



UNIVERSITI  
TEKNOLOGI  
MARA

Fakulti  
Sains Gunaan

**SUBMISSION FOR EVALUATION**  
**FINAL YEAR PROJECT 2 - RESEARCH PROJECT**

**ADSORPTION KINETICS AND OPTIMIZATION OF METHYLENE BLUE  
REMOVAL USING CALCINED VOLCANIC ROCK**

Name : NURUL BATRISYAH BINTI ASMAT  
Student ID : 2023150103  
Program : AS245  
Course code : FSG671  
Mobile Phone :  
E-mail : nrsyaaa4@gmail.com

**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 SHARIZAL BIN HASAN

Date

30/7/2025

Turnitin Similarity % : 8%

Signature

**ADSORPTION KINETICS AND OPTIMIZATION OF METHYLENE BLUE  
REMOVAL USING CALCINED VOLCANIC ROCK**

**NURUL BATRISYAH BINTI ASMAT**

**DEGREE OF BACHELOR OF SCIENCE (Hons.) APPLIED CHEMISTRY  
FACULTY OF APPLIED SCIENCES  
UNIVERSITI TEKNOLOGI MARA**

**AUGUST 2025**

**ADSORPTION KINETICS AND OPTIMIZATION OF METHYLENE BLUE  
REMOVAL USING CALCINED VOLCANIC ROCK**

**NURUL BATRISYAH BINTI ASMAT**

**Final Year Project 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**

## **ABSTRACT**

### **ADSORPTION KINETICS AND OPTIMIZATION OF METHYLENE BLUE REMOVAL USING CALCINED VOLCANIC ROCK**

This study investigated the potential of pre-treated volcanic rock from Mount Merapi as an effective and sustainable adsorbent for methylene blue (MB) removal from aqueous solution. This study aims to quantify its adsorption capacity, determine the influence of parameters and identify the underlying kinetic behaviour. Volcanic rock undergoes pre-treatment via acid treatment and calcination. Adsorption experiments were conducted in batch mode to evaluate the effects of calcination time, contact time, adsorbent dosage and pH on MB removal, with kinetic models used for analysis. Optimal calcination for 2 hours at 800°C can enhance MB removal up to 100% and achieve an impressive adsorption capacity of 2.70 mg/g. Adsorption was rapid with near complete removal within 30 minutes, and optimal conditions were identified at a 2.00 g adsorbent dosage and a solution pH of 9. Kinetic analysis indicated a strong fit to the Pseudo-Second-Order model, with  $R^2$  was 0.9954, suggesting a chemisorption mechanism. The findings confirmed treated volcanic rock as an eco-friendly solution for efficient cationic dye wastewater treatment, highlighting its potential for sustainable pollution control.

## TABLE OF CONTENTS

<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENT</b>	<b>iii</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>TABLE OF FIGURES</b>	<b>viii</b>
<b>LIST OF SYMBOLS</b>	<b>x</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xi</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.2 Problem Statement	3
1. 3 Research Questions	4
1.4 Objectives	4
1.5 Significance Study	5
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>7</b>
2.1 Overview of Dye Pollution in Industrial Waste	7
2.2 Challenges and Solutions in Removing Dyes from Wastewater	8
2.3 Volcanic Rock as an Adsorbent	12
2.4 The Role of Pre-Treatment for Volcanic Rock	18
<b>CHAPTER 3 METHODOLOGY</b>	<b>19</b>
3.1 Materials and Chemicals	19
3.2 Equipment and Instrument	19
3.3 Method and Procedure	20
3.3.1 Sample Preparation	20
3.3.2 Preparation of Dye Methylene Blue Solution	20
3.3.3 Adsorption of Different Parameters	21
3.3.4 Data Analysis	23
3.4 Flow Chart	27