

**EFFECT OF TEMPERATURE AND HEATING RATE ON
PRODUCTS YIELD IN PYROLYSIS OF SHAMPOO BOTTLE
AND BOTTLE CAP**

DEFVERLINE HENSLYCHELL ANAK HENDRY

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

FEBRUARY 2025

**EFFECT OF TEMPERATURE AND HEATING RATE ON PRODUCTS
YIELD IN PYROLYSIS OF SHAMPOO BOTTLE AND BOTTLE CAP**

DEFVERLINE HENSLYCHELL ANAK HENDRY

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

FEBRUARY 2025

This Final Year Project entitled **“Effect of Temperature and Heating Rate on Products Yield in Pyrolysis of Bottle Shampoo and Bottle Cap”** was submitted by Defverline Henslychell Anak Hendry in partial fulfilment of the requirements for the Degree of Bachelor of Science (Hons.) Chemistry with Management, in the Faculty of Applied Science and was approved by

Dr. Siti Nurlia Ali
Supervisor
B. Sc. (Hons.) Chemistry with
Management
Universiti Teknologi MARA
02600 Arau
Perlis

Dr. Siti Nurlia Ali
Project Coordinator
B. Sc. (Hons.) Chemistry with
Management
Universiti Teknologi MARA
02600 Arau
Perlis

Dr. Nur Nasulhah Kasim
Head of Programme
B. Sc. (Hons.) Chemistry with
Management
Universiti Teknologi MARA
02600 Arau
Perlis

Date: _____

ABSTRACT

EFFECT OF TEMPERATURE AND HEATING RATE ON PRODUCTS YIELD IN PYROLYSIS OF SHAMPOO BOTTLE AND BOTTLE CAP

The global demand for renewable energy and the requirement for sustainable waste management have revealed the importance of alternative energy sources. Pyrolysis is a thermochemical recycling method that promises a way to convert plastic waste into valuable energy sources. However, the efficiency and yield of pyrolysis products depend on several factors such as temperature and heating rate. Despite previous studies on pyrolysis, limited research has focused on how these parameters influence the yield and characteristics of pyrolysis oil and char derived from different types of high-density polyethylene (HDPE) waste. This study aimed to investigate the effects of temperature and heating rate on the products yield from different types of HDPE waste which are shampoo bottle and bottle cap. Shampoo bottle and bottle cap waste were subjected to pyrolysis under 450 – 600 °C with heating rate of 5 – 20 °C/min in a fixed bed reactor, and the resulting oil and char were analyzed for their properties. The results showed that the highest oil yield obtained is 68 wt. % at 600 °C with heating rate of 5 °C/min for shampoo bottles while the bottle cap obtained the highest oil yield of 69.23 wt. % at 550 °C with the same heating rate. The study also revealed that increasing temperature and heating rate led to an increase in gas yield while reducing oil and char yield. This is due to higher temperatures, increases thermal cracking, causing char yield to decrease while increased gas production and a slight decrease in oil yield beyond the optimal temperature. In contrast, lower temperatures and slower heating rates resulted in higher char formation due to incomplete degradation of the polymer structure. From the FT-IR spectrum, the intensity of hydroxyl and alkanes group in oil decreased as the temperature and heating rate increased while char reveals intensity of alkanes and aldehydes in char decreased. Based on oil yield and processing conditions, bottle caps waste appears to be the better feedstock due to its ability to achieve a higher oil yield at a lower temperature, which can improve energy efficiency.

TABLE OF CONTENTS

	Page
ABSTRACT	iii
ABSTRAK	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
LIST OF TABLES	viii
LIST OF FIGURES	x
LIST OF SYMBOLS	xii
LIST OF ABBREVIATIONS	xiii
 CHAPTER 1: INTRODUCTION	 1
1.1 Background of study	1
1.2 Problem statement	1
1.3 Significance of study	5
1.4 Objectives	5
1.5 Scope and limitation of study	6
 CHAPTER 2: LITERATURE REVIEW	 7
2.1 High Density Polyethylene (HDPE)	7
2.1.1 Molecular structure	7
2.1.2 Properties	8
2.2 Management of HDPE waste	9
2.2.1 HDPE disposal rate	9
2.2.2 Managing HDPE Waste using Waste Hierarchy	10
2.2.3 Energy recovery of HDPE	12
2.3 Degradation methods of HDPE	13
2.3.1 Thermal degradation	16
2.3.2 Effect of temperature in pyrolysis of HDPE	17
2.3.3 Effect of heating rate in pyrolysis of HDPE	20
 CHAPTER 3: METHODOLOGY	 23
3.1 Sample Collection and Preparation	23
3.2 Apparatus and Instrumentation	23
3.3 Analysis of sample	24
3.3.1 Proximate analysis	24
3.4 Pyrolysis of two types of HDPE	27
3.5 Analysis of product	27
3.6 Flow chart	28