# CATALYTIC EFFECT OF COBALT(II) NITRATE DURING PYROLYSIS OF IMPREGNATED OIL PALM EMPTY FRUIT BUNCH FIBRES

**NINA SUHAILA NOR WAHID**

This report is submitted in partial fulfillment
of the requirements for the degree of
**Bachelor of Engineering (Hons) Chemical**

**FACULTY OF CHEMICAL ENGINEERING**
**UNIVERSITI TEKNOLOGI MARA**
**SHAH ALAM**

**July 2018**

# ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my degree and for completing this long and challenging journey successfully in Universiti Teknologi MARA, UiTM Shah Alam with the help and support from many individuals. I would like to extend my sincere thanks to all of them.

My gratitude and thanks go to my supervisor Dr. Rusmi Alias. I'm highly indebted for his guidance and convincing supervision as well as providing necessary information regarding the project.

My appreciation goes to Faculty of Chemical's staffs who provided the facilities and assistance during sampling. Special thanks to my colleagues and friends for helping me with this project.

Finally, this thesis is dedicated to my parents for the vision and determination to educate me. Without them, I would not be able to be here without their guidance.

# ABSTRACT

Fossil fuel downturn has created an attention for researchers to discover new fuels substitution for future generation. Impregnation of metals onto biomass has been utilized as feedstocks for producing bioproducts by thermal conversion such as pyrolysis. In this study, investigation is made on the adsorption of Cobalt (II) Nitrate from aqueous solution onto shredded oil palm empty fruit bunch (SOPEFB) fibres via varying important parameters such as contact time and initial metal concentration. The SOPEFB was soaked into Cobalt (II) Nitrate aqueous solution and the Co-loaded SOPEFB being digested to analyse the Cobalt concentration via ICP-OES. The contact time was varied between 2 to 48 hours and the adsorption of Cobalt was observed that achieve an equilibrium at the last 24 hours. The adsorption isotherm was fitted well with Freundlich model with correlation coefficient, R2 of 0.9976. The study also reveals that adsorption of Cobalt occurs thru multilayer heterogeneous SOPEFB fibres surface. Besides, the Co-loaded SOPEFB was aimed to produce biooil by catalytic slow pyrolysis. The experiment showed the best fit temperature for catalytic pyrolysis was at 500°C as it yielded the most liquid oil. Then, catalytic slow pyrolysis was set up at 500°C and it displayed that liquid yields in catalytic pyrolysis was slightly reduced compared to nonimpregnated SOPEFB fibres due to further catalytic cracking had occurred onto biomass to form more gas yields as soon it was produced at the particular temperature.

# TABLE OF CONTENTS


DECLARATION ..... I

SUPERVISOR'S CERTIFICATION ..... II

COORDINATOR'S CERTIFICATION ..... III

ACKNOWLEDGEMENT ..... IV

ABSTRACT ..... V

LIST OF TABLES ..... VIII

LIST OF FIGURES ..... IX

LIST OF SYMBOLS ..... XI

LIST OF ABBREVIATIONS ..... XII

CHAPTER ONE: INTRODUCTION ..... 1

1.1 Research Background ..... 1

1.2 Problem Statement ..... 2

1.3 Objective ..... 3

1.4 Scope of Study ..... 3

CHAPTER TWO: LITERATURE REVIEW ..... 4

2.1 Overview ..... 5

2.2 Biomass ..... 5

2.2.1 Composition of Biomass ..... 6

2.2.2 Oil Palm Empty Fruit Bunch (OPEFB) Fibres ..... 8

2.3 Pyrolysis ..... 10

2.3.1 Catalytic Slow Pyrolysis ..... 12

2.3.2 Cobalt Catalyst ..... 13

2.3.3 Biooil ..... 15

2.4 Adsorption Process ..... 17

2.4.1 Adsorption Isotherm Models ..... 19

CHAPTER THREE: RESEARCH METHODOLOGY ..... 23

3.1 Overview ..... 23

3.2 Materials ..... 23

3.3 Methodology ..... 24

# CHAPTER ONE
# INTRODUCTION

## 1.1 Research Background

One of the major palm oil provider called Malaysia typically has a massive amount of wastes known as biomass which produced from the palm oil mills. The biomass can be categorized as oil palm empty fruit bunch (OPEFB), shell kernel and oil palm mesocarp fibre (OPMF). Malaysia which produces these wastes has over 80 million tonnes and it is can prolong increases up to 100 million tonnes in 2020 (Nor-Azemi, Fuadi, & Syed-Hassan, 2014). Despite of having these huge amount of biomass, it is renowned to be one of the renewable energy resources in the future.

This anthropogenic climate change of fossil fuel gives a new view of using biomass as a substitution to fossil fuels in more years to come as there are many arisen issues these days such as topics of fossil fuel resources depletion, oil prices upsurge desperately and environmental issues from the fossil fuels consumption (Nor-Azemi, Fuadi, & Syed-Hassan, 2014). The author also stated that the reason why biomass so called renewable energy resources due to the importance of energy produces with less conservational contamination equated to fossil fuel.

The lower Sulphur (S) and Nitrogen ($N_2$) contents also give upriser for it to be chosen. Besides, the secretion of neutral Carbon Dioxide ($CO_2$) from biomass can be absorbed by photosynthesis process by trees and its natural conversion reduces $CO_2$ emission to the atmosphere. Jahirul et al. (2012) has revealed the level of atmospheric $CO_2$ has already exceeded the dangerous level and probably global warming situation is expected to be growing gradually in 10 years earlier than had previously been predicted. Reduction of emission needs to be taken into serious action by 2050. Thus, with all of these concerns have boosted researchers for finding some alternatives to fossil derived products.