

Surfactant Enhanced High Vacuum Dual Phase Extraction (HVDPE) Remediation of Petroleum Contaminated Bedrock Aquifer (In-situ Case Study)

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This paper will focus on the application of surfactant-enhanced multi-phase extraction (MPE) remediation using non-ionic surfactants to improve the in-situ recovery of diesel fuel in contaminated soil, bedrock, and groundwater.

The Site is an active telephone facility in Northern California that experienced a leak from a diesel fuel UST in 1991. The release of diesel hydrocarbons to soil has been documented to have migrated through near-surface sandy soils into the underlying fractured bedrock and to groundwater at the Site. The diesel constituents have persisted in the groundwater for 18 years, despite active remedial efforts involving MPE. The fractured and weathered bedrock (siltstone, claystone, sandstone) has generally low permeability, presenting a serious challenge to effective recovery of the diesel constituents. As a result, MPE tests at the Site with low vacuum and low groundwater extraction rates show low recovery rates. Given these conditions, it appeared that surfactants might be effective at enhancing the movement and mass recovery of the diesel constituents.

The purpose of the pilot test study was to evaluate a presumptive remedy of enhancing the MPE and increasing the extraction of hydrocarbons using a commercial non-ionic surfactant product.

Normally hydrophobic organic chemicals (HOC) exhibit limited solubility in water as the contaminants tend to partition and sorb (i.e., absorb and/or adsorb) onto or into the soil or bedrock matrix. This partitioning can account for as much as >90% of the total contaminant mass. Consequently, the subject contaminants exhibit a limited 'availability' for in-situ and/or ex-situ treatment. The adsorption or absorption of contaminants onto or into solids is considered the principal limiting factor affecting the effectiveness of most treatment technologies. Surfactant enhanced remediation selectively desorbs and dissolves target contaminants from the solid to liquid phase. The surfactants also cause the water to flow much faster through low-permeability soils and rock, allowing for their improved mass recovery and/or improved treatment by various remediation techniques, such as MPE or groundwater pumping.

The pilot test involved multiple injections of a non-ionic surfactant blend in a central monitoring well while conducting vacuum-enhanced MPE of groundwater at downgradient monitoring wells. Maintaining capture of injected solutions was essential to achieve regulatory acceptance. The test showed immediate substantial changes in the concentrations of diesel constituents, and the mass removed increased sharply over previous results without surfactants.

This presentation will highlight the approach and findings of the pilot test results and implications for the effectiveness of using surfactant/vacuum-enhanced MPE for diesel fuel recovery, in low-permeability soils and bedrock.

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Mr. Ivey is the President and Senior Remediation Specialist with Ivey International Inc. He has over twenty years of environmental experience, and has worked on more than 1200 projects worldwide. His background includes: Organic Chemistry, Geological Engineering, and a Master's Certification in Project Management.

Among some of his more recent accomplishments include his being awarded:

- The 2007 Environmental Business Journal Business Achievement Award Bronze Medal, February 20, 2008;
- The 2006 North American Frost & Sullivan Award for Technology Innovation, February 7, 2007;
- The 2006 Environmental Business Journal Remediation Technology Merit Award, February 28, 2007; and
- The 2006 Globe Award for Environmental Innovation & Application, on March 31, 2006.

He holds several international patents; continues to conduct applied soil, solid waste, waste water, and groundwater research, and is currently working on several remediation projects around the world.