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# Hyper-branched phosphonated polyethyleneimine composite for the removal of samarium(III) ions from aqueous solutions: effect of process parameters

Wissam Amina Miloudi, Khalil Oukebdane*, Omar Abderrahim

*Laboratory of Separation and Purification Technologies, Department of Chemistry, Faculty of Sciences, Tlemcen University, Box 119, Tlemcen, Algeria, emails: oukebdane.khalil@yahoo.fr (K. Oukebdane) ORCID-0000-0002-8537-4129, miloudiwissam13@gmail.com (W.A. Miloudi) ORCID-0000-0001-7821-201X, abderrahimomar@yahoo.fr (O. Abderrahim) ORCID-0000-0001-8298-950X*

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**ABSTRACT**

Recovering rare-earth elements from hydro-ecosystems, particularly from water, is currently a critical priority. In this study, a synthesized extractant called phosphonated polyethyleneimine (PPEI) was characterized and used in the sorption of samarium ions Sm(III). The batch process allowed for the study of various parameters, including contact time, pH, temperature, and concentration of solutions, on the sorption of samarium by PPEI. The extraction efficiency of samarium ions exceeded 87% at an equilibrium time of 40 min and a maximum pH of 4.1. The sorption kinetics of Sm(III) were found to be in accordance with the pseudo-second-order model, and the sorption isotherms were modeled using different models, including Langmuir, Freundlich, Temkin, and Dubinin–Radushkevich. The most suitable model was found to be Langmuir, which predicts an adsorption capacity of 20.96 mg/g. The values of $\Delta H°$, $\Delta S°$, and $\Delta G°$ were calculated from the sorption data as a function of temperature, and the results indicated that the sorption of Sm(III) on PPEI was endothermic and spontaneous. A desorption study showed that the best eluent was sulfuric acid, with an elution efficiency of 97%. Finally, a regeneration study was performed to evaluate the potential for reuse of the PPEI composite for other applications. Overall, the results suggest that PPEI is a promising extractant for wastewater treatment.

*Keywords:* Hyper-branched material; Phosphonated polyethyleneimine; Radionuclides; Samarium; Sorption

* Corresponding author.

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