Pilot Scale Testing of Swellable Organosilica-Nanoparticle Composite Materials for the In Situ and Ex Situ Remediation of Groundwater Contaminated with Chlorinated Organics

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Swellable organically-modified silica (SOMS) can capture up to 8-times its volume in organic compounds found as either neat liquids, vapors, or dissolved in water. Absorption is substantial due to the expanding nanoporous matrix which is great tension that the matrix can lift >10,000 times it own weight upon expansion. Embedded nanoscale zero valent iron (or bimetallic particles) can be used to dechlorinate captured organics. Laboratory testing has shown that SOMS-nZVI materials are effective in rapidly dechlorinating trichloroethylene to ethane and chloride ion. The glass matrix serves to concentrate the chlorinated solvents and protect the embedded metal particles from deactivation by dissolved ions. In conjunction with laboratory testing, three pilot projects were carried out in central Ohio at industrial sites with groundwater contaminated by either trichloroethylene or perchloroethylene. Composite materials were injected into the aquifer to create a soft curtain up-gradient from monitoring wells. Soil testing was used to determine the distribution of the material post-injection using fluorescently labeled particles. Chlorinated solvent concentrations were measured as a function of time to assess the effectiveness.

In a separate set of tests and pilot projects, SOMS with embedded nanoscale palladium particles was used as a replacement for air sparge towers in the ex situ treatment of groundwater contaminated with chlorinated solvents. Reduction is accomplished by dissolved hydrogen gas. The system has been shown to be effective in dechlorinating trichloroethylene and perchloroethylene from levels exceeding 20,000 ppb to less than 1 ppb. In addition, SOMS-Pd is effective at reducing trinitrotoluene, atrazine, and triclosan in water. Results of bench work and pilot scale tests (1,000 gal/hr) will be presented.