Application of pyrophyllite mine waste for the removal of cadmium and lead ions from aqueous solutions

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ABSTRACT

The application of pyrophyllite mine waste as a low-cost adsorbent for the removal of cadmium and lead ions from aqueous solution has been investigated. Silica and alumina are found to be the two major constituents of pyrophyllite waste. Experimental conditions in terms of shaking time, pH, amount of adsorbent, metal ion concentration, and temperature have been optimized for the maximum uptake of cadmium and lead ions. It has been observed that 75% of cadmium and 98% of lead ions could be removed at acidic pH within 30 min of equilibrium time. The experimental data are analyzed by the Freundlich and Langmuir isotherm models. The thermodynamic parameters such as $\Delta G^\circ$, $\Delta H^\circ$, and $\Delta S^\circ$ indicate the effectiveness of pyrophyllite waste to remove cadmium and lead ions from aqueous solution. The positive value of $\Delta H^\circ$ indicates that the adsorption process is endothermic in nature. The kinetics of adsorption is best fitted by a pseudo-second-order equation. The Fourier transform infrared, field emission scanning electron microscope, and X-ray photoelectron spectroscopy studies have been conducted to confirm the adsorption of cadmium and lead ions on pyrophyllite waste.

Keywords: Adsorption; Pyrophyllite waste; FTIR; FESEM; XPS; Cadmium; Lead; Freundlich isotherm; Thermodynamic parameter; Kinetics

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