



Verification of double-shell model for sorption of cesium, cobalt, and europium ions on poly-acrylonitrile-based Ce(IV) phosphate from aqueous solutions

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ABSTRACT

Kinetic and equilibrium models were navigated for sorption of Cs⁺, Co²⁺, and Eu³⁺ ions from their aqueous solutions by poly-acrylonitrile-based Ce(IV) phosphate. Pseudo-first order, pseudo-second order, intra-particle diffusion, and Boyed rate expressions were used to determine the suitable sorption pathway, in addition to their verification using the double-shell theory. Such expressions initially revealed that the sorption process is governed by the pseudo-second-order and particle diffusion protocols; DSM finally confirmed that chemical reaction and/or film diffusion control could be discarded as controlling steps. Langmuir and Freundlich isotherm models were applied and separately compared. Thermodynamic parameters were determined. Positive values of enthalpy change, ΔH (27.5, 28.2, and 29.1 kJ/mol), for Cs⁺, Co²⁺, and Eu³⁺ ions confirmed the endothermic nature of the sorption process and suggested that chemisorption was the predominant mechanism. The high positive values of the entropy change, ΔS (142.77, 123.10, and 118.19 J/mol/K) for the mentioned cations, showed an increased randomness at the solid/solution interface. The obtained negative values of free energy change, ΔG (–8.4 to –12.28, –4.88 to –7.951, and –3.743 to –6.757 kJ/mol), for the aforementioned species indicated the feasibility and the spontaneous nature of the sorption at different reaction temperatures.

Keywords: Ion exchange; Acrylonitrile; Cerium(IV) phosphate; Cesium; Cobalt and europium

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