Bull Environ Contam Toxicol (2012) 88:210–214
DOI 10.1007/s00128-011-0425-6

Removal of Cr(VI) by Nanoscale Zero-valent Iron (nZVI) From Soil Contaminated with Tannery Wastes

Ritu Singh · Virendra Misra · Rana Pratap Singh

Received: 21 July 2011 / Accepted: 4 October 2011 / Published online: 14 October 2011

Abstract The illegal disposal of tannery wastes at Rania, Kanpur has resulted in accumulation of hexavalent chromium [Cr(VI)], a toxic heavy metal in soil posing risk to human health and environment. 27 soil samples were collected at various depths from Rania for the assessment of Cr(VI) level in soil. Out of 27 samples, five samples had shown significant level of Cr(VI) with an average concentration of 15.84 mg Kg^{-1}. Varied doses of nanoscale zero-valent iron (nZVI) were applied on Cr(VI) containing soil samples for remediation of Cr(VI). Results showed that 0.10 g L^{-1} nZVI completely reduces Cr(VI) within 120 min following pseudo first order kinetics. Further, to test the efficacy of nZVI in field, soil windrow experiments were performed at the contaminated site. nZVI showed significant Cr(VI) reduction at field also, indicating it an effective tool for managing sites contaminated with Cr(VI).

Keywords Nanoscale zero-valent iron · Hexavalent chromium · Tannery waste · Windrows

R. Singh · V. Misra (✉)
Ecotoxicology Division, Indian Institute of Toxicology Research (Council of Scientific & Industrial Research), Post Box 80, Mahatma Gandhi Marg, Lucknow, UP 226 001, India
e-mail: virendra_misra2001@yahoo.co.in

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

Leather production is a major industry in India and is a major source of pollution also. Kanpur, the largest and the most industrialized city in the state of Uttar Pradesh, sits on the bank of the Ganges River, 126 m above the sea level. Today Kanpur is better known for its leather industry. One neighborhood area, Jajmau, in the south eastern part of the city, near the south bank of River Ganga, is home to more than 350 tanneries. These tanneries daily produces large amount of solid toxic wastes/sludge with serious environmental impact during leather processing (Tarcan et al. 2010). The lack of stringent laws and treatment facilities has led to tannery wastes/sludge being dumped on temporary sites at Rania leading to the contamination of soil and ground water. This area has been used as a dumping ground for more than a decade. Land based disposal practices were practiced under the assumption that the dominant species in the tannery waste would be the thermodynamically stable Cr(III) species. However, significant levels of toxic Cr(VI) in ground water and surface water reported in the different parts of the world have raised critical questions on this kind of disposal practices (Belay 2010).

Different types of treatment technologies such as phytoremediation, microbial remediation, chemical reduction, physical sorption (using ion exchange resin, activated carbon etc.), membrane filtration (ultrafiltration, nanofiltration, reverse osmosis), soil flushing, electrokinetic removal etc. have been reported for the removal of Cr(VI) (Owlad et al. 2009). Recently the application of zero-valent iron nanoparticles (nZVI) has received considerable attention in the area of environmental remediation. nZVI has emerged as a potential technology for the remediation of surface water, ground water and soil contaminated with a wide array of organic (Elliott et al. 2009) as well as inorganic contaminants (Franco et al.