Improved Understanding of In Situ Chemical Oxidation (ISCO)

Cleanup
CU-1289

Background:

The use of in situ chemical oxidation (ISCO) has dramatically increased at Department of Defense (DoD), Department of Energy (DOE) and defense contractor sites, as responsible parties attempt to aggressively destroy chlorinated solvent and dense non-aqueous phase liquid (DNAPL) source areas with the goal of reducing the duration and cost of site remediation. Unfortunately, performance of the ISCO technology at the field-scale has varied significantly due to the limited understanding of the chemical reaction mechanisms and kinetics, the interactions between the oxidant, contaminants, and the aquifer matrix, and the effects of secondary water quality constituents on oxidation reactions and by-product generation, all of which are critical factors in effectively applying ISCO. This research project will provide a better understanding of the site-specific applicability of ISCO and the potential post-treatment impacts of the technology.

Objective:

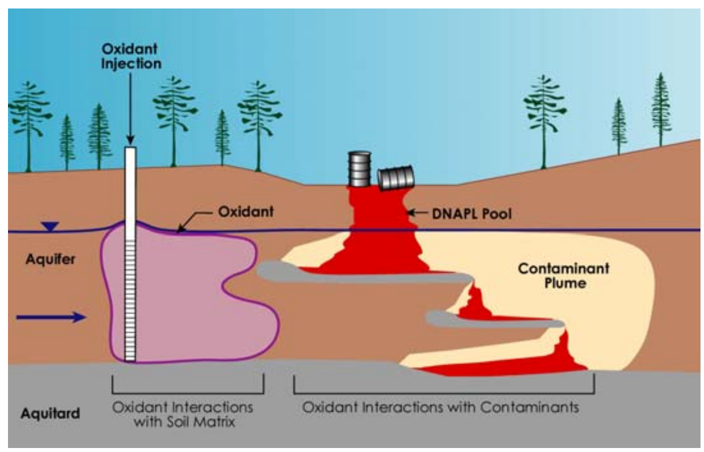
The objectives of this project are: (1) develop a comprehensive perspective on the kinetics of oxidation of common groundwater contaminants by the most commonly used oxidants (permanganate [MnO_4^-] and Fenton's reagent [H_2O_2/Fe^{2+}]); (2) evaluate the effect of the aquifer matrix on oxidant mobility and stability using standardized oxidant demand measurement protocols; and (3) identify significant secondary impacts of ISCO on groundwater geochemistry and microbial activity at the field-scale.

Summary of Process/Technology:

The research program will focus on characterizing the interactions between the oxidant, the target contaminants, and the aquifer matrix, and the implications of oxidant reactivity on post-treatment groundwater conditions using three parallel research tasks. In the first task, the reactivity of common groundwater contaminants with both MnO_4^- and H_2O_2/Fe^{2+} will be characterized using a novel stopped-flow reactor system to determine contaminant degradation rates and identify principal reaction products. In the second task, batch and column methods for determining natural oxidant demand (NOD) will be compared to develop appropriate measurement protocols for this parameter. The rate and extent of the NOD of eight aquifer matrix types will be correlated with geochemical characteristics of each media type. Modeling tools will be developed to facilitate analysis of oxidant mobility in the subsurface based on soil characteristics. In the third task, detailed groundwater monitoring will be performed at two field sites during and following treatment using ISCO (one MnO_4^- and one H_2O_2/Fe^{2+} application). The monitoring program will focus on characterizing the extent and duration of post-treatment impacts on groundwater geochemistry and microbiology.

Benefit:

Groundwater contamination related to the presence of DNAPL requires the development of robust, reliable, and cost-effective treatment technologies. ISCO is a very promising technology; however, the interactions between oxidants and the aquifer matrix and the reactivity of a broad range of target contaminants are not well understood. Research data will be integrated into an ISCO guidance document for chlorinated solvent remediation that includes specific guidance on technology applicability, protocols for laboratory treatability testing, design guidance for oxidant delivery systems, and approaches for effective technology performance monitoring and validation.



Application of ISCO at the Field-Scale

Accomplishments:

This project began in FY 2002. Accomplishments will be noted upon completion of the project. For information on the project's status, see the **timeline of tasks and deliverables**.

Contact Information:

Dr. Eric Hood
GeoSyntec Consultants, Inc.
160 Research Lane, Suite 206
Guelph, Ontario N1G 5B2, CANADA
Phone: (519) 822-2230
Fax: (519) 822-3151
E-mail: ehood@geosyntec.com

REVISED 11/25/03