin substrate (ELS™), and a dechlorination microbial culture (SDC-9™) was added to site groundwater to enhance biological processes. In addition, the BGC test also included a soluble organic iron and sulfate source to generate reactive iron sulfides. The ISCR test included zero valent iron to enhance direct abiotic degradation processes.

Results/Lessons Learned. Upon mixing the substrates, highly reducing conditions (-500 mV) were established in each of the tests. The BGC and ISCR bottles turned black by Day 14 and Day 42, respectively, indicating the precipitation of iron sulfides.

Carbon tetrachloride (CT) was reduced from 38,000 µg/L to 180 µg/L (99.5%) in less than 42 days in the BGC test without production of chloroform (CF) nor methylene chloride (MC). CT was reduced by 99.8% to 42 µg/L in less than 42 days in the ISCR test. Less than stoichiometric production of CF production was observed which was subsequently degraded in the ISCR tests. Tetrachloroethene (PCE) was reduced in both the BGC (94%) and ISCR (88%) tests by Day 42. However, trichloroethylene (TCE) was only generated in the ISCR test suggesting an initial biological reduction process in that test with primarily abiotic degradation in the BGC. Significant CM and CE reduction was not observed by Day 42 in the BIO test. Carbon disulfide was observed in the BGC test suggesting reduction of CT by contact with reactive iron sulfides. Although biological processes have been demonstrated to effectively treat the contaminants at the site, the addition of an iron source substantially increased the degradation of both the CEs and CMs in the bench test. The BGC degradation of CT occurred without the production of daughter products. The presence of CT was considered to be responsible for the early inhibition of biological degradation of CEs. It is anticipated that as CT is reduced, CEs reduction will increase. The bench test indicate that both BGC and ISCR can substantially enhance treatment. The test is ongoing and the presentation will compare bench test and field observations.