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Removal of hexavalent chromium from contaminated ground water using zero-valent iron nanoparticles

Ritu Singh · Virendra Misra · Rana Pratap Singh

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Abstract Batch experiments were conducted on ground water samples collected from a site contaminated with Cr(VI) to evaluate the redox potential of zero-valent iron (Fe^0) nanoparticles for remediation of Cr(VI)-contaminated ground water. For this, various samples of contaminated ground water were allowed to react with various loadings of Fe^0 nanoparticles for a reaction period of 60 min. Data showed 100% reduction of Cr(VI) in all the contaminated ground water samples after treatment with 0.20 gL^{-1} of Fe^0 nanoparticles. An increase in the reduction of Cr(VI) from 45% to 100% was noticed with the increase in the loading of Fe^0 nanoparticles from 0.05 to 0.20 gL^{-1}. Reaction kinetics of Cr(VI) reduction showed pseudo first-order kinetics with rate constant in the range of 1.1×10^{-3} to 3.9×10^{-3} min^{-1}. This work demonstrates the potential utility of Fe^0 nanoparticles in treatment and remediation of Cr(VI)-contaminated water source.

Keywords Cr(VI) · Remediation · Reaction kinetics · Zero-valent iron (Fe^0) nanoparticle · Batch experiments

R. Singh · V. Misra (✉)
Ecotoxicology Division, Indian Institute of Toxicology Research (Council of Scientific and Industrial Research), Post Box 80, Mahatma Gandhi Marg, Lucknow 226 001, UP, India
e-mail: Virendra_misra2001@yahoo.co.in

R. Singh
e-mail: ritu2735@gmail.com

R. Singh · R. P. Singh
Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Rae Bareilly Road, Lucknow 226 025, UP, India

R. P. Singh
e-mail: ranapsingh1@hotmail.com

Introduction

Chromium (Cr) is a well-known heavy metal having wide range of application in metal plating, leather tanning, metal corrosion inhibition, pigment production, and wood-preserving industries. Cr exists in primarily two-valence states, i.e., trivalent Cr(III) and hexavalent Cr(VI). Cr(III), a micronutrient important in the biological activity of insulin, is relatively stable and has low solubility in aqueous solution (Puls et al. 1999). In contrast, Cr(VI) is highly toxic, soluble, and mobile in the aquatic systems (Cheryl and Susan 2000). Moreover, Cr(VI) has been classified as a potential carcinogen, mutagen, and teratogen and has acute toxicity for different biological systems. According to BIS (Bureau of Indian Standards) desirable limit for drinking water, the maximum acceptable limit for Cr (VI) in drinking water is 0.05 mgL^{-1}.

Several techniques for Cr(VI) removal such as ion exchange, filtration, electrochemical precipitation, activated carbon adsorption, bioremediation, etc., have been reported in literature. However, these conventional methods are relatively expensive and

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