Use of Chemical Oxidation to Reduce Rate-Limited Matrix Diffusion of PCE from Low Permeability Materials – A Numerical Study

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Abstract. Observations at sites contaminated with dense non-aqueous phase liquid (DNAPL) products, suggest a significant fraction of dissolved chemical diffuses into low permeability materials (LPM) of the aquifer. Traditional source removal techniques (e.g., surfactant/co-solvent flushing, pump-and-treat) rely on groundwater flow to remove the contaminant. As groundwater with treating agents does not easily access these LPM zones, after free phase removal, plume concentrations often rebound as diffused mass is returned back to the higher permeability flow zone. Because maximum contaminant levels (MCLs) are several orders of magnitude below effective solubility, this rate-limited diffusion results in plume concentrations still exceeding MCLs despite primary source removal. Chemical oxidants such as potassium permanganate are able to diffuse into LPM and destroy DNAPL compounds, mitigating matrix-limited diffusion and rebound effects. A series of numerical simulations were conducted, evaluating the effectiveness of in situ chemical oxidation using potassium permanganate in removing diffused DNAPL components from low permeability zones. Results are used to design large soil tank experiments to further research this cleanup method.

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