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Use of nano zero-valent iron coated coffee grounds for removal of Zn(II) and Ni(II) from aqueous solutions

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ABSTRACT

This research investigates the adsorption capacity of a novel composite material, namely nano zero-valent iron coated coffee grounds (nZVI-CG), for removal of zinc (Zn) and nickel (Ni). nZVI particles were synthesized and immobilized to the surface of waste coffee grounds (CG) using the ultrasonic-assisted liquid phase method. Characterization of synthesized nZVI-CG composite and bare CG showed that nZVI coating has increased the surface area significantly. Batch tests were conducted to examine the effects of pH, reaction time and initial metal concentrations on Zn^{2+} and Ni^{2+} removal. At an initial metal concentration of 10 mg-Ni/L and 10 mg-Zn/L, nZVI-CG removal rates for Zn^{2+} and Ni^{2+} were observed as 98.89% and 97.29%, respectively; while removal rates of bare CG have remained at 51% (Zn^{2+}) and 48.1% (Ni^{2+}). Moreover, acidic conditions were observed to deteriorate Ni^{2+} and Zn^{2+} adsorption since most functional groups of the metals were protonated. Increasing initial nickel and zinc concentrations decreased removal rates. While the model fittings improved with increasing pH, in the case of nZVI-CG, Langmuir isotherm gave the best fits for Ni^{2+} and Zn^{2+} at pH 5 and 7. Also, our experimental results followed the pseudo-second-order kinetic model, regardless of the used adsorbent. Consequently, our results showed that nZVI-CG composite material is a promising alternative adsorbent for pilot scale metal removal/recovery applications.

Keywords: Adsorption; Nano zero-valent iron; Coffee grounds; Zn(II); Ni(II)

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