Fakulti Sains Gunaan

SUBMISSION FOR EVALUATION
FINAL YEAR PROJECT 2 - RESEARCH PROJECT

ADSORPTIVE REMOVAL OF METHYLENE BLUE USING ACTIVATED CARBON DERIVED FROM BANANA STEM

Name	:	ADAM NABIL BIN AZNAN
Student ID	:	2023105167
Program	:	RAS245
Course code	:	FSG671
Mobile Phone	:	018-9024546
E-mail	:	2023105167@student.uitm.edu.my

Approval by Main Supervisor :

I certify that the work conducted by the above student is completed and approve this report to be submitted for evaluation.

Supervisor's name	:	DR ZAIDI BIN AB GHANI
Date	:	1/8/2025
Turnitin Similarity %	:	24%
Signature	:	

ADSORPTIVE REMOVAL OF METHYLENE BLUE USING ACTIVATED CARBON DERIVED FROM BANANA STEM

ADAM NABIL BIN AZNAN

Final Year Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Bachelor of Science (Hons.) Applied Chemistry in the Faculty of Applied Sciences Universiti Teknologi MARA

AUGUST 2025

TABLE OF CONTENTS

ABSTRACT

In this study, zinc chloride ($ZnCl_2$) was used as the activating agent for producing activated carbon derived from banana stems. The activated carbon was then applied to extract methylene blue (MB) dye from aqueous solutions. The adsorption process was investigated using isotherm models Langmuir, Freundlich, and Temkin. Among these, the Langmuir model provided the best fit, with a maximum monolayer adsorption capacity (q_m) of 180 mg/g and a correlation coefficient (R^2) of 0.9996, indicating monolayer adsorption on a homogeneous surface. To better understand the adsorption mechanism and rate-controlling steps, kinetic studies were conducted using pseudo-first-order (PFO), pseudo-second-order (PSO), and intraparticle diffusion (IPD) models. The PSO model showed the best correlation with experimental data, with R^2 values ranging from 0.9964 to 0.9995, and predicted adsorption capacities (q_e) closely matching the experimental values. IPD analysis indicated a multi-step adsorption process with R^2 values between 0.7647 and 0.8049, and increasing boundary layer thickness as concentration increased. Thermodynamic analysis revealed that the adsorption process was endothermic, with an enthalpy change ($\Delta H°$) of 102.71 kJ/mol, and accompanied by an entropy change ($\Delta S°$) of 358.24 J/mol·K, indicating increased randomness at the solid-liquid interface. The Gibbs free energy change ($\Delta G°$) ranged from –4.04 to –6.91 kJ/mol, confirming that the adsorption of methylene blue onto banana stem derived activated carbon is spontaneous and thermodynamically favorable. These findings highlight the material's efficiency, cost-effectiveness, and environmental sustainability for dye removal in wastewater treatment applications.