Detoxification of Cr(VI) using biochar-supported Cu/Fe bimetallic nanoparticles

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Abstract

Nanoscale zero-valent iron (nZVI) has been proven to be more effective for the treatment of hexavalent chromium (Cr(VI)) when modified with the transition metal Cu. In this study, biochar-supported Cu/Fe bimetallic nanoparticles (Cu-nZVI/BC) were prepared and used for Cr(VI) removal from aqueous solution. The effects of the pH value, the initial concentration of Cr(VI), coexisting ions and humic acids (HA) were investigated. The compositional structures of Cu-nZVI/BC were analyzed by transmission electron microscopy, scanning electron microscopy, X-ray diffraction and X-ray photoelectron spectroscopy. The maximum removal efficiency of Cr(VI) was 50.57% (126.41 ± 3.75 mg g⁻¹) for Cu-nZVI/BC at pH 2. The adsorption kinetic data were in agreement with the pseudo-second-order model, which confirmed that the adsorption step was a chemical adsorption and reduction process. The presence of Ca²⁺ and NO₃⁻ had an inhibitory effect on Cr(VI) removal, while dHA increased the removal efficiency at high concentrations. This study proves that Cu-nZVI/BC removal of solution Cr(VI) is feasible and shows significant potential in practical applications.

Keywords: Nanoscale zero-valent iron; Bimetallic; Biochar; Chromium; Heavy metal