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Sensitivity Analysis of Diffusion in Low-Permeability Geological Formations

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Anaerobic biodegradation of chlorinated Volatile Organic Compounds (VOCs), such as perchloroethene (PCE) and trichloroethene (TCE), requires highly reducing conditions to stimulate anaerobic bacteria to dechlorinate the contaminants. The use of Hydrogen Release Compound (HRC) is a common practice to accelerate in situ bioremediation and to increase total cost effectiveness. An understanding of migration behavior of dissolved hydrogen in geological formations is therefore an important research subject for predicting potential areas of remediation during acceptable time periods.

Migration of chemical substances in a geological formation is basically controlled by advection and diffusion. When there is no flow and/or the permeability of geological formation is very low, migration of substances becomes dominated by diffusion.

In this study, sensitivity analysis of diffusion in low-permeability geological formations is performed. Three patterns of model were considered to simulate point source, line source and planar source of diffusion. Expected areas of hydrogen migration were assumed to be in the order of meters, and acceptable remediation time periods were considered to be from several months to several years. The results of this study illustrated that migration due to diffusion is very sensitive to the magnitude of diffusion coefficient. The area of migration due to natural diffusion could be very limited. An incorporation of natural migration with pressurized injection and/or other approaches, like electro-migration, for stimulating mass transport could be necessary when performing bioremediation in low-permeability geological formations.

Keywords: Bioremediation, Volatile Organic Compounds, Hydrogen Release Compound, Diffusion, Low-Permeability, Sensitivity Analysis