Nanocomposite adsorbent based on β-cyclodextrin-PVP-clay for the removal of naproxen from aqueous solution: fixed-bed column and modeling studies

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ABSTRACT

The study of dynamics in the fixed bed column was performed using nanocomposites fabricated based on cloisite 15A, PVP and β-cyclodextrin (CD@Clay-PVP) as an adsorbent for removal of naproxen from aqueous solutions. Chemically modified nano-clay was characterized by using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and X-ray diffraction (XRD). The effect of different parameters of the column as well as flow rate, influent naproxen concentration and bed height were investigated to determine the adsorption characteristics by this adsorbent. Three mathematical models (bed depth service time (BDST), Thomas, Yoon–Nelson and Clark) were applied for experimental data in order to predict the breakthrough curve and determine the optimal parameters of the bed. Thomas model showed that the value of maximum solid-phase concentration decreased when the flow rate and the bed height increased but increased with increasing initial naproxen concentration. The BDST model showed that the rate constant decreased when both the bed heights and the initial concentration increased, but increased with the increase in flow rate. The value of Thomas kinetic rate constant increased with higher flow rate but decreased with increasing initial concentration and the height of the bed. The rate constant Yoon–Nelson model (K YN ) increased with both increasing flow rate and initial concentration but decreased with increasing bed height. Also, Clark model (R 2 = 0.9646 to 0.997) is good predicts for the breakthrough curve of naproxen adsorption process, meanwhile, the behavior of this system was simulated as a Freundlich adsorption. The value of the volumetric sorption capacity of the bed increased with increasing flow rate, initial concentration and bed height. The characteristic parameters of the relevant models for the process of designing columns were obtained using their linear and nonlinear regressions. The analysis of the error of experimental and calculated data demonstrated that all models were similar for describing the adsorption process across all adsorption conditions within the analyzed range.

Keywords: Fixed bed column; Naproxen; Adsorption; Error analysis; Breakthrough modeling

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