Micron-Size Zero-Valent Iron Emplacement in Porous Media Using Polymer Additives: Column and Flow Cell Experiments

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Abstract. At the Hanford Site, an extensive In Situ Redox Manipulation (ISRM) permeable reactive barrier was installed to prevent chromate from reaching the Columbia River. However, chromium has been detected in several wells, indicating a premature loss of the reductive capacity in the aquifer. Laboratory experiments have been conducted to investigate whether barrier reductive capacity can be enhanced by adding micron-scale zero-valent iron to the high-permeability zones within the aquifer using shear-thinning fluids containing polymers. Porous media were packed in a wedge-shaped flow cell to create either a heterogeneous layered system with a high-permeability zone between two low-permeability zones or a high-permeability channel surrounded by low-permeability materials. The injection flow rate, polymer type, polymer concentration, and injected pore volumes were determined based on preliminary short- and long-column experiments. The flow cell experiments indicated that iron concentration enhancements of at least 0.6% (w/w) could be obtained using moderate flow rates and injection of 30 pore volumes. The 0.6% amended Fe^0 concentration would provide approximately 20 times the average reductive capacity that is provided by the dithionite-reduced iron in the ISRM barrier. Calculations show that a 1-m-long Fe^0 amended zone with an average concentration of 0.6% w/w iron subject to a groundwater velocity of 1 m/day will have an estimated longevity of 7.2 years.

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