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RESEARCH PAPER

Synthesis, characterization and role of zero-valent iron nanoparticle in removal of hexavalent chromium from chromium-spiked soil

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Abstract Chromium is an important industrial metal used in various products/processes. Remediation of Cr contaminated sites present both technological and economic challenges, as conventional methods are often too expensive and difficult to operate. In the present investigation, Zero-valent iron (Fe^0) nanoparticles were synthesized, characterized, and were tested for removal of Cr(VI) from the soil spiked with Cr(VI). Fe^0 nanoparticles were synthesized by the reduction of ferric chloride with sodium borohydride and were characterized by UV–Vis (Ultra violet–Visible) and FTIR (Fourier transform infrared) spectroscopy. The UV–Vis spectrum of Fe^0 nanoparticles suspended in 0.8% Carboxymethyl cellulose showed its absorption maxima at 235 nm. The presence of one band at 3,421 cm^{-1} ascribed to OH stretching vibration and the second at 1,641 cm^{-1} to OH bending vibration of surface-adsorbed water indicates the formation of ferrioxyhydroxide (FeOOH) layer on Fe^0 nanoparticles. The mean crystalline dimension of Fe^0 nanoparticles calculated by XRD (X-ray diffraction) using Scherer equation was 15.9 nm. Average size of Fe^0 nanoparticles calculated from TEM (Transmission electron microscopy) images was found around 26 nm. Dynamic Light Scattering (DLS) also showed approximately the same size. Batch experiments were performed using various concentration of Fe^0 nanoparticles for reduction of soil spiked with 100 mg kg^{-1} Cr(VI). The reduction potential of Fe^0 nanoparticles at a concentration of 0.27 g L^{-1} was found to be 100% in 3 h. Reaction kinetics revealed a pseudo-first order kinetics. Factors like pH, contact time, stabilizer, and humic acid facilitates the reduction of Cr(VI).

Keywords Zero-valent iron nanoparticle · Characterization · Remediation · Contaminants · Reaction kinetics · Humic acid · Environment · EHS

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Introduction

Chromium compounds are used in various industries (e.g., textile dying, tanneries, metallurgy, metal electroplating, electronic, and wood preserving); hence, large quantities of Cr have been discharged into the environment due to improper disposal and leakage (Kimbrough et al. 1999). Oxidation states of

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