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Adsorption of C.I. Reactive Red 2 by ZnAl-layered double hydroxides: kinetics, equilibrium, and thermodynamics

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ABSTRACT

In this investigation, the co-precipitation method is utilized to form ZnAl-layered double hydroxides (LDHs). Samples with Zn/Al ratios of 1, 2, and 3 are denoted as ZnAl1, ZnAl2, and ZnAl3, respectively, and were used as adsorbents to decolorize C.I. Reactive Red 2 (RR2). The surface characteristics of ZnAl-LDHs were measured by X-ray diffraction, specific surface area analysis, and scanning electron microscopy. The effects of RR2 concentration, ZnAl3 dose, and pH on RR2 adsorption were elucidated. Kinetic analyses were performed using pseudo-first-order and pseudo-second-order, and the intra-particle diffusion models. Equilibrium results were plotted using Langmuir, Freundlich, and Temkin isotherms. The particle size, specific surface area, pore volume, and pore width of ZnAl3 were 17 nm, 29.5 m^2/g, 0.23 cm^3/g, and 31 nm, respectively. The regression results revealed that the adsorption kinetics were more accurately represented by a pseudo-second-order model, and the equilibrium results were most accurately fitted using the Temkin isotherm. The maximum RR2 adsorption capacity of ZnAl3 was 66.7 mg/g. RR2 removal proceeded via physisorption, and the process parameters, enthalpy ($\Delta H°$) and entropy ($\Delta S°$), for ZnAl3 were determined to be –5.26 kJ/mol and 102 J/mol/K, respectively.

Keywords: Adsorption; Layered double hydroxides; Isotherm; Kinetics; Thermodynamics

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