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Studies of Cr(VI) adsorption on novel jute cellulose-kaolinite clay biocomposite

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ABSTRACT

In this article, we have described the adsorption behavior of a biocomposite adsorbent prepared from crystalline cellulose of jute and kaolinite clay (locally available as Bijoypur clay). Despite lacking structural advantages such as smectite type montmorillonite clay used in other composites, this cellulose-clay composite showed good adsorption capacity. Cellulose was extracted from jute fiber and clay was modified with a surfactant named dodecylamine to prepare the biocomposite adsorbent. Effect of pH and contact time was investigated to figure out chromium adsorption capacity of the adsorbent. Maximum adsorption capacity was obtained at pH 4. The concentration of chromium in the test solution was determined by UV-spectrophotometer. The morphology of the composite was investigated using scanning electron microscope. Differential scanning calorimetry and thermogravimetric analysis of composite were carried out to investigate thermal behavior of the composite. The composite was characterized before and after adsorption experiment using Fourier-transform infrared spectroscopy and X-ray diffraction to validate the interaction of adsorbate chromium with adsorbent. Adsorption data of chromium by the adsorbent was analyzed according to Freundlich, Langmuir, Dubinin–Radushkevich, and Temkin adsorption models. Maximum adsorption capacity calculated from Langmuir isotherm model was 11.76 mg g^{-1} which was closer to results obtained experimentally. Pseudo-first-order, pseudo-second-order, and intraparticle diffusion kinetic models were proposed to understand the mechanism controlling the adsorption process. Moreover, this biocomposite was easily regenerated in sodium hydroxide solution and a maximum chromium desorption of 81.9% was achieved, which enabled the scope of reusability. Finally, a mechanism was proposed with illustration to show the adsorption potential of the composite.

Keywords: Biocomposite; Kaolinite; Crystalline cellulose; Chromium; Clay

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