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Adsorption of Pb(II), Cu(II) and Ni(II) ions on functionalized carbon nanotube-C60 hybrid: adsorption process, isotherm, thermodynamic and kinetic studies

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ABSTRACT

In this study, the functionalized carbon nanotube-C60 hybrid was tested for the adsorption of the heavy metals. The results of this study showed that the hybrid is suitable to remove heavy metal ions such as copper, nickel and lead from aqueous solutions. The experiment was conducted at varying contact time, adsorbent dose, adsorbate concentration and pH, from 30 to 180 min, 0.04 to 0.1 g, 10–50 mg L^{-1} and 2–8, respectively. Most of the significant changes are observed at 30 min of contact time, 0.06 g of the adsorbent and 20 mg L^{-1} of the adsorbate concentration. Maximum percentage removal was obtained for Pb, Cu and Ni ions at pH of 5 with the lowest amount of the precipitate (≈94%, 90.65% and 2.4%) and at pH of 7 with the highest amount of the precipitate (≈99.96%, 99.88% and 99.50%), respectively. Four kinetic and isotherm models are used for predicting the kinetics and mechanisms of adsorption by calculating the correlation coefficient and their parameters. The results showed that the best mechanisms of adsorption model and correlation coefficient (R^2) of metals follow for Pb (D-R, 0.999 and Langmuir, 0.966), Cu (D-R, 0.965) and Ni (Freundlich, 0.961 and Temkin, 0.965). At pH 7 for each of the three metals, ΔG is negative (reaction spontaneous) and at pH 5, reaction is spontaneous for lead and copper, and non-spontaneous for nickel. At pH 5–7, ΔHs are negative, thus the reactions are exothermic. The best kinetic models and correlation coefficient (R^2) that seem to explain better the experimental data are for lead, copper and nickel are pseudo-second-order, 0.999; pseudo-second-order, 0.999 and pseudo-first-order, 0.981, respectively.

Keywords: Functionalized nanotube-C60 hybrid; Percentage removal; Kinetic models; Adsorption isotherm; Isotherm models; Heavy metal

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