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Modeling of adsorption isotherms of (5,5′-disodium indigo sulfonate) from aqueous solution onto activated carbon: equilibrium, thermodynamic studies, and error analysis

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ABSTRACT

The activated carbon (AC) and its ability to remove dyes (5,5′-disodium indigo sulfonate, Indigotine I, blue CI *n*°1, Indigo carmine, IC) used in textiles and biology from aqueous solution are investigated. The kinetic and equilibrium parameters of quantitative adsorption for IC removed by AC were studied by UV-visible absorption spectroscopy. The present work deals with the adsorption of IC dyes on AC, and the effects of parameters affecting the adsorption capacity were determined to find the optimal conditions for determining the maximum amount of adsorption. The physicochemical characteristics of the AC were characterized by BET method and point of zero charge. The adsorption mechanism of IC onto AC was studied; the adsorption kinetics was found to follow a pseudo-second-order kinetic model. The equilibrium adsorption data for IC on AC were analyzed by several models. The smaller root mean square error values for the Langmuir and Dubinin-Radushkevich models indicate the best fitting; the monolayer adsorption capacity of IC was found to be 79.49 mg/g at 25°C and 298.34 mg/g at 40°C at pH 2. The adsorption isotherms at different temperatures have been used to obtain thermodynamic parameters: the free energy ($\Delta G°$ = –0.071 to –1.050 kJ/mol), enthalpy ($\Delta H°$ = 28.11 kJ/mol), and entropy ($\Delta S°$ = 0.093 kJ/mol K) of adsorption with an activation energy E_a of 51.06 kJ/mol. The negative $\Delta G°$ and positive $\Delta H°$ values indicate that the overall adsorption is spontaneous and endothermic. This study in tiny batch gave rise to encouraging result, and we wish to achieve the adsorption tests in column mode under the conditions applicable to the treatment of industrial effluents, and the present investigation showed that AC is a potentially useful adsorbent for the dyes.

Keywords: Indigotine; Removal; Kinetics; Equilibrium; Thermodynamics; Modeling; Isotherm; Mechanism

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