

Kinetics and thermodynamics of fluoride removal using cerium-impregnated chitosan

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ABSTRACT

The kinetics and thermodynamics of fluoride adsorption on cerium-impregnated chitosan (CIC) have been studied by the sets of experiments at various conditions (initial fluoride concentration, adsorption time and temperature). The characteristic of the adsorbent before and after fluoride adsorption was examined using Fourier transform infrared spectroscopy (FTIR), scanning electron microscope (SEM) and energy dispersive spectrum (EDS) techniques. Adsorption of fluoride was strongly affected by pH. Pseudo-second order kinetic model best described the reaction rate, and the adsorption capacity calculated by using model equation, was consistent with the actual measurement. Isotherms for the adsorption of fluoride on CIC were developed and the equilibrium data fitted well to the Freundlich, Langmuir, Temkin and Dubinin-Radushkevich (D-R) isotherm. The adsorption isotherms were compared for six different error functions, i.e., the sum of the squares of errors (SSE), sum of the absolute errors (SAE), the average relative error (ARE), the hybrid fractional error function (HYBRID), the Marquardt's percent standard deviation (MPSD), and regression coefficient (R²) to test the adequacy and accuracy of the model equations. Thermodynamic parameters such as enthalpy, entropy and free energy were calculated using Van't Hoff equations. The thermodynamics of fluoride adsorption on CIC indicates the spontaneous and endothermic nature of adsorption. Reusability of the CIC adsorbent material was tested up to nine consecutive cycles. Quantitative desorption of fluoride from CIC was found to be more than 93% at pH 12. The performance of the adsorbent material was studied with field water samples collected from a fluorosis endemic-region.

Keywords: Chitosan; Fluoride; Isotherms; Error-functions; Thermodynamics

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