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An investigation of natural and modified diatomite performance for adsorption of Basic Blue 41: isotherm, kinetic, and thermodynamic studies

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ABSTRACT

In the present study, natural diatomite (ND) and Mn-modified diatomite (MD) were utilized for adsorption of Basic Blue 41 (BB 41) from aqueous solution at temperatures of 298, 308, and 318 K. Based on the results of isotherm studies, the Freundlich isotherm model is better than the Langmuir and Temkin models. Isotherm constants increase as the temperature increases, indicating that the removal process is favorable at higher temperatures. Adsorption kinetics for BB 41 on diatomite best fit the pseudo-second-order model which had kinetic constants that were higher than pseudo-first-order and intra-particle diffusion models. When the initial dye concentration rises from 10 to 80 mg L^{-1}, adsorption capacity on ND and MD increase from 6.15 to 62.43 mg g^{-1} and 9.06 to 75.95 mg g^{-1} at 318 K, respectively. Gibbs free energy ($\Delta G°$) values for BB 41 adsorption on ND and MD were determined as –11.224 and –15.586 kJ mol^{-1} at 318 K, respectively. Enthalpy ($\Delta H°$) values for this removal process were calculated as 31.746 and 48.706 kJ mol^{-1}, with entropy ($\Delta S°$) values determined as 133.319 and 170.728 J mol^{-1} K^{-1} for ND and MD, respectively. Activation energy (E_A) values were determined as 42.7 and 58.83 kJ mol^{-1} for BB 41 removal onto ND and MD adsorbents, respectively. Economic analysis of the preparation of Mn-modified diatomite was carried out. The results indicate that diatomite could be a good material compared to more costly adsorbents used for dye removal.

Keywords: Adsorption; Basic Blue 41; Diatomite; Isotherm; Kinetic; Thermodynamic

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