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Preparation and characterization of kaolin coated with Fe_3O_4 nanoparticles for the removal of hexavalent chromium: kinetic, equilibrium and thermodynamic studies

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ABSTRACT

In this study, removal of Cr(VI) by kaolin-Fe_3O_4 nanoparticles was investigated with variation of pH, adsorbent dosage, initial Cr(VI) concentration, ionic strength and temperature. Kaolin nanoparticles were synthesized by co-precipitation method. Maximum adsorption was observed at pH 3. The removal efficiency of Cr(VI) was increased with increasing adsorbent dosage, but was decreased with increasing initial Cr(VI) concentration and temperature. The removal efficiency of Cr(VI) was decreased in the presence of sulfate, chloride and bicarbonate ions while it was increased in the presence of carbonate ion. Studies of kinetic models and adsorption equilibrium revealed that the adsorption of Cr(VI) onto kaolin-Fe_3O_4 nanoparticles followed pseudo-second-order kinetic model and Freundlich isotherm. Maximum adsorption capacity was estimated to be 76.62 mg/g. Thermodynamic studies indicated that the adsorption of Cr(VI) onto kaolin-Fe_3O_4 nanoparticles was an exothermic (ΔH = –99.35 kJ/mol) process. Adsorption activity of Cr(VI) by kaolin-Fe_3O_4 nanoparticles was decreased (10%–30%) after 10 successive cycles.

Keywords: Kaolin-Fe_3O_4; Kinetic and isotherm models; Thermodynamics; Adsorption; Cr(VI)

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