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Nanoscale zero-valent iron application for the treatment of soil, wastewater and groundwater contaminated with heavy metals: a review

Motasem Y.D. Alazaiza[a,*], Ahmed Albahnasawi[b], Nadim K. Copty[c], Mohammed J.K. Bashir[d], Dia Eddin Nassani[e], Tahra Al Maskari[a], Salem S. Abu Amr[f], Mohammed Shadi S. Abujazar[f,g]

[a]*Department of Civil and Environmental Engineering, College of Engineering, A'Sharqiyah University, 400 Ibra, Oman, emails: my.azaiza@gmail.com (M.Y.D. Alazaiza), tahra.almaskari@asu.edu.om (T. Al Maskari)*
[b]*Department of Environmental Engineering-Water Center (SUMER), Gebze Technical University, 41400 Kocaeli, Turkey, email: ahmedalbahnasawi@gmail.com*
[c]*Institute of Environmental Sciences, Bogazici University, Bebek, Istanbul, Turkey, email: ncopty@boun.edu.tr*
[d]*Department of Environmental Engineering, Faculty of Engineering and Green Technology (FEGT), Universiti Tunku Abdul Rahman, 31900 Kampar, Perak, Malaysia, email: jkbashir@utar.edu.my*
[e]*Department of Civil Engineering, Hasan Kalyoncu University, 27500 Gaziantep, Turkey, email: diaeddin.nassani@hku.edu.tr*
[f]*Faculty of Engineering, Karabuk University, Demir Campus, 78050 Karabuk, Turkey, email: sabuamr@hotmail.com*
[g]*Al-aqsa Community Intermediate college, Al-aqsa University, Gaza P.B.4051 – Palestinian Authority, email: mohammedshadi@hotmail.com*

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ABSTRACT

Nanoscale zero-valent iron (nZVI) has been extensively investigated for the remediation of soil, wastewater, and groundwater contaminated with heavy metals. This paper presents a collective review of nZVI synthesis, nZVI interaction mechanisms with heavy metals, factors affecting nZVI reactivity, recent applications of nZVI for heavy metals removal, and the environmental concerns of nZVI application for soil microorganisms and plants. Modified nZVI, spatially biochar supported nZVI (BC@nZVI) and sulfidation nanoscale zero-valent iron (S-nZVI) showed high heavy metals removal efficiency and more stable performance compared to nZVI alone. The removal of heavy metals by nZVI is as a synergistic process where adsorption, oxidation/reduction and precipitation occur simultaneously or in series. pH and organic matter are the main factors that significantly affect nZVI reactivity. Toxic effects of nZVI are observed for the soil microorganisms as the direct contact may cause a decrease in cell viability and membrane damage. A low concentration of nZVI promotes the growth of plant whereas high concentration decreases root length. It is observed that, further research is needed to enhance nZVI recovery techniques, evaluate the effectiveness of novel modified nZVI and their effects on the environment, and the full-scale application of nZVI.

Keywords: Nanoscale zero-valent iron; Heavy metals; Groundwater; Wastewater

* Corresponding author.

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