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Elucidation of the removal of trivalent and divalent heavy metal ions from aqueous solutions using hybrid-porous composite ion-exchangers by nonlinear regression

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ABSTRACT

The removal of trivalent and divalent heavy metal ions from aqueous solutions by the ion-exchange process was investigated via a theoretical study using two- and three-parameter isotherm models. Fe^{3+} and Ni^{2+} ions were chosen as models of trivalent and divalent heavy metal ions in this study. A hybrid zeolite/carbon composite was used to remove these ions from aqueous solutions in a batch test to provide the required data for the theoretical study. This work studied the effect of shaking time (0–24 h), pH solution (2–10), and initial ions concentration (50–500 ppm). The experimental data of ion-exchange of both metal ions were studied using the two-parameter isotherm models including Langmuir isotherm, Freundlich isotherm, and Temkin isotherm. Also, the experimental data of ion-exchange were studied using the three-parameter isotherm models including Hill isotherm, Khan isotherm, Redlich–Peterson isotherm, Radke–Prausnitz isotherm, Sips isotherm, Toth isotherm, Koble–Corrigan isotherm and Liu isotherm. The experimental data of ion-exchange of Fe^{3+} ions best fitted the Temkin isotherm. Also, they followed the three-parameter isotherm models comparably due to the correlation factor for all studied models ranging from 0.923–0.924 despite the values of some model parameters were away from reality. But, Koble–Corrigan isotherm was not applicable for Fe^{3+} ion-exchange. While the experimental data of ion-exchange of Ni^{2+} ions best fitted the Langmuir isotherm with R^2 = 0.930. Also, they fitted the three-parameter isotherm models indistinguishably despite some model parameters diverted away from reality. For both metal ions, the determined values of exponent of the Toth isotherm confirmed the system heterogeneity.

Keywords: Hybrid-porous composites; Zeolite; Heavy metals; Ion-exchange; Isotherm models

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