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An Approach with Synergistic Advantages of Combining Colloidal Activated Carbon and Zero Valent Iron

Katherine Djernes Pappano, Ph.D. and Kristen A. Thoreson, Ph.D. (Regenesis, San Clemente, CA, USA)

Background/Objectives. This paper explores combining the sorptive properties of colloidal activated carbon with the reductive properties of colloidal zero valent iron (ZVI) in order to remediate contaminated soil and groundwater. The combined approach allows the rapid removal of contaminants and provides long-term treatment with a single application of product. The activated carbon removes contaminants from aqueous solution by sorption and provides a matrix for biodegradation of contaminants. In this way, the activated carbon is regenerated, allowing contaminant turnover and control over back diffusion. ZVI provides a highly reducing groundwater environment and an additional pathway for the reductive dechlorination of PCE and other VOC to ethane and other dissolved phase hydrocarbons via an abiotic reductive pathway. The colloidal nature of the activated carbon and ZVI allows the materials to be co-applied at low pressure with uniform distribution in the subsurface to ensure contact with contaminants.

Approach/Activities. The sorption and degradation of PCE by activated carbon and ZVI was analyzed in batch and column laboratory studies. Colloidal activated carbon and colloidal ZVI were studied in combination under abiotic conditions, as well as in the presence of a chlorinated solvent degrading bacteria inoculum. To monitor both the sorption of PCE onto activated carbon as well as any degradation, the PCE and daughter product concentrations in the aqueous solution were monitored, and organic extractions were also performed in order to measure the total mass balance across all phases (water, soil, colloidal activated carbon). A separate sand column study was conducted to test the transport properties of these colloidal agents.

Results/ Lessons Learned. The laboratory studies demonstrated that the combination of colloidal activated carbon, ZVI, and contaminant degrading bacteria resulted in a synergistic performance. These studies suggested that PCE is sorbed to activated carbon within one day and, once sorbed, the PCE remains available to be degraded. As PCE is degraded, the activated carbon is regenerated, providing a mechanism for long-term treatment by controlling rebound due to back diffusion. PCE and daughter products can also be degraded by the ZVI in this system. Column studies demonstrated that the colloidal activated carbon and the colloidal ZVI are readily transported through sand. The co-application of colloidal activated carbon and ZVI does not show competition or diminished performance of either technology.