



The Reduction Kinetics of Hexavalent Chromium by soluble Fe(II) and Magnetite

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Hexavalent chromium (Cr(VI)) is one of the most common inorganic pollutants in natural and engineered environments. Its toxicity and mobility have triggered environmental scientists to carry out a number of studies for the effective remediation of groundwater and soil contaminated with Cr(VI). A well-known remedial tactic to solve Cr(VI) contamination problems in subsurface environments is to apply redox chemistry; i.e., the Cr(VI) in the subsurface can be reductively transformed by highly reductive materials (both natural and anthropogenic origin) to less mobile and less toxic Cr(III). In this study, we have investigated the kinetics and chemical stoichiometry for the homogeneous and heterogeneous Cr(VI) reductions by soluble Fe(II) and Fe(II)-bearing soil mineral (magnetite, Fe_3O_4) in batch systems. The estimated kinetic rate constants for the Cr(VI) reductions stay in the range of $2.81 - 49.90 \text{ hr}^{-1}$. The reactions followed the theoretical stoichiometry requiring three electron equivalents of Fe(II) for the reduction of Cr(VI) to Cr(III) in the homogeneous phase. We have examined the effects of mineral dosage, initial Cr(VI) concentration, and addition of soluble Fe(II) in this research. Batch studies showed that the kinetic rates for the reductions of Cr(VI) are significantly affected by the initial Cr(VI) concentration and the Fe(II) contents in homogeneous solution and heterogeneous suspension. Most reactions approached to an equilibrium condition of Cr(VI) in ten minutes under homogeneous and heterogeneous systems. The soluble Fe(II) in the homogeneous solution was more reactive than surface Fe(II) on magnetite in the heterogeneous suspension, when the Fe(II) content was same in each system. The sorption of Cr(VI) on magnetite and precipitation in homogeneous solution were investigated by measuring the concentrations of Cr(VI), Fe(II), and Fe(III) in the solids. A significant conversion of Fe(II) to Fe(III) was observed but no Cr(VI) was found in solids. This verifies

Cr(VI) was reductively transformed to Cr(III) coupled with the oxidations of Fe(II) to Fe(III) in both systems. The addition of soluble Fe(II) enhanced the reduction of Cr(VI) in magnetite suspensions. The results obtained from this research confirmed that Fe(II)-bearing soil mineral and soluble Fe(II) could significantly affect the fate of Cr(VI) in subsurface environments.