

THE INFLUENCE OF PHYSICAL HETEROGENEITY ON IMMISCIBLE-LIQUID DISSOLUTION AND PERMANGANATE-BASED IN SITU REMEDIATION

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Minimal research has been conducted to examine dissolution and remediation of NAPL located in lower-permeability (K) media. The purpose of this research was to investigate dissolution of non-uniformly distributed residual NAPL located in lower-K media and how mass transfer was affected. Additionally, in situ chemical oxidation (ISCO) effectiveness using KMnO_4 in the laboratory and field was examined.

A series of column and flow cell experiments were conducted with trichloroethene (TCE). For uniformly distributed residual NAPL control experiments, reduced interfacial pool area and residence time were likely the most important mass transfer limitation. For non-uniformly distributed residual NAPL, by-pass flow attributed to reduced effective permeability was initially the most important factor affecting non-ideal mass transfer. Dissolution times increased with physical heterogeneity due to by-pass flow. Mass transfer was more non-ideal for non-uniformly distributed NAPL. Non-ideal mass transfer was most pronounced for non-uniformly distributed NAPL in lower-K zones. NAPL location influences dissolution behavior and ultimately remediation. Mass flux reduction versus mass reduction comparisons for the experiments exhibited how mass transfer trends vary between systems.

The effectiveness of KMnO_4 ISCO of residual TCE located in lower-K media was examined. KMnO_4 solution was flushed through a flow cell followed by water flushing to evaluate long-term mass flux behavior, which was then compared to a water-flush control. For water flushing following KMnO_4 flushing, mass flux was similar to the control experiment. However, since contaminant mass was reduced, the number of pore volumes required for complete TCE removal via water flushing was estimated to be reduced by half.

1,1-Dichloroethene (DCE) is thought to be located in lower permeability strata adjacent to the water table at the Samsonite Building Area. Eight injection wells were emplaced in the source zone area, with well screens spanning the vadose and saturated zones, and injected with ~250 kg of 1.7% KMnO_4 solution. Bench-scale studies using core material determined that DCE was readily degraded by KMnO_4 , even at lower reagent concentrations (< 1 mM). The natural oxidant demand was determined to be 1.0×10^{-5} g of KMnO_4 /g of sediment. Aqueous DCE levels dropped below detection after KMnO_4 solution was present.