Chitosan–clay composite as highly effective and low-cost adsorbent for batch and fixed-bed adsorption of methylene blue

Abstract

Modified Ball clay (MBC) and chitosan composite (MBC–CH) was prepared and its application for methylene blue (MB) adsorption from aqueous solution in an industrial prototype fixed-bed column adsorption was investigated. Morphological structure and functional groups of the MBC–CH were determined by scanning electron spectroscopy and Fourier transform infrared spectroscopy analysis, respectively. Batch adsorption studies revealed that MB adsorption on MBC–CH increased with increase in initial concentration and solution pH 4–12. Study on effect of some inorganic salts on MB adsorption revealed that sodium sulphate anions ðSO2 4Þ had greater inhibition effect than those of sodium chloride and sodium bicarbonate on both MBC and MBC–CH. The effects of initial concentration (30–300 mg/L), adsorbent bed height (2.5–4.5 cm) and influent flow rate (5–10 mL/min) on fixed-bed column adsorption breakthrough curves were evaluated. Column sorption capacities were 70 mg/g for MBC and 142 mg/g for MBC–CH. Dynamic modeling analysis revealed that Bohart–Adams model can best be used to predict  
the effluent breakthrough curves for successful design of MB adsorption than Yoon–Nelson model. Adsorption system failure studies showed that the adsorbents were resilient with some improvement observed at time of exhaustion and increased volume of effluent treated. The MBC–CH had above 50% adsorption uptake capacity after five regeneration cycles, this was higher than MBC. Adsorption of MB on MBC–CH was spontaneous, endothermic and had great affinity between the adsorbate and adsorbent. The findings of this study revealed that MBC–CH is a potential adsorbent for cationic dye pollution remediation.