

## ABSTRACT

Kang, Namgoo, Ph.D., Purdue University, December 2004. Enhanced Utilization of Oxidants for In Situ Chemical Oxidation of Chlorinated and Aromatic Hydrocarbons. Major Professor: Inez Hua.

Dense non-aqueous phase liquids (DNAPLs) serve as significant sources of contaminants that can be released to groundwater, and considerable efforts have been towards developing techniques for reduction of source mass. In situ chemical oxidation (ISCO) has been widely employed as an effective tool for source zone remediation. The most frequently used oxidants for ISCO are iron-catalyzed hydrogen peroxide (Fenton's reagent) and potassium permanganate ( $\text{KMnO}_4$ ). It has been frequently claimed that these oxidants are required in excessive quantities for successful performance in the contaminated subsurface because of non-specific losses of both oxidants and iron catalyst. Efforts are needed to tackle these issues, especially in the presence of DNAPLs. Therefore, the present investigation is focused on developing potentially viable strategies for enhancing utilization of Fenton's reagent and potassium permanganate in the presence of both soil and DNAPLs.

Two innovative approaches for these oxidants have been developed to accomplish this research goal. The first innovative approach explores the generation of micro-encapsulated  $\text{KMnO}_4$  particles (MEPPs). The MEPPs demonstrated significantly sustained release of the oxidant in aqueous solution and yet expedited dissolution upon contact with DNAPLs such as perchloroethylene (PCE). This targeted release approach opens the new horizon for potential applications that are not possible by tradition approaches. The second approach explores enhanced utilization of Fenton's reagent for either DNAPL-phase PCE or dissolved aromatic compounds such as benzene, toluene, ethylbenzene, and xylene (BTEX) under dark Fenton's reactions in the presence of soil.

To this end, this approach introduced an iron catalyst combined with *N*-2-(hydroxyethyl) iminodiacetic acid (HEIDA), an organic chelating agent. For a better understanding of oxidant utilization in dark Fenton's systems, the relative magnitude of non-specific losses of hydroxyl radicals ( $\cdot\text{OH}$ ), the actual oxidant in Fenton's systems, was estimated and compared to consumption by the target contaminants.