Kinetic and thermodynamic aspects of the adsorption of Pb\textsuperscript{2+} and Cd\textsuperscript{2+} ions on tripolyphosphate-modified kaolinite clay

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Abstract

Kaolinite clay obtained from Ubulu-Ukwu, Delta state in Nigeria was modified with tripolyphosphate reagent to obtain TPP-modified Kaolinite clay. The kinetics and thermodynamics of the adsorption of Pb\textsuperscript{2+} and Cd\textsuperscript{2+} by TPP-Kaolinite clay were studied. Increasing temperature and initial metal ion concentration increased the sorption capacity of the adsorbent. The rates of adsorption of both Pb\textsuperscript{2+} and Cd\textsuperscript{2+} increased with increasing temperature but decreased with increasing initial metal ion concentration and time. The pseudo-second-order initial sorption rates for the sorption of Pb\textsuperscript{2+} were found to be higher than those of Cd\textsuperscript{2+}. Pseudo-first-order model was found to only describe well, the data obtained in the first 8 min of the adsorption process. The sorption of both metal ions was endothermic and spontaneous with \(\Delta H^\circ\) values of +13.94 kJ mol\(^{-1}\) and +24.93 kJ mol\(^{-1}\) for Pb\textsuperscript{2+} and Cd\textsuperscript{2+}, respectively. Activation energy values obtained were between +8 kJ mol\(^{-1}\) and +22 kJ mol\(^{-1}\). These values suggest that the rate-controlling step in the adsorption of Pb\textsuperscript{2+} and Cd\textsuperscript{2+} by TPP-Kaolinite clay was diffusion-controlled. The sorption of metal ions from binary solutions of both metal ions at different initial metal ion concentrations reduced the initial sorption rates of the adsorption of Pb\textsuperscript{2+} by TPP-Kaolinite clay and increased that for Cd\textsuperscript{2+}. The adsorption capacity of TPP-Kaolinite clay for both metal ions was also decreased by simultaneous presence of both metal ions.