SERDP Strategic Environmental Research and Development Program

Foam Delivery of Hydrogen for Enhanced Aquifer Contacting and Anaerobic Bioremediation of Chlorinated Solvents

Cleanup
CU-1203

Background:

Hydrogen sparging of aquifers contaminated with chlorinated solvents has shown promise as a method to enhance microbial dechlorination in-situ. The major concern in the application of this remedial approach is the ability to distribute hydrogen effectively throughout the contaminated interval such that complete dechlorination can occur. As is true for aerobic biosparging application, the horizontal and vertical extent of residual gas saturation formation during hydrogen sparging is limited to only a small, conical region around and above the screened interval because of the low density and viscosity of hydrogen compared to water.

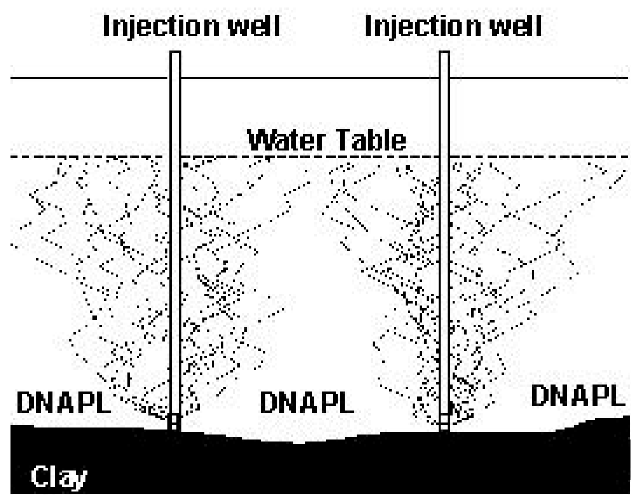
A promising method to improve hydrogen contact throughout a contaminated interval – and to greatly extend the horizontal migration of hydrogen in the subsurface – is to deliver the hydrogen as an "in-situ generated foam", a dispersion of gas in water that is stabilized from coalescence by the presence of a small amount of surfactants. It is generated by injection of a slug of dilute surfactant solution into the well, followed by gas injection. The gas bubbles that form are inhibited from coalescence by the surfactant adsorbed at the interfaces, and the lamellae or "soap films" between the bubbles increase the resistance of the gas to flow through porous media. A previous field study has demonstrated that the use of foam greatly improves the extent of aquifer contacting by injected gas.

Objective:

The objective of the project is to investigate the ability of hydrogen-foams to more effectively contact aquifer sands and support rapid dechlorination activity compared to conventional hydrogen sparging.

Summary of Process/Technology:

Tasks to be accomplished in this proposed research are the following: (1) screen surfactants for their foam properties in porous media, (2) evaluate surfactants to verify that they are benign to the microbial process and are not rapidly degraded, (3) evaluate the acceleration of reductive dechlorination due to solubilization of DNAPL into micelles, (4) utilize sand columns and mechanistic models to quantify enhanced foam mobility in heterogeneous systems, (5) incorporate the heterogeneity enhanced mechanisms in the UTCHEM numerical simulator, (6) validate the foam enhancement of reductive dechlorination by hydrogen sparging in a bench scale three-dimensional sand pack model, and (7) develop the design for a hypothetical field application.



During Hydrogen Sparging, Gas Saturation is Limited to a Small, Conical Region Around and above the Screened Interval.

Benefit:

The expected benefit of this process is a decrease in well spacing and a decrease in the frequency of sparging. Larger well spacing will be possible by transporting hydrogen further into the base of the aquifer where DNAPL is located. Increased residual hydrogen gas saturation in the contacted region will decrease the frequency of replenishing the hydrogen.

Accomplishments:

This is an FY01 New Start project.

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