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Kinetics and mechanistic description of adsorptive uptake of crystal violet dye by lignified elephant grass complexed isolate

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Abstract

Lignified isolate was successfully synthesized from simulated effluent of modified procedure for bio – ethanol production from elephant grass. The effectiveness of lignin isolate (EA); complexed with Al^{3+} (Al –EA) and Mn^{2+} (Mn – EA) for adsorbing aqueous crystal violet dye (CVD) was evaluated. The adsorbents were characterized using Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). Removal efficiencies of Al – EA (98.42 %) and Mn – EA (97.87 %) were obtained at contact time of 30 min and 343 K. Kinetic study showed that Brouer – Weron – Sotolongo, Fractal – like mixed 1,2 – order and Elovich models were the best three models in describing the adsorption kinetics of both adsorbent. Similarly, the predicted kinetic data were adjured statistically significant using F- test and student's t-test. Application of mechanistic models suggests film diffusion as the rate controlling mechanism. The estimated average thermodynamic parameters (ΔG^0 (-18.438 KJ/mol), ΔH^0 (+27.968 KJ/mol) and ΔS^0 (29.536 KJ/mol)) reveal that CVD adsorption onto Al – EA and Mn – EA was feasible, spontaneous and endothermic.

Keywords: Adsorption, lignin, crystal violet, kinetics, mechanistic modeling.

1. Introduction

The discharge of ill – treated dye contaminated wastewater into the aquatic environment, due to activities of several heavy industries (such as textile, paper, printing, leather, food, cosmetics, etc), remains a veritable source of esthetic pollution, eutrophication and perturbation in the aquatic terrain. Highly colored water is generally not suitable for domestic and industrial use; hence affecting its marketability **[1-2]**.