

Rapid and high capacity adsorption of heavy metals by Fe₃O₄/montmorillonite nanocomposite using response surface methodology: preparation, characterization, optimization, equilibrium isotherms, and adsorption kinetics study

ABSTRACT

Fe₃O₄/montmorillonite nanocomposite (Fe₃O₄/MMT NC) was synthesized for removal of Pb²⁺, Cu²⁺ and Ni²⁺ ions from aqueous systems. The nanoadsorbent was characterized by X-ray diffraction and transmission electron microscopy and mean diameter of magnetic nanoparticles was about 8.24 nm. The experiments were designed by response surface methodology and quadratic model was used to prediction of the variables. The adsorption parameters of adsorbent dosage, removal time, and initial heavy metal ions concentration were used as the independent variables and their effects were investigated on the heavy metal ions removal. Variance analysis was utilized to judge the adequacy of the chosen models. Optimum conditions with initial heavy metal ions concentration of 510.16, 182.94, and 111.90 mg/L, 120 s of removal time and 0.06 g/0.025 L, 0.08 g/0.025 L, and 0.08 g/0.025 L of adsorbent amount were given 89.72%, 94.89%, and 76.15% of removal efficiency Pb²⁺, Cu²⁺ and Ni²⁺ ions, respectively. Prediction of models was in good agreement with experimental results and Fe₃O₄/MMT NC was found successful in removing heavy metals from their aqueous solutions.

Keyword: Heavy metals; Fe₃O₄/montmorillonite nanocomposites; Adsorption; Response surface methodology; Adsorption kinetics