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Effective adsorption of methylene blue dye using activated carbon developed from the rosemary plant: isotherms and kinetic studies

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ABSTRACT

In this study, the adsorption efficiency of the inactivated rosemary (RM) plant and the derived activated carbon (RMAC) for the removal of methylene blue (MB) dye were investigated. RM and RMAC displayed maximum adsorption capacities of 153.17 and 110.67 mg g^{-1}, respectively, for optimum batch conditions. The MB adsorption data of both RM and RMAC were better described by the Langmuir isotherm model than the Freundlich isotherm models; however, the former showed the physical adsorption with a mean free energy of 8.08 kJ mol^{-1} and the latter reflected the chemisorption with mean free energy of 28.87 kJ mol^{-1}. The MB adsorption of both adsorbents followed the pseudo-second-order kinetics model. The MB dye adsorption process was determined to be a non-spontaneous and exothermic reaction for the RM adsorbent, whereas the RMAC reflected the spontaneous and endothermic nature of the MB adsorption. This study showed that the RMAC can be used as an efficient sorbent for MB dye removal in comparison with its non-activated form.

Keywords: Activated carbon; Adsorption; Isotherm models; Methylene blue; Rosemary plant

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