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Equilibrium, kinetic, and thermodynamic studies of lead ion adsorption from mine wastewater onto MoS2-clinoptilolite composite

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Abstract

This work explored the potential of clinoptilolite, molybdenum sulphide (MoS2), and MoS2-clinoptilolite composite in lead (Pb) removal from aqueous medium and industrial mining wastewater. MoS2-clinoptilolite composite was successfully prepared by a hydrothermal method. The surface properties, structure, and composition of the synthesized composite and the parent compounds were analyzed by scanning electron microscopy, X-ray diffraction, energy-dispersive X-ray spectroscopy, and Fourier transform infrared spectroscopy. The removal efficiency of lead from aqueous solution was studied in batch-mode experiments. The MoS2-clinoptilolite was used for the removal of Pb ions (50 mg/L) from an aqueous solution: ~100% of the Pb was removed with a MoS2-clinoptilolite dose of 0.075 g, pH 6 at 328K within 90 min. The adsorption capacities of Pb onto MoS2-clinoptilolite were found to be higher than those onto clinoptilolite. Metal ion adsorption behavior was well explained by the Freundlich model, that is, multilayer adsorption of Pb molecules occurred on the heterogeneous surface of adsorbents in case of clinoptilolite, while in the case of MoS2-clinoptilolite, the Langmuir model was suitable, that is, the adsorption occurred on a monolayer surface. The rate of Pb adsorption was explained by pseudo-second-order model suggesting that the adsorption process is presumably chemisorption. Thermodynamic parameters such as ΔH°, ΔS°, and ΔG° were calculated, which indicated that the adsorption was spontaneous and exothermic in nature. The selectivity of each adsorbent for Pb was also tested by adding the adsorbents to real gold mine water which contains competitive metal ions.