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Removal of heavy metal ions from aqueous solution by anionic polyacrylamide-based monolith: equilibrium, kinetic and thermodynamic studies

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ABSTRACT

In the present study, a macroporous polyacrylamide-based monolith bearing negatively charged sulfonic acid groups was synthesized as a new adsorbent for the removal of heavy metals ions (Pb^{2+}, Cd^{2+}, and Cr^{3+}) from aqueous solutions. Vinylsulfonic acid was selected as an anionic monomer to introduce a negative charge on the surface of the resulting monolith that forms a complex with investigated metal ions. The influences of solution pH, contact time, monolith dosage, initial concentration, and temperature on Pb^{2+}, Cd^{2+}, and Cr^{3+} removal were determined using the batch equilibrium technique. Adsorption data were modeled with Langmuir, Freundlich, and Dubinin–Raduskevich isotherm models. The experimental equilibrium data for Pb^{2+}, Cd^{2+}, and Cr^{3+} using the synthesized monolith showed a good correlation with the Langmuir isotherm model. Based on the Langmuir model, the maximum monolayer adsorption capacities of the monolith were 22.8 mg g^{-1} for Cd^{2+}, 33.3 mg g^{-1} for Pb^{2+}, and 66.7 mg g^{-1} for Cr^{3+} at 25°C. Kinetic studies revealed that the adsorption of the metal ions onto the monolith followed pseudo-second-order kinetics. The negative and positive values of free energy ($\Delta G°$) and enthalpy ($\Delta H°$) revealed that the adsorption of the metal ions onto the monolith was spontaneous and endothermic, respectively.

Keywords: Heavy metals removal; Polyacrylamide monolith; Adsorption; Isotherms; Kinetics; Metal; Thermodynamics

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