

CHAPTER I

INTRODUCTION



1.1 Introduction

What are plastics?

Plastics are relatively tough substances of high molecular weight. Generally plastics are subclassified into thermoplastics and thermosets. Thermoplastic softens when heated while thermosetting plastics are highly crosslinked solid which do not soften upon heating.

The problems of waste plastics together with the lack of energy from oil and hydrocarbon gas have been increased for many years and many researches of transforming waste plastics into other useful substances have been undertaken. Especially, a transformation of waste plastics from polyolefinic plastic such as polypropylene, polystyrene, polyethylene into hydrocarbon which have property is oil because those plastic hasn't crosslink structure, to consist of hydrocarbon has high hydrogen and hasn't contain impurity.

Currently, an effective solution of waste plastics problem should be done through 4 processes: land covering, burning and recycle energy, recycling and reduction of plastic use, however some of these processes cause the problem of air pollution and inadequate land for covering. Although, waste plastics can be recycled into plastic pellets and reused for producing new products or used with new plastics, the limitations of using recycle plastics are durability and quality degradation. New products produced from recycle plastics may not be effective and durable as its original ones. The ideas of this research are to transform mixed polypropylene with polystyrene and mixed polypropylene with polyethylene into different molecular weight hydrocarbons and use some of its liquid qualifications as an oil, on the other hand to reduce waste plastics as well. The processes to serve these intended purposes have been done through catalytic cracking reaction by iron on activated carbon under hydrogen atmosphere in microreactor.

It is found that the advantage of using catalyst is that activated carbon from palm-oil shell (which is a residual local product) has high carbon, low inorganic and high acidity which is suitable for cracking reaction of high molecular weight hydrocarbon. Besides, iron catalyst is cheaper than other 8 metal groups, therefore catalyst used for these processes can reduce a cost of production. It is also as effective as commercial one it can change many variables into proper conditions (such as pressure, temperature, time, catalytic amount and others).

This research aims to recycle locally raw materials and waste plastics into more-valued chemical substances and more useful products. The usefulness of this research may not only serve the idea of using recycle products but also help to reduce an environmental problem.

Thermoplastic may be amorphous, partially crystalline or crystalline. Table 1.1 shows the structure of the major thermoplastic polymers.

Table 1.1 Major thermoplastic polymers.

Name	Abbreviation	Family	Formula	Melting temp.	Density
Low density polyethylene	LDPE	Polyolefin	CH ₂ -	110 (T _m)	0.910
High density polyethylene	HDPE	Polyolefin	CH ₂ -	120 (T _m)	0.950
Polypropylene	PP	Polyolefin	$\begin{array}{c} \text{CH}_3 \\ \\ -\text{CH}_2-\text{CH}- \end{array}$	175 (T _m)	0.902
Polyvinyl chloride	PVC	Vinyl	$\begin{array}{c} \text{Cl} \\ \\ -\text{CH}_2-\text{CH}- \end{array}$	100 (T _g)	1.35
Polyvinyl acetate	PVA	Vinyl	$\begin{array}{c} \text{O} \\ \\ \text{O}-\text{CCH}_3 \\ \\ -\text{CH}_2-\text{CH}- \end{array}$		
Polystyrene	PS	Styrenic	$\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ -\text{CH}_2-\text{CH}- \end{array}$		
Acrylonitrile butadiene styrene	ABS	Styrenic	$\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ -\text{CH}_2-\text{CH}- \end{array}$	100 (T _g)	1.05
Acrylonitrile styrene	SAN	Styrenic			

Table 1.1 (continued)

Name	Abbreviation	Family	Formula	Melting temp.	Density
Polymethylmethacrylate		Acrylic	$\begin{array}{c} \text{O} \\ \parallel \\ \text{O}-\text{CCH}_3 \\ \\ -\text{CH}_2-\text{C}- \\ \\ \text{CH}_3 \end{array}$	100 (T_g)	1.05
Polyhexamethylene diamide	Nylon 66	Polyamide	$-\text{NH}-(\text{CH}_2)_6-\text{NH}-\text{C}(=\text{O})-(\text{CH}_2)_4-\text{C}(=\text{O})-$	265 (T_m)	1.14
Polycaprolactam	Nylon 6	Polyamide	$-\text{NH}-(\text{CH}_2)_5-\text{C}(=\text{O})-$	225 (T_m)	1.14
Polyethyleneterephthalate	PET	Polyester	$-\text{C}(=\text{O})-\text{C}_6\text{H}_4-\text{C}(=\text{O})-\text{OCH}_2\text{CH}_2\text{O}-$	270 (T_m)	
Polybutyleneterephthalate	PBT	Polyester	$-\text{C}(=\text{O})-\text{C}_6\text{H}_4-\text{C}(=\text{O})-\text{O}-(\text{CH}_2)_3\text{CH}_2\text{O}-$	250 (T_m)	1.3
Polycarbonates	PC	Polyester	$-\text{O}-\text{R}'-\text{O}-\text{C}(=\text{O})-\text{O}-\text{R}-\text{O}-\text{C}(=\text{O})-$	190 (T_g)	1.2

The problem of waste disposal is increasing with the use of increasing amounts of plastic materials. The waste arises from number of the sources including agriculture, automotive, construction, distribution and domestics use. Organized recovery presently exists only in the case of production wastes inside polymer factories. In domestic garbage there is an ever-increasing portion of plastic wastes, the destruction of which requires expensive equipment.

Protection of the environment requires improved packaging materials which are self-destructing which will be degraded very rapidly when exposed to the effects of sunlight, humidity, rain fall and soil bacteria. It was expected that polymers degrading under the influence of the atmospheric agents would solve the problem of waste disposal.

The pyrolysis of mixed-plastic waste has been proposed as a means of recycle to produce petrochemical feed stock. Therefore, this work aims to investigate the performances of the tested iron on activated carbon from palm oil shell catalyst on mixed plastics. There are three main plastics, which arise in municipal solid waste, low-density polyethylene (LDPE), polystyrene (PS) and polypropylene (PP). There are many studies on the pyrolysis of the individual single type of plastic conversion, simple plastic mixture and also mixed-plastics waste to generate either a fuel or petrochemical feedstock. Each type of three plastics was mixed with each of the other three plastics in a ratio of 1:1 and pyrolyzed in the reactor under the hydrocracking conditions. The yield and composition of the liquid hydrocarbon were determined.

1.2 Objective

The objectives of this study are :

- (1) To investigate the performance of the prepared iron on activated carbon from palm oil shell catalyst on mixed polypropylene (PP) and polystyrene (PS) conversion to liquid hydrocarbon.
- (2) To investigate the performance of the prepared iron on activated carbon from palm oil shell catalyst on mixed polypropylene (PP) and polyethylene (LDPE) conversion to liquid hydrocarbon.
- (3) To investigate the influence of reaction conditions (temperature, initial pressure of hydrogen gas, time, content of catalyst, percent of Iron loading on activated carbon) of the above reactions.

Scope of this study

- (1) To investigate the performance of the prepared catalyst on the mixed polypropylene (PP) and polystyrene (PS) conversion to liquid hydrocarbon under the following condition ;
 - Reaction temperature range of 390-435 °C
 - Initial pressure of hydrogen gas range of 15-40 kg/cm²
 - Reaction time range of 30 -75 min.
 - Mass of catalyst per mixed plastic. (0.30, 0.45 and 1.0 g per 15 g of mixed plastics)
 - Percent of iron on the catalyst that used in the reaction. (1%,5%,10%)

- (2) To investigate the performance of the prepared catalyst on the mixed polypropylene (PP) and polyethylene (LDPE) conversion to liquid hydrocarbon under the following condition ;
 - Reaction temperature range of 415-465 °C
 - Initial pressure of hydrogen gas range of 25-40 kg/cm²
 - Reaction time range of 30-75 min.
 - Weight ratio of catalyst per mixed plastic. (0, 0.30, 0.45 and 1.0 g per 15 g of mixed plastics)
 - Percent of iron on the catalyst that used in the reaction. (1%, 5%, 10%)

The reaction products were analyzed by gas chromatography. This standard test method (ASTM D-2887) covers the determination of the range distribution of petroleum product. The boiling range distribution determined by distillation is simulated by the use of gas chromatography. A non-polar packed or open tubular (capillary) gas chromatographic column is used to elute the hydrocarbon components of the sample in order of increasing boiling point. The boiling range distribution of petroleum fractions provides an insight into the composition of feedstock and products related to petroleum refining processes. The boiling range distribution obtained by this test method is essentially equivalent to those obtained by true boiling point (TBP) distillation. They are not equivalent to results from low efficiency distillations such as those obtained with test method ASTM D86 or method ASTM D1160.