Feasibility Assessment of Reducing Soil for Degrading Trichloroethylene

Yuwen Hou (hywadsl@gmail.com) and Chenju Liang (cliang@nchu.edu.tw)
(Department of Environmental Engineering, National Chung Hsing University, Taiwan)

Background/Objectives. Chlorinated solvents such as trichloroethylene (TCE) as dense nonaqueous phase liquid have densities greater than water, low viscosity and low water solubility, and their presence in soil and groundwater system is usually regarded as a long-term source of contamination. In situ chemical reduction (ISCR) is a potential technique to remediate TCE contamination. The objectives of this study were to investigate the application of various reducing and chelating agents on creating reducing soil conditions for degrading TCE.

Approach/Activities. Laboratory-scale experiments were initially conducted to explore the applicability of using thiosulfate ($S_2O_3^{2-}$), dithionite ($S_2O_4^{2-}$), metabisulfite ($S_2O_5^{2-}$) and green tea extract as ISCR reductants in the presence or absence of chelating agents (citric acid (CA) and oxalic acid (OA)) for reductively degrading TCE in aqueous phase and soil slurries.

Results/Lessons Learned. The results revealed that all aqueous phase test conditions resulted in <20% of TCE degradations within 14-day reaction time. However, $S_2O_5^{2-}$/OA and $S_2O_5^{2-}$/CA resulted in complete TCE degradations and $S_2O_5^{2-}$ alone resulted in 83% of TCE degradation in soil slurries. In addition, $S_2O_4^{2-}$/OA and $S_2O_4^{2-}$/CA resulted in approximately 50% TCE degradations and other experimental conditions resulted in <20% in soil slurries. It can be seen that $S_2O_5^{2-}$ with the assistance of OA and CA could yield reducing soil conditions for degrading TCE. Furthermore, the reaction system (i.e., $S_2O_5^{2-}$/OA) was selected to examine TCE degradation kinetics and intermediates and also reaction pathway was proposed. Characterization of reduced soils was conducted using SEM/EDS and XRD. The results of this study exhibited that $S_2O_5^{2-}$/OA could serve as an ISCR reagent to reduce soil iron oxide minerals naturally present in soils to a lower valent Fe(II). The reduced soils containing Fe(II)/Fe(III) cations, hydroxide anion, and other anions such as carbonate, or sulfate is capable for the reductive dechlorination of TCE.