INVESTIGATION OF THE LONG-TERM PERFORMANCE OF ZEROVALENT IRON FOR REDUCTIVE DECHLORINATION OF TRICHLOROETHYLENE

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This research investigated the long-term performance of zerovalent iron for mediating the reductive dechlorination of trichloroethylene (TCE). Over a two year period, rates of TCE dechlorination in columns packed with iron filings were measured in simulated ground waters containing either 3 mM $CaSO_4$, 5 mM $CaCl_2$ or 5 mM $Ca(NO_3)_2$. At early elapsed times, TCE reaction rates were pseudo-first order in TCE concentration, and were independent of the solution pH. With increasing elapsed time, reaction rates deviated from pseudo-first order behavior due to reactive site saturation, and increased iron surface passivation towards the influent end of each column. The extent of passivation was dependent on both the TCE concentration and the background electrolyte solution. For most of the investigation, TCE reaction rates in 3 mM $CaSO_4$ and 5 mM $CaCl_2$ solutions were statistically identical at the 0.05 confidence level. However, TCE reaction rates in 5 mM $Ca(NO_3)_2$ were slower. In columns operated using chloride and sulfate containing waters, the effective half-life for TCE dechlorination increased from approximately 400 minutes after ten days elapsed, to approximately 2500 minutes after 667 days. The effective TCE half-life in the nitrate containing water increased from approximately 1500 minutes after ten days, to approximately 3500 minutes after 667 days. Measurements of iron corrosion rates in nitrate and chloride solutions showed that nitrate contributed to increased iron surface passivation and decreased rates of iron corrosion. Corrosion current measurements indicated that halocarbon reduction on fresh iron surfaces was cathodically controlled, whereas on aged iron surfaces, iron corrosion was anodically controlled. Anodic control of iron corrosion contributed to the development of reactive site saturation with time, and to similar reaction rates for TCE and perchloroethylene. Passivation of the iron surfaces was found to be dependent on the adhering tendency of the corrosion products, and not on the overall mass of corrosion products in the columns. The decrease in TCE reaction rates over time can be attributed to anodic control of iron corrosion, and not to increasing reactant mass transfer limitations associated with diffusion through porous corrosion products.