Removal of Simulated Chromium-Contaminated Wastewater Using Polyethylenimine-Modified Zero-Valent Iron Nanoparticles

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Abstract

In recent years, zero-valent iron nanoparticles (nZVI) have been considered the best candidate for the remediation of heavy metals such as chromium (Cr) in contaminated groundwater. Surface modification of nZVI has proven to enhance its stability and mobility in groundwater. In this work, the decontamination of a Cr-contaminant (Cr(VI)) through reductive reaction with polyethylenimine (PEI) coated nZVI (PEI–nZVI) was studied. Characterization was conducted using X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and X-ray absorption near edge structure (XANES). The XRD patterns indicated that the nZVI product after Cr- contaminated water treatment corresponds to Fe_3O_4. Interestingly, the XANES and XPS analyses revealed the reduction of toxic Cr(VI) to less toxic Cr(III) with concurrent oxidization of nZVI to form Fe_2O_3, Fe_3O_4, or FeO. A Cr(VI) removal efficiency of over 99.9% was observed within 10 min for the Cr concentration range 150-300 ppm. Cr(VI) was significantly adsorbed onto the surface of the nZVI nanoparticles; this could represent a cost-effective method for the *in-situ* remediation of Cr-contaminated water. Owing to its excellent performance for the removal of Cr(VI), the environmentally friendly PEI–nZVI core-shell nanoparticle represents an effective method for Cr(VI) decontamination.

Keywords – Zero-valent iron nanoparticle, Polyethyleneimine, Chromium-contaminated water, Decontamination, XANES/EXAFS.