

Hydrocarbon Source Emission Reduction in Lower-Permeability Layers using In Situ Sodium Persulfate Interface Treatment

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Background/Objectives. Typically in-situ remediation of VOCs involves the passing of a liquid or gas through an impacted region where the contaminant is either removed through flushing, oxidized through contact with a reactant, or biodegraded. This could lead to preferential treatment of the more transmissive zones while residual NAPL or dissolved-phase matrix storage will remain untreated. The residual material in the lower transmissive zone can result in a steady emission from the lower permeability region to the groundwater flowing through the more transmissive regions by diffusion resulting in long-term groundwater impacts. This presentation looks at characteristics of treatment applications at the interface between the higher/lower permeability zones with the goal of localized instead of complete treatment of the lower permeability zone and the long-term effect on emission reduction. Examples of laboratory investigations using sodium persulfate and hydrogen peroxide as an interface treatment will be presented with lessons learned.

Approach/Activities. This talk will look at characteristics of different in-situ treatments to identify potential options for treatment of sources contained in lower permeability soils. With those characteristics identified, results from three hydrocarbon tank studies (4 ft x 4 ft x 2 in tanks) will be presented all with sources contained in a lower permeability region and a clean, higher permeability region above it with clean water flowing across the interface. The 60-cm thick lower permeability region initially contained either a dissolved or LNAPL source. Treatments involve a 10% hydrogen peroxide treatment for 40-h where the source is a 22 mg/L dissolved toluene source, a 14-d 10% sodium persulfate treatment for a multi-component dissolved source (41 mg/L MTBE, 14 mg/L benzene, 26 mg/L toluene, 11 mg/L ethylbenzene, and 8 mg/L p-xylene), and a series of 10% sodium persulfate and sodium hydroxide applications to treat a 10-cm thick LNAPL-impacted lower permeability layer (8,000 mg LNAPL/kg soil). For the base activation condition, the oxidant and activator were added separately to control where and when reactions occurred.

Results/Lessons Learned. Hydrogen peroxide (H_2O_2) produced only localized treatment in the lower permeability zone near the injection point due to its reactivity. The trapped oxygen remained in place for 60 d during which effluent toluene concentrations were non-detect. After 60 d, effluent concentrations rebounded to near untreated conditions. Sodium persulfate delivery and subsequent diffusion into the low permeability layer generated a 25 to 60-cm clean zone in the dissolved source tank. This resulted in approximately 90% and 48% reduction in BTEX and MTBE emissions respectively. In the LNAPL-impacted experiment, there was 55% to 73% reduction in emissions relative to the control tank with minimal source removal due to the high contaminant mass. Results suggest reaction rates and behaviors, solubility, efficiency, treatment time and method all affect the extent of interface treatment.