

**UNIVERSITI TEKNOLOGI MARA**

**FAST PYROLYSIS OF EMPTY FRUIT  
BUNCH AND PALM KERNEL SHELL  
FOR PRODUCTION OF BIO-OIL  
USING AUGER REACTOR**

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Thesis submitted in fulfillment  
of the requirements for the degree of  
**Doctor of Philosophy**

**Faculty of Chemical Engineering**

May 2017

## ABSTRACT

Pyrolysis has received a lot of interest as it can convert biomass into gas, liquid (bio-oil) and solid products. Bio-oil can be utilized as a feedstock for various chemicals as well as fuels production, and heat and power generations. The purpose of this research is to optimize the process conditions for bio-oil production from oil palm empty fruit bunch (EFB) and palm kernel shell (PKS) in an auger reactor and to elucidate the detailed characteristics of bio-oil. The maximum bio-oil yield for EFB was 64.54 wt% at temperature of 500 °C, nitrogen flow rate of 2 L/min and mass feeding of 8 kg/hr, while the maximum of 64.38 wt% of bio-oil yield was obtained at temperature of 550 °C, nitrogen flow rate of 3 L/min and 8 kg/hr for PKS. The highest higher heating value obtained for both EFB and PKS bio-oil was 27.28 kJ/mol and 26.68 kJ/mol, respectively, for bio-oil produced at 550 °C. The moisture content observed to be reduced with increasing pyrolysis temperature. Both of the GC-MS and FT-IR spectra indicated that phenol is a major component and the oxygenated species is the major component in both EFB and PKS bio-oil and most of compound infused to the organic phase at high temperature. The UV-Fluorescence absorption, which indicates the aromatic content, was also the highest for 550°C bio-oil for both EFB and PKS. The result also shows that the PKS has higher aromatic content compared to EFB. The activation energy obtained for EFB at isothermal condition was 99.78 kJ/mol, while 112.43 kJ/mol for PKS. Besides that, the frequency factor for EFB is found to be  $1.02 \times 10^6 \text{ s}^{-1}$ , while  $1.44 \times 10^6 \text{ s}^{-1}$  for PKS. The activation energy obtained at third lump are 140.63 kJ/mol for EFB, while 246.07 kJ/mol for PKS. For isothermal condition it was lower than non-isothermal condition since the amount of energy needed for pyrolysis reaction to occur at high temperature and high heating rate are lower than slower heating rates due to the transport effect.

**Keyword:** Biomass pyrolysis, Bio-oil, Oil Palm, Empty Fruit Bunch, Palm Kernel Shell, Biofuel, Renewable energy

## ACKNOWLEDGEMENT

Alhamdulillah, all praise to Allah S.W.T, I have successfully completed my thesis on “Fast pyrolysis of empty fruit bunch and palm kernel shell for production of bio-oil using auger reactor”. I am very grateful to Allah who gave me tremendous courage and spirit while facing the entire obstacle. Without his help and mercy, this would have not possible.

First of all, I wish to express my gratefulness to my project supervisor, Professor Dr. Mohammad Asadullah for his supervision, guidance and critiques towards this project which have been greatly helpful to the advancement of my research. I also would like to thank my co-supervisor, Dr. Syed Shatir Ashgrar and Dr. Amin Azdarpour for being a uniformly excellent advisor. They were always helpful and provided me insightful suggestions and supports.

I wish to thank the Universiti Teknologi Mara (UiTM) for providing the facilities to advance the project. In addition, my deepest appreciation also extends to all my colleagues, laboratory technicians, lecturers and others who have provided assistance at various occasions. Their views, tips and corporation were helpful indeed.

Last but not least, I take this opportunity to extend my sincere gratitude to my husband and family for their unconditional love, unfailing sacrifice and moral support, which are far more valuable than I could express in words.

# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>ii</b>
<b>AUTHOR'S DECLARATION</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>v</b>
<b>ACKNOWLEDGEMENT</b>	<b>vi</b>
<b>TABLE OF CONTENTS</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>xii</b>
<b>LIST OF FIGURES</b>	<b>xiv</b>
<b>LIST OF SYMBOLS</b>	<b>xviii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xix</b>
<b>CHAPTER ONE: INRODUCTION</b>	<b>1</b>
1.1 Background of Study	1
1.2 Problem Statement	3
1.3 Research Hypothesis	5
1.4 Objectives	6
1.5 Scope and Limitation of The Study	6
1.6 Significant Of Research	7
1.7 Thesis Structure	8
<b>CHAPTER TWO : LITERATURE REVIEW</b>	<b>9</b>
2.1 Introduction	9
2.2 Renewable Energy	9
2.3 Biomass	10
2.3.1 Composition of Biomass	10
2.3.1.1 Cellulose	11
2.3.1.2 Hemicellulose	12
2.3.1.3 Lignin	12
2.3.2 Oil Palm Biomass	13

2.3.2.1 Empty Fruit Bunch (EFB)	13
2.3.2.2 Palm Kernel Shell (PKS)	15
2.4 Biomass Conversion Technologies	16
2.4.1 Thermal Conversion	16
2.4.2 Biochemical Conversion	16
2.5 Pyrolysis of Biomass	16
2.6 Types of Pyrolysis	18
2.6.1 Slow Pyrolysis	18
2.6.2 Fast Pyrolysis	18
2.6.3 Flash Pyrolysis	20
2.7 Fast Pyrolysis Products	20
2.7.1 Liquid (Bio-Oil)	20
2.7.1.1 Bio-Oil Properties	21
2.7.1.1.1 Physical Characteristic	21
2.7.1.1.2 Chemical Characteristics	22
2.7.2 Solid Char	23
2.7.3 Pyrolysis Gas	23
2.8 Fast Pyrolysis Technology	24
2.8.1 Fixed Bed Reactor	24
2.8.2 Fluidized Bed Reactor	25
2.8.3 Transported Bed Reactor	26
2.8.4 Free Fall Reactor	26
2.8.5 Ablative Reactor	27
2.8.6 Auger Reactor	27
2.9 Parameter That Affect Product Yield	28
2.9.1 Effect of Pyrolysis Temperature	29
2.9.2 Effect of Nitrogen Flow Rate	31
2.9.3 Effect of Feeding Rate on the Product Yield	33
2.9.4 Effect of Particle Size	35
2.10 Kinetic Study of Pyrolysis	36
2.10.1 Isothermal	37
2.10.1.1 Integral Method	37
2.10.1.2 Differential Method	38
2.10.2 Non-Isothermal	39