CONCENTRATION OF BIOPETROL SYNTHESIZED FROM STEARIC ACID THROUGH CATALYTIC CRACKING USING ZEOLITE AS CATALYST

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ABSTRACT

Biopetrol is an alternative fuel that have same characteristic with the petrol in term of its molecular formula, or to be specifically the octane number of molecules. In this research, the objective is to study the effect of catalyst which is Zeolite to enhance the production of Isooctane from Stearic Acid. The experiment starts with heating the Stearic Acid until it melts at 69.6^{o}C, and then 20 grams of zeolite being added and the heating process proceed until the temperature reached 98^{o}C as the isooctane produce will evaporates. The next experiment is repeated by with different mass of zeolite which is 10 grams, 5 grams and 1 gram. This reaction is called as Catalytic Cracking, where the zeolite will enhance the production of Isooctane. From the result obtained from the Gas Chromatogram result, the percentage of actual concentration of isooctane obtained for 20 g Zeolite is 3.95%, 10g zeolite is 2.769%, 5g zeolite is 3.387% and 1g Zeolite is 2.946%. The highest percentage of Isooctane produced is Stearic Acid distillate with 20g Zeolite, which is 3.95%. This experiment could be more effective by applying dynamic state concept to the process.

ABSTRAK

Biopetrol adalah salah satu alternatif bahan bakar yang mempunyai karakter yang sama dengan petrol biasa iaitu dari segi formula molekulnya. Untuk lebih tepat lagi, ia mempunyai bilangan oktana dalam struktur molekul. Dalam penyelidikan ini, objektif utama adalah untuk mengkaji kesan pemangkin Zeolite dalam meningkatkan lagi penghasilan Isooktana (biopetrol) daripada Asid Stearik. Experimen di mulakan dengan memanaskan Asid Stearik sehingga menjadi cecair pada suhu 69.6^{o}C dan seterusnya ditambah dengan zeolite dan penasan diteruskan sehingga suhu mencecah 98^{o}C di mana isooktana yang sudah terbentuk akan meruap. Experimen diulang dengan menggunakan berat Zeolite yang berbeza iaitu 10 gram, 5 gram and 1 gram. Kaedah in dikenali sebagai kaedah penguraian pemangkin, di mana Zeolte akan membantu meningkatkan penghasilan isooktana. Daripada keputusan Gas Chromatogram yang diperolehi, peratusan kepekatan untuk 20 g Zeolite adalah 3.95%, 10g zeolite adalah 2.769 %, 5g zeolite 3.387% dan 1g zeolite adalah 2.946%. Kepekatan isooktana yang diperolehi dari didihan Asid Stearik dengan 20 g zeolite iaitu 3.95%. Experimen ini dapat diperbaiki dengan mengaplikasi konsep keadaan dinamik ke atas prosess ini.

TABLE OF CONTENT

2 LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

P	-	Pressure
M	-	Mass
ΔH	-	Enthalpy change of reaction
ΔS	-	Entropy change of reaction
ΔG	-	Energy change of reaction
T	-	Temperature
P	-	Density
M	-	Viscosity of liquid (Pa.s)
H	-	Heat transfer coefficient
^{o}C	-	Degree Celsius
kg	-	Kilogram
K	-	Degree Kelvin
M	-	Meter
N	-	Number of moles
L	-	Liter

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 Introduction

Based on world crisis today, demanding the fuel price risen up, it is really burden people. Since then, people getting on researches to search new alternative fuel to substitute petrol and bio-diesel. As a brief introduction, bio-petrol is one of bio-fuel that could replace petrol and diesel. Bio-fuel is much cheaper and bio-economical such as bio-diesel and bio-petrol. Bio-fuel produced from acid can be used as fuel. Advantages of biofuels are the following:

(a) biofuels are easily available from common biomass sources,
(b) They are represents a carbon dioxide-cycle in combustion,
(c) biofuels have a considerable environmentally friendly potential,
(d) There are many benefits the environment, economy and consumers in using biofuels, and
(e) They are biodegradable and contribute to sustainability [1].

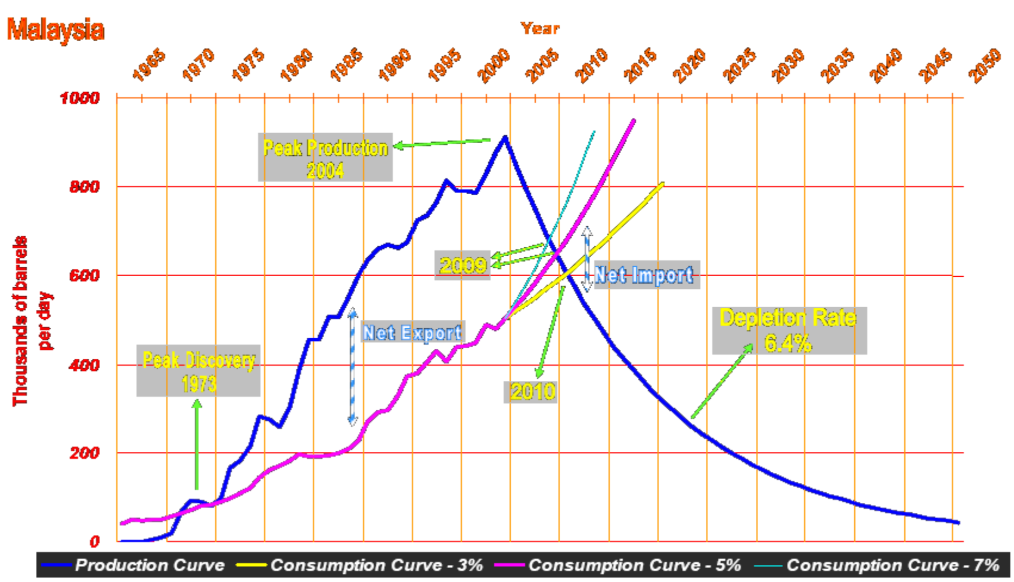
This research is about production of bio-petrol from catalytic cracking of stearic acid using zeolite as catalyst. The former research produced bio-petrol without using any catalyst. So, this study is to find out the effectiveness of catalytic cracking in producing biopetrol.

1.1 Problem Statement

The idea of this research is to solve out the fuel crises that really need to have other alternative. Currently, the world is depending to the only major source of energy as known as the petroleum fossil fuel. It is a nonrenewable energy and the next few decades the source to the crude oil will be finished. Since then, various studies are done to specify the global time in oil production between 1996 to 2035.

As we knew, Malaysia owns some petroleum sources and well known as one of the main fuel exporter to the world. Now, a few plants are using biomass energy technologies use waste or plant matter to produce energy with a lower level of greenhouse gas emissions than fossil fuel sources. Most of countries aware of this issue and they tend to develop research and modern technology to produce biofuels.

Figure 1.1 : Malaysia's Looming Energy Crisis (M. Noor, 2008)



Malaysia is the one of the major oil exporters in the world. Malaysia also has the crisis of the declining of these mineral sources. Malaysia's oil production is decreases in 2004 and would then decline by 6.4 percent annually. Figure 1.1 shows the declining Malaysia oil's production by 2004. Forecast, by 2009 to 2010 Malaysia will become a net importer because out of mineral sources (petroleum) and the demand of oil increasing. Bio-petrol is one of bio-fuels which can be fuel alternatives in substituting petrols and diesel.

At an average, about 0.1 tonne of Palm Oil Mill Effluent (POME) is generated for every tone of fresh fruit bunch processed. POME consists of water soluble components of palm fruits, saturated fatty acids as palmatic acid, stearic acid and oleic acid and also suspended materials as palm fiber and oil. Despite of its biodegradability, the POME cannot be discharged without treating it. This is because POME is very acidity and could pollute environment. By thinking of this, producing biopetrol from the POME can be the alternative solutions for treating the POME. At the same time, contribute to the production of biopetrol from the fatty acids. Producing petrol from the waste of palm oil will give an alternative choice to the users, especially for petrol-engine vehicles' owners. In addition, this biopetrol, which is graded 100 for its octane number, burns very smoothly so biopetrol can reduce emissions of some pollutants (Omar, 2005).

Stearic acid is one of the dominative components in palm oil waste. Its disposal into water supply sources causes serious water pollution. Besides that the loss of stearic acid as a useful industrial component also occurs so that it is not utilized much and always eliminated to improve and upgrade the quality of crude palm oil. Thus, it is disposed as palm oil waste and then pollutes water resources by its spillage.

At the fuel peak time, this research could be the very important as it could be commercialize. In this research, the concentration of isooctane that is produced from Stearic Acid and also the conversion of fatty acids form desired isooctane in biopetrol will be the objectives as well as studying the effect of catalyst to the production of Isooctane.

1.2 Objectives

- To analyze isooctane from Stearic Acid.
- To improve the production of biopetrol octane from catalytic cracking of Stearic Acid.

1.3 Scopes

There are some scopes that have been identified in this research. The scopes are listed as below:-

- To apply the catalytic cracking process.
- To determine the amount catalytic cracking process.
- To describe and understand the molecular arrangement in cracking process.
- To identify the presence of isooctane in the product solution by using Gas Chromatography
- To determine the amount of isooctane in sample obtained using Gas Chromatography method as well.
- To study the effectiveness of catalyst to the cracking process based on the amount of the catalyst.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Petroleum or fossil fuel has been the limited source. Since then, various studies are done to specify the global time in oil production between 1996 to 2035. Biomass energy technology use waste or plant matter to produce energy with a lower level of greenhouse gas emissions than the fossil fuel sources [3].Nowadays, in developed countries, there are researches and technologies to employ and applied efficient bioenergy conversion by using biofuels whereas getting competitively cheap compared with petrol.

Definition of fuel is any material that is burned or altered in order to obtain energy [4]. Fuel does releases energy when it is consumed by combustion or nuclear fusion. Fuel could neither store the energy nor released the energy when needed. The energy released can be transform into work.

All carbon-based life from microorganisms to animals and humans depend on and use fuels as their source of energy. Their cells engage in an enzyme-mediated chemical process called metabolism that converts energy from food or solar power into a form that can be used to sustain life [5]. In addition, there are some techniques where energy can be converted into another. As application of this conversion energy, human uses heat to cook and generating electricity daily application.

2.1 Fossil Fuel

Petroleum crude oil also known as fossil source fuels which only can be obtained from the earth’s crust. Fossil fuel range from the highest boiling crude oil to the most volatile material with low carbon: hydrogen ratio such as methane. It is generally accepted that they formed from the fossilized remains of dead plants and animals [6] by exposure to heat and pressure for millions years. It was estimated by the Energy Information Administration that in 2006 primary sources of energy consisted of petroleum 36.8%, coal 26.6%, natural gas 22.9%, amounting to an 86% share for fossil fuels in primary energy production in the world. Non-fossil sources included hydroelectric 6.3%, nuclear 6.0%, and (geothermal, solar, wind, wood waste) amounting 0.9 percent [7].

As known, the fossil fuels are non-renewable resources as the take millions year to form and keeps depleting much faster than it forms. Currently fossil fuel is the major energy source; in the future insufficient fossil fuel will gives big impact to human. This contributes toward the generation of renewable energy to get any kind of energy and fuel alternative other than fossil fuel.

2.2 Biofuel

Biofuel is referred as liquid or gaseous fuels that are produced recent dead biological mass and the fossil fuel also derived from long term dead biological material or predominantly called as biomass. As theoretically, biofuels can be produced form any biological carbon source. A variety of biofuels can be produced from biomass resources including liquid fuels, for example ethanol, methanol, biodiesel, Fisher-Tropsch diesel, carboxylic acid and gaseous fuel such as methane and hydrogen.

Biofuels is an environmental-friendly fuel so, due to its environmental merits, it is not possible the biofuel will replace the fossil fuels in the automotive fuel market. Advabtages of biofuels are the following: (a) biofuels are easily available from common biomass sources, (b) they are representing a carbon doxide- cyle in combustion, (c) biofuels have a considerable environmentally friendly potential, (d) beneficial in environment, economic and consumer by using biofuel, (e) they are biodegradable and contribute to sustainability [8]. Liquid and gaseous fuels can be produce from biomass through thermochemical and biological reactions. It is proven that biofuels produced from biomass is non-polluting, have reliable resources and sustainable.

Most of the biofuel is burned to release its stored chemical energy. The largest advantage of biofuel in comparison of other fuel is that the energy within the biomass can be stored for an indefinite time-period without any danger.

2.2.1 Types of Biofuel

Biofuels stand for liquid or gaseous fuel for transport produced from biomass. They may be pure (100%) biofuels for dedicated vehicles or blend fuels in such a proportion that they can substitute conventional motor fuels without affecting car performance [8].

2.2.2 Bioalcohol

The alcohol fuels are usually of biological rather than petroleum sources. When obtained from biological sources, they are sometimes known as bioalcohols. Bioalcohol is one kind of biofuel produced from alcohol such as methanol (CH_3OH), ethanol (C_2H_5OH), propanol (C_3H_7OH), butanol (C_4H_9OH) which can be used for motor fuels. But, still the bioalcohol in development and research stages.

2.2.3 Bioethanol

Bioethanol is a fuel derived from plants such as wheat, sugar beet, corn and wood. Ethanol or ethyl alcohol produced by hydrolysis and fermentation process where the carbohydrates in the plant material can be converted into sugar by hydrolysis process. The fermentation process is to convert sugar to alcohols by microorganism, usually yeast. The resulting alcohol from the process is ethanol

2.2.4 Biomethanol

Currently, methanol made from the natural gas, but it also can be produced via partial oxidation reactions [9]. In figure 2.1 shows the production of biomethanol from carbohydrates by gasification and partial oxidation with O_2 and H_2O.

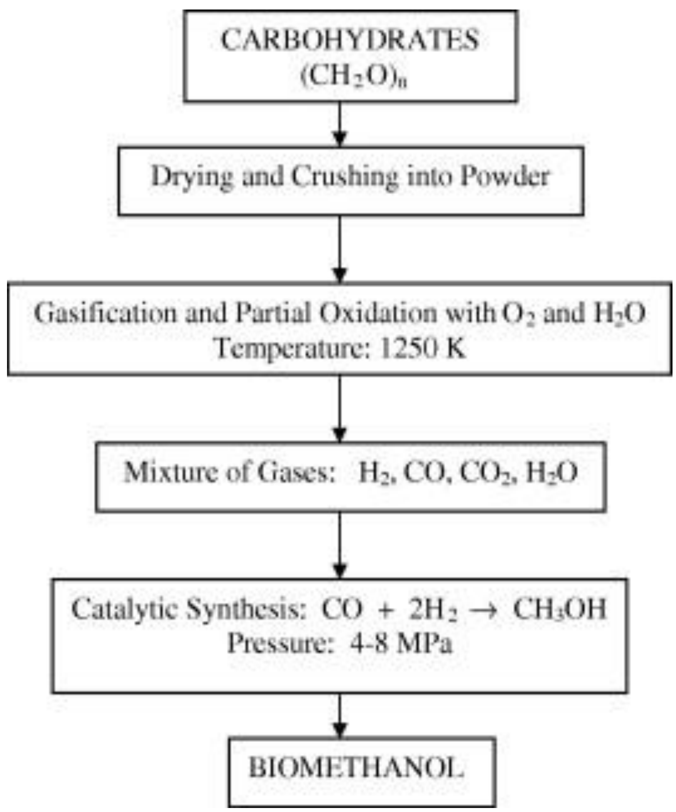


Figure 2.1: Biomethanol from carbohydrates by gasification and partial oxidation with O_2 and H_2O.

Adding sufficient hydrogen to the synthesis gas to convert all of the biomass into methanol carbon than double the methanol produced from the same biomass base [10].

As a renewable resource, biomass represents a potentially inexhaustible supply of feedstock for methanol production.

2.2.5 Vegetable Oils or Biodiesel

Vegetable oils are chemically triglycerides molecules where three fatty acids groups are attached to one glycerol molecule. It can be converted into maximum liquid and gaseous hydrocarbons by pyrolysis, decarboxylation, deoxygenation and catalytic cracking process [11, 12]. The liquid produced from pyrolysis process has similar chemical components to the conventional diesel fuel and can be used as alternative engine fuel. The process transesterification converts the vegetables oils into methyl, ethyl, 2-propyl and butyl esters by presence of potassium and/ or sodium alkoxides as catalyst. This is process is purposely done to lower down the viscosity of the oil by transforming the large-branched molecular structure into smaller-straight chain bio-oil molecules [8]. Biodiesel is technically proved that it is much better than the convectional petroleum diesel fuel.

2.2.6 Fischer-Tropsch Diesel or Bio-oil

The Fischer-Tropsch process is one of the advanced conversion technology that contribute the gasification of biomass feedstock, cleaning and conditioning the produced synthesis gas and liquid biofuel. Any type of biomass can be used as a feedstock, including woody and grassy materials and agricultural and forestry residues. The biomass is gasified to produce synthesis gas, which is a mixture of carbon monoxide (CO) and hydrogen (H_2). Prior to synthesis, this gas can be conditioned using the water gas shift to achieve the required H_2/CO ratio for the synthesis. The liquids produced from the syngas, which comprise various hydrocarbon fractions, are very clean which is sulphur free, straight-chain hydrocarbons, and can be converted further to automotive fuels. Figure 2.2 below, shows the process steps in production of green diesel and green gasoline facilities from biomass via Fisher–Tropsch synthesis.

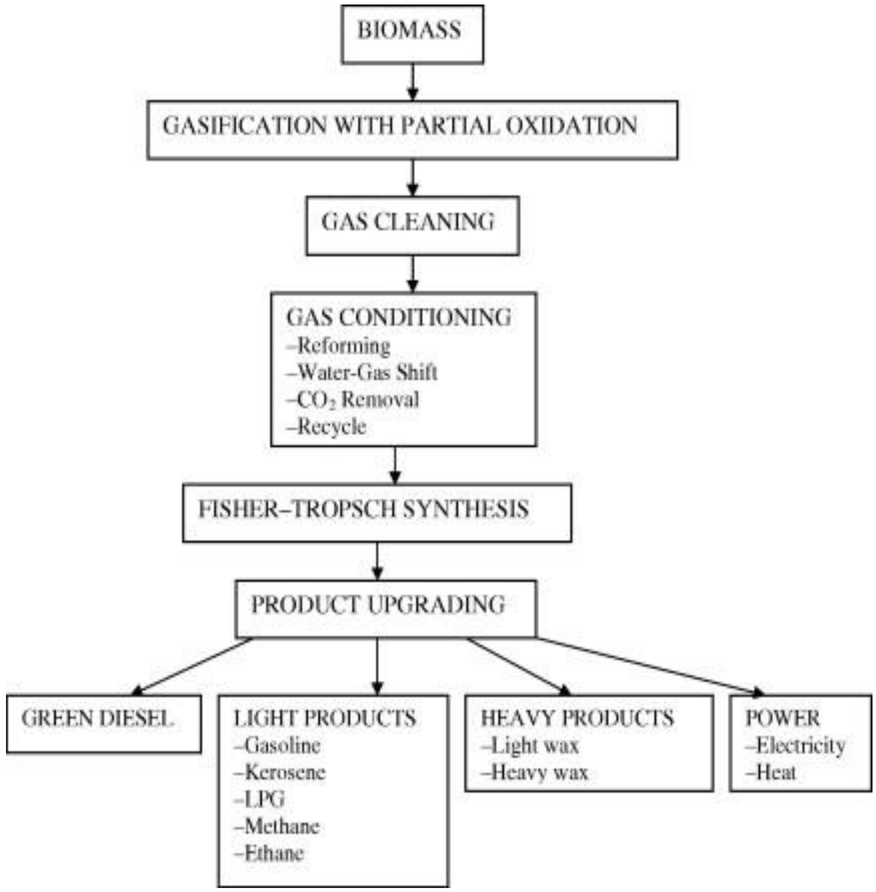


Figure 2.2: Green diesel and green gasoline facilities from biomass via Fisher–Tropsch synthesis

2.2.7 Bio-gas

Term "biogas" is usually defined as methane and carbon dioxide mixture produced from anaerobic digestion of biomass sludge such as animal wastes, sewage sludge and industrial effluents. This biogas produced in digester filled with feedstock like dung or sewage [8]. Basically, the process includes the anaerobic digestion of organic material by anaerobes. The solid byproduct, digestive, can be used as a biofuel or a fertilizer.

This kind of conversion do contribute energy and at the same time is beneficial effect to environment as well as human health, this is because during the digestion process bacteria in the sludge killed.

2.2.8 Biopetrol

Gasoline or petrol is a complex mixture of hydrocarbons which consists a mixture of C_4 to C_{10} alkanes. However isooctane ($C_{18}H_{18}$) as dominative component in petrol is assigned an octane number of 100. Isooctane or 2, 2, 4-trimethylpentane ($CH_3C(CH_3)_2CH_2CH(CH_3)CH_3$) is burns smoothly with a little knock in petrol engine. It is the highest quality of petrol (Mansur, 2005).

The other alternative to produce petrol is by using biopetrol. Biopetrol is defined as fuel which has the same characteristics with the commercial petrol in terms of its molecular formula.

2.3 Petroleum Refining

Petroleum refining is the process of separating the many compounds present in crude petroleum. This process is called fractional distillation where the crude oil is heated; where several of the compounds in crude oil will boil at different temperatures and change to gases; and are later condensed back into liquids. This is based on principle which the longer the hydrocarbon, the higher the boiling points [16].

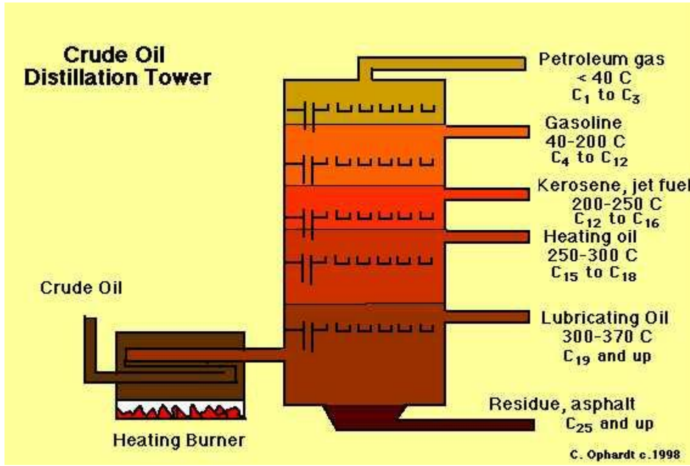


Figure 2.3: Distillation column in refining petroleum

Basically the crude petroleum is heated and changed into a gas. The gases are passed through a distillation column which becomes cooler as the height increases. When a compound in the gaseous state cools below its boiling point, it condenses into a liquid. The liquids may be drawn off the distilling column at various heights. Petroleum refining is industrial process plant where pure crude oil is processed and refined into various useful petroleum products such as gasoline, diesel fuel, heating oil, kerosene and liquefied petroleum gas [15] as shown in figure 2.3. It is very complex plant completed with different equipments and process. Table 2.1 shows the boiling points of each compound during the refining process.

Table 2.1: Boiling point for each compound in hydrocarbon cracking (Solomons, 1997)

Boiling Range of Fraction	Number of Carbon Atoms per Molecule	Use
Below 20	C1 – C4	Natural Gas, bottled gas, petrochemicals
20 – 60	C5 – C6	Petroleum ether, solvents
60 – 100	C6 – C7	Ligroin, solvents
40 – 200	C5 – C10	Gasoline (straight run gasoline)
175 – 325	C12 – C18	Kerosene and jet fuel
250 – 400	C12 and higher	Gas oil, fuel oil, and diesel oil