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Kinetic, isotherm and thermodynamic studies of the adsorption of methylene blue dye onto agro-based cellulosic materials

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ABSTRACT

The purpose of this work is to establish the optimal experimental conditions for the removal of methylene blue (MB-as model basic dye) from aqueous solution by adsorption onto four agro-based materials, namely, cedar sawdust, pine sawdust, wheat straw, and Provence cane *Arundo donax*. Results show that an increase in acidity or ionic strength of the medium has generally a negative effect on the discoloration yield. From the data of pH effect, there is no need to change the initial pH of the MB solution to be treated. Equilibrium was reached after 20–30 min of agitation when cedar sawdust, pine sawdust, and Provence cane are used as adsorbents. However, in the case of wheat straw, an agitation for 40 min is required. The pseudo-second-order model was found as the best to explain the adsorption kinetics effectively. The adsorption may be controlled by external mass transfer followed by intra-particle diffusion mass transfer. The adsorption equilibrium data were fitted well by the Langmuir isotherm and the maximum adsorption capacity was estimated to be about 100, 71.4, 143, and 91 mg g^{-1} for cedar sawdust, pine sawdust, straw, and Provence cane, respectively. For all the adsorbents tested, adsorption decreases with the increase in solution temperature. The values of the thermodynamic parameters of each system adsorbent/MB indicated that adsorption is a spontaneous and exothermic process. The comparison of the characteristics of the supernatants recovered after adsorption shows clearly that cedar sawdust leads to the production of a liquid with minimum values of turbidity, conductivity, and permanganate index.

Keywords: Adsorption; Methylene blue; Agro-based materials; Kinetic study; Thermodynamic parameters

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