Effective Removal of Brilliant Green Dye using Adsorbent derived from Sewage Sludge: Linear and Nonlinear Regression Analysis

Priyanka Shrivastava, M.K. Dwivedi & Vibha Malviya

Department of Chemistry, Govt. Holkar (Model, Autonomous) Science College, Indore (M.P.), India

priyanka191189@gmail.com, dwivedimk12@gmail.com, vibha220391@gmail.com

Abstract. Sewage sludge, a by-product of wastewater treatment, has been explored as a cost-effective adsorbent for removing Brilliant Green dye from wastewater. Thermal activation at 900°C enhanced the material's surface area and porosity, optimizing its adsorption properties. Characterization of the adsorbent was conducted using techniques such as XRF, FTIR, SEM, and XRD. Equilibrium adsorption behaviour was studied using isotherm models, including Freundlich, Langmuir, Redlich-Peterson, and Dubinin-Radushkevich, while kinetic studies employed pseudo-first-order, pseudo-second-order, and intraparticle diffusion models. Nonlinear regression analysis was applied to fit the experimental data and determine model parameters. Various error functions (R^2, χ^2, SSE, G^2, HYBRID, MPSD, RMSE, MSE) were used to identify the most suitable isotherm. Batch experiments showed that the dye removal efficiency reached 96.20% under optimal conditions: contact time of 180 minutes, pH 5.0, adsorbent dose of 10 g/L, and temperature of 30°C. The Langmuir isotherm provided the best fit for equilibrium data, while adsorption kinetics were described by the pseudo-second-order model. Thermodynamic analysis revealed the adsorption process to be spontaneous, feasible, and endothermic. These findings suggest that activated sewage sludge can be effectively used for the removal of dyes from wastewater.

Keywords: Adsorption, Brilliant Green, Sewage Sludge, Thermodynamics, Nonlinear Regression