Field Test of Electrokinetically-Delivered and Thermally Activated Persulfate (EKTAP) for Remediation of Chlorinated Solvents in Clay

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Background/Objectives. Remediation of chlorinated organic compounds, such as 1,2-dichloroethane (1,2-DCA), sequestered in low-permeability soils has proven to be a difficult task that may require the integration of several technologies. In-situ chemical oxidation (ISCO) with persulfate has shown potential; however, amendment transport by hydraulic injection is ineffective in low-permeability soils. Electrokinetic (EK) enhanced transport has been proposed as an alternative for amendment delivery. EK coupled with thermally activated persulfate (EKTAP) has recently been tested at the bench-scale and shown promise to overcome such challenging subsurface conditions (Chowdhury, A. I., Gerhard, J. I., Reynolds, D., & O'Carroll, D. M. (2017). Low Permeability Zone Remediation via Oxidant Delivered by Electrokinetics and Activated by Electrical Resistance Heating: Proof of Concept. *Environmental science & technology*, *51*(22), 13295-13303). This study evaluates the ability of EKTAP to enhance the delivery and effectiveness of persulfate in clayey soil. The pilot field test was completed at a chlorinated solvent impacted site underlain by clay in Sarnia, Ontario, Canada.

Approach/Activities. Approximately 37 kg of persulfate was injected over the course of 57 days with EK-enhancement. EK assisted transport was implemented by applying a direct current (DC) between two sets of electrodes spaced 3 m apart. Following injection, persulfate was thermally activated by applying an alternate current (AC) between the two sets of electrodes for an additional 139 days. Groundwater and soil sampling results taken from this EKTAP cell were compared to two parallel control cells, one with the influence of EK and one without.

Results/Lessons Learned. Results showed that EK can effectively increase the delivery of persulfate in clayey soil. The application of AC significantly increased soil temperatures in-situ, validating the EKTAP concept. Substantial decreases of chlorinated organic compounds, including 1,2-DCA, resulted during EK-enhancement in areas of persulfate delivery. Activation by naturally occurring iron is assumed to have occurred. The impact of other mechanisms (e.g., dilution) on the observed decreases in chlorinated organic compounds is being investigated. Further developments to the EKTAP cell design are required to achieve more uniform distributions in heat and persulfate for efficient thermal activation. This field study nonetheless demonstrates that the application of EKTAP can result in enhanced oxidant transport into low-permeability strata and create favorable conditions for the degradation of chlorinated organic compounds.