



Effect of reversed-Direct current in combination of electrokinetic and PRB on remediation of TCE-contaminated soil

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Abstract

Remediation of soils contaminated with chlorinated hydrophobic organic compounds (CHOCs) remains a challenge for environmental scientists worldwide. In the present study electrokinetic technology was coupled with permeable reactive barrier (PRB) composed of micro-scale Fe to treat a Tetrachloroethylene (TCE)-contaminated soil. A nonionic surfactant, Triton X-100, was selected as the solubility enhancing agent. Four bench-scale tests (T1 to T4) were conducted to investigate the effect of revised direct current in EK-PRB method on removal of TCE-contaminated soil under potential gradient of 1 V.cm^{-1} for 10 days. Cumulative electro-osmosis flow, electrical current and pH in anode and cathode reservoir were measured every 24^{h} during the run. In T4, direction of current was reserved after 5 day for investigation of TCE-remove in the cathode column by Fe-PRB method. Results showed that the TCE removal was generally increased in anode and cathode by revised current in EK-PRB test compared with EK-PRB test without revised current (73% in anode, 64% in cathode versus 24% in anode and 18% in cathode).

Keywords: Electrokinetic, Tetrachloroethylene, Surfactant, Permeable Reactive Barrier

1. INTRODUCTION

Chlorinated aromatic hydrocarbons (CAHs), a family of compounds that are commonly used as organic solvents, have been increasingly detected in soil and groundwater. The most prevalent CAHs are perchloroethylene (PCE), trichloroethylene (TCE), and trichloroethane (TCA). Since the 1960s, these solvents have been used for degreasing in industries such as dry cleaning, electronics, industrial manufacturing, and machine maintenance. Due to leakage of these CAHs from storage tanks and machinery, dissolved PCE, TCE, and TCA now appear in soil and groundwater at concentrations that have been proved to be unhealthy and even carcinogenic [1]. The low interfacial tension between liquid CAHs and water allows the CAHs to easily enter small fractures and pore spaces. However, the high relative solubility's of CAHs and the low partitioning of CAHs to soil materials imply that soils will not significantly retard the movement of CAHs [2]. The low sorption of CAHs onto soil matrix suggests that CAHs are mainly in the dissolved state in soil pore solution, the movement of which is relatively easy.

In situ or on-site cleanup methods could be applied to reduce environmental impacts and the cost of remediation in contaminated soil with CAHs. Recently, a proven technology that has drawn attention by site governmental officials and remediation engineers is electrokinetic (EK) remediation. This emerging in situ technology can separate the contaminants from low-permeability soils, i.e., clays and silts, by applying a low intensity direct current to the soil. The EK process involved in soil remediation can be based on three key mechanisms: (1) the advection of electro-osmotic (EO) flow (forced water movement) driven by electric current, (2) the movement of H^+ ions produced from water electrolysis at the anode advancing through the soil toward the cathode, and (3) the electromigration of charged ions toward the opposite electrodes [3-4]. Dissolution, adsorption/desorption, reduction-oxidation, and precipitation are always accompanied during the process. The EK process has been reported to be successful and cost effective to treat both organic [4-5] and inorganic contaminants [6] from low-permeability soils. This technology has been commercialized for years under such names as Lasagna, Electro-Klean, and Electrokinetic Ltd. The remediation limitation of EK process by itself is that it can only remove the contaminants from the soil phase to the solution phase or it can