1,4-Dioxane Bioaugmentation during and after Anaerobic Degradation

Lingke Zeng (lzeng@langan.com), Stewart Abrams (sabrams@langan.com), and Amita Oka (Langan, Lawrenceville, NJ)
Mengyan Li and Fei Li (New Jersey Institute of Technology, Newark, NJ)

Background/Objectives. 1,4-Dioxane is commonly comingled with chlorinated solvents. The most common remediation technology for chlorinated solvents is anaerobic biodegradation. 1,4-Dioxane is not known to be degraded under anaerobic conditions. It was often observed that 1,4-dioxane concentration increased moderately during anaerobic bioremediation in a diluted plume. However, at the plume fringe or in a high groundwater flux aquifer where aerobic, anoxic, and anaerobic respirations can co-exist, 1,4-dioxane was observed to be degraded during the implementations of anaerobic degradation. Therefore, a study was conducted to investigate 1,4-dioxane bioaugmentation following the chlorinated solvent anaerobic degradation via abiotic (iron sulfide) and biotic (reductive dechlorination). The objective of the study is to identify a potential technology that can co-metabolically degrade 1,4-dioxane during or after CVOCs degradation.

Approach/Activities. A treatability study was started in May 2017 at the Langan Treatability Facility at the New Jersey Institute of Technology. The study investigated the enhancement of degradation via the addition of sulfate and sulfide for biotic and abiotic degradation. A total of five microcosm treatments included live control, killed control, bioaugmentation (EVO and SDC-9), sulfate amended (EVO, DHC, and Epsom salt), and sulfide amended (EVO, DHC, and calcium polysulfide). All microcosm bottles contained rock fragments, groundwater and trichloroethene spiked at 7 mg/L. The rock and groundwater were collected from a fractured bedrock aquifer in northern New Jersey. CVOCs were completely degraded in less than 10 weeks. Meanwhile, 1,4-dioxane concentration increased approximately 50% to 10 µg/L at the end of this study.

A second study using the same microcosms was initiated in August 2018 at Dr Li's lab at NJIT. This study is on-going and will be completed in October 2018. DD-4 was amended as the bioaugmentation culture for 1,4-dioxane.

Results/Lessons Learned. The on-going study will provide the knowledge for the field implementation of 1,4-dioxane biodegradation. Specifically, the study is investigating the following:

- The amount of oxygen to convert the anaerobic microcosms to the anoxic conditions.
- The stability of iron sulfide complex under anoxic to aerobic conditions.
- The potential of 1,4-dioxane co-metabolic degradation with residual methane and fermentation products (metabolic acids) of EVO.
- The potential of DD-4 competing with other microbes including fermentors.

If the co-metabolic degradation of 1,4-dioxane is approved to be feasible during or after anaerobic degradation, the new technology to remediate commingled CVOC and 1,4-dioxane will be considered for the site remediation.