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Preparation of a sludge-based adsorbent and adsorption of dimethyl phthalate from aqueous solution

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ABSTRACT

In this paper, a sludge-based adsorbent (SBA) was prepared from biochemical sludge from a wastewater treatment plant by chemical activation using 3.0 M $ZnCl_2$ followed by pyrolysis at 700°C for 1 h in an anoxic atmosphere. The physical and chemical properties of the SBA were characterized by N_2 adsorption, scanning electron microscopy (SEM), Fourier Transform infrared red (FT-IR) spectroscopy, X-ray diffraction (XRD), and Boehm titrations. The adsorption behavior of dimethyl phthalate (DMP) on the SBA was studied in batch reactors by investigating a range of variables including pH, DMP concentration, and adsorption time. The optimal pH for DMP adsorption was found out to be around 6, as this gave the best surface charge interactions. Adsorption equilibrium isotherms and the kinetics models of DMP adsorption on the SBA were also investigated. Experimental data indicated that the Freundlich model was most applicable to the adsorption process to show the SBA's heterogeneous surface supporting sites of varied affinities with DMP. In addition, the adsorption kinetics of DMP on SBA was described by the pseudo-second-order kinetic model suggesting that the chemical adsorption was the predominant rate-limiting stage of the adsorption process. It was demonstrated that the SBA is a low-cost promising and highly effective product for removal of DMP from aqueous solutions. The effectiveness of the SBA can be explained in terms of the π-electron interactions, electrostatic interactions, and H-bonding interactions contributing its high adsorption capacity.

Keywords: Sludge-based adsorbent; Adsorption; Dimethyl phthalate; Kinetics; Equilibrium isotherm

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