

**STUDY ON THE CONCENTRATION OF ISOOCTANE FROM OLEIC  
ACID**

**MOHD SHAHLI BIN MOHD SHEK**

**A thesis submitted in fulfillment of  
the requirement of the award of the degree of  
Bachelor of Chemical Engineering**

**Faculty of Chemical and Natural Resources Engineering  
University Malaysia Pahang**

**MAY 2008**

” I declare that this thesis is the result of my own research except as cited references.  
The thesis has not been accepted for any degree and is concurrently submitted in  
candidature of any degree.”

Signature :  
Name of Candidate : Mohd Shahli Bin Mohd Shek  
Date : 28 April 2008

To my beloved ones; my mother, father, Along, Angah, Alang, Uda, Ucu, and all my  
dearest friends

## ACKNOWLEDGMENT

In preparing this thesis, I was in contact with many people, researchers, academicians and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main supervisor, Mr. Syaiful Nizam b. Hassan for encouragement, guidance, critics and friendship.

I am also indeed indebted to FKKSA lectures and technical staff especially Madam Nor Hafizah Bt Zainal Abidin for her guideline and advices. Without their continued support and interest, this thesis would not be the same as presented here.

My fellow postgraduate students should also be recognized for their support. My sincere appreciation also extends to all my colleagues especially my lab partner Ms. Zaryati and other who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am very grateful to all my members in UMP and all my family members.

## Abstract

The purpose of analyzing and determination of the concentration of biopetrol obtained from oleic acid is to determine the quantitative amount of biopetrol required in future. Biopetrol is the latest finding in research of renewable liquid fuel and regarding on research that has being done, biodiesel that produced from vegetable oils can reduce emission of pollutants. In this study, oleic acid will be used as the raw material and thermal cracking method is used. Simple distillation at various temperatures which is 98°C, 200°C, 280°C, 320°C and 360°C is used to crack the long oleic acid chain to form biopetrol. The heat required will cracks the sample's molecular bonds randomly into small hydrocarbon radicals, followed by random isomerization of these radicals to form a mixture of new chains of alkanes with isooctane as the major component subjected. After cracking process, the sample is analyzed using Gas Chromatography method with comparison of the standard isooctane as reference. The results obtained from the analysis show that isooctane exists in the sample at retention time of 2.140 at average by comparing with standard isooctane calibration curve. The concentration of the Isooctane after cracking process is at various temperatures is in between 0.4 % to 3.4 %. This experiment is a success because the concentration of the desired component has being determined.

### **Abstrak**

Tujuan menganalisa dan menentukan kepekatan biopetrol yang diperolehi dari asid oleic adalah untuk menentukan banyaknya jumlah biopetrol yang diperlukan di masa hadapan. Biopetrol adalah penemuan terbaru dalam kajian untuk minyak yang boleh diperbaharui dan melalui kajian, penghasilan biodiesel dari minyak sayuran dapat mengurangkan pencemaran. Dalam kajian ini, asid oleic adalah sebagai bahan mentah dan teknik penguraian haba akan digunakan. Penyulingan pada 98°C, 200°C, 280°C, 320°C and 360°C digunakan untuk meguraikan rantai panjang asid oleic kepada biopetrol. Haba yang dibekalkan akan menguraikan rantai panjang asid oleic secara rawak kepada rantai hydrocarbon, diikuti dengan pengisomeran radikal tersebut untuk membentuk campuran rantai alkanes yang baru termasuklah isooktana yang menjadi bahan utama dalam kajian ini. Selepas penguraian tersebut, sampel akan dianalisa menggunakan alat Gas Kromatografi dengan membandingkan sampel yang terhasil dengan sampel isooktana yang asli. Graf dari hasil analisis menunjukkan bahawa isooktana wujud pada masa 2.140 minit secara purata. Kepekatan isooktana yang terhasil dari penguraian haba pada suhu yang berbeza adalah diantara 0.4 % hingga 3.4 %. Kajian ini telah mencapai objektifnya kerana kepekatan bahan yang diinginkan telah dapat diketahui.

## TABLE OF CONTENT

<b>CHAPTER</b>	<b>TITLE</b>	<b>PAGE</b>
	Declaration of Originality and Exclusiveness	i
	Dedication	v
	Acknowledgement	vi
	Abstract	vii
	Abstrak	viii
	Table of Content	ix
	List of Tables	xii
	List of Figures	xiii
	List of Symbols	xiv
<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
	1.1 Introduction	1
	1.2 Biopetrol from Oleic Acid	1
	1.3 Problem Statement	2
	1.4 Objectives	3
	1.5 Scope of Study	4
<b>2</b>	<b>LITERATURE REVIEW</b>	<b>5</b>
	2.1 Definition of Fuel	5
	2.2 Uses of Fuel	5
	2.3 Fuel Types by Period of Natural Renovation	6
	2.3.1 Fossil Fuels	6
	2.3.2 Petroleum Fuels	6
	2.3.3 Renewable Fuels	7
	2.4 Biological Fuels	8
	2.5 Biofuels Production Method	8
	2.6 Biofuels Impact on the Oil and Gas Sector	9
	2.6.1 Impact on Oil and Gas Market	9
	2.6.2 Impact on Oil Demand Growth	10
	2.7 Carbon Emissions	11
	2.8 Overview on Petroleum Refining Process	12

2.9	Conversion of Oil Refining	14
2.9.1	Cracking	14
2.9.1.1	Thermal Cracking	14
2.9.1.2	Catalytic Cracking	16
2.10	Chemicals	17
2.10.1	Oleic Acid	17
2.10.2	Isooctane	19
<b>3</b>	<b>METHODOLOGY</b>	21
3.1	The Overall Methodology	21
3.2	Preparation of Calibration Curve for Pure Isooctane	21
3.3	Sample Preparation	22
3.3.1	Experiment1 : Heating Oleic Acid at 98°C	22
3.3.2	Experiment2 : Heating Oleic Acid at 200°C	23
3.3.3	Experiment3 : Heating Oleic Acid at 250°C – 280°C	24
3.3.4	Experiment4 : Heating Oleic Acid at 290°C – 320°C	25
3.3.5	Experiment5 : Heating Oleic Acid at 330°C – 360°C	26
3.4	Analysis with Gas chromatography	27
<b>4</b>	<b>RESULTS AND DISCUSSION</b>	29
4.1	Introduction	29
4.2	Preparation of Calibration Curve	30
4.3	Observation for Oleic Acid Cracking	31
4.3.1	Cracking at 98°C	31
4.3.2	Cracking at 200°C	32
4.3.3	Cracking at 250°C – 280°C	32
4.3.4	Cracking at 290°C – 320°C	33
4.3.5	Cracking at 330°C – 360°C	34
4.4	Result for Isooctane Working Curve	34
4.5	Result for Oleic Acid Cracking	35
4.6	Discussion	36
4.7	Safety Precaution	38

<b>5</b>	<b>CONCLUSION &amp; RECOMMENDATION</b>	39
5.1	Conclusion	39
5.2	Recommendation	40
	<b>REFERENCE</b>	42
	<b>APPENDICES</b>	44

**LIST OF TABLES**

<b>Table</b>	<b>Title</b>	<b>Page</b>
2.1	Estimated Reserves and Availability of Fossil Fuels	6
2.2	Main Commercial Fuels Derivatives from Crude-Oil Properties	7
2.3	Main Pollutant Products from Fossil Fuels Emission	11
2.4	Boiling Point Difference for Hydrocarbon Cracking	13
2.5	Physical and Chemical Properties of Oleic Acid	19
2.6	Physical Properties of Isooctane	20
3.1	Sample of Isooctane and Hexane mixture	21
3.2	Gas Chromatography FID Data Condition	28
4.1	Component Ratio for Preparation of Working Curves	30
4.2	Result from Gas Chromatography Analysis	30
4.3	Results Summary for Oleic Acid Cracking at Various Temperature	36
4.4	Summary of the Peak Area	37

## LIST OF FIGURES

<b>Figure</b>	<b>Title</b>	<b>Page</b>
1.1	Malaysia's Looming Energy Crisis	3
2.1	Structure of Oleic Acid	17
2.2	<i>Cis</i> -configuration of Oleic Acid	18
3.1	Simple Distillation Units	22
3.2	Flow Diagrams for Cracking Process of Oleic Acid at 98°C	23
3.3	Flow Diagrams for Cracking Process of Oleic Acid at 200°C	24
3.4	Flow Diagrams for Cracking Process of Oleic Acid at 250°C-280°C	25
3.5	Flow Diagrams for Cracking Process of Oleic Acid at 290°C-320°C	26
3.6	Flow Diagrams for Cracking Process of Oleic Acid at 330°C-360°C	27
4.1	Oleic Acid after Cracking Process	29
4.2	Working Curve for Hexane-Isooctane Mixture	31
4.3	Sample 1 (Oleic Acid at 98°C)	32
4.4	Sample 1 (Oleic Acid at 200°C)	32
4.5	Sample 3 (Oleic Acid at 250°C – 280°C)	33
4.6	Sample 3 (Oleic Acid at 290°C – 320°C)	33
4.7	Sample 3 (Oleic Acid at 330°C – 360°C)	34
4.8	Chromatogram for Standard Isooctane	35
4.9	Isooctane Concentration Obtained from Cracking Oleic Acid at Various Temperature	38

**LIST OF SYMBOLS**

<b>Symbols</b>	<b>Title</b>
P	Pressure
m	Mass
$\Delta H$	Enthalpy change of reaction
$\Delta S$	Entropy change of reaction
$\Delta G$	Energy change of reaction
T	Temperature
$\rho$	Density
$\mu$	Viscosity of liquid (Pa.s)
h	Heat transfer coefficient
$^{\circ}\text{C}$	Degree Celsius
kg	Kilogram
K	Kelvin
m	Meter
n	Number of moles
L	Liter
MBD	Million Barrel per Day
$D_o$	Dissociation Energy

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

Petrol or commonly known as gasoline is the most demanding fuel in this century. Gasoline is a liquid obtained from petroleum, used especially as a fuel for cars, aircraft and other vehicles. The declining petroleum source that we face today causes the increasing of the petroleum prices all over the world. This problem can be solving by using an alternative source to replacing this material.

Many researches have been done to find alternative fuel to substitute petrol which is biopetrol. Some of the process based on agricultural oil and convert it obtain methyl esters (biodiesel). Biodiesel is only suitable for diesel engine. The gasoline engines need bio-gasoline to be produce (Bhatia, 2006). This study is done to produce isooctane which as the major component in gasoline and oleic acid is used as the raw material. Oleic acid is a monosaturated fatty acid and about 40% of oleic acid consists in palm oil. Thermal cracking method will be used to convert oleic acid to biopetrol.

#### **1.2 Biopetrol from Oleic Acid**

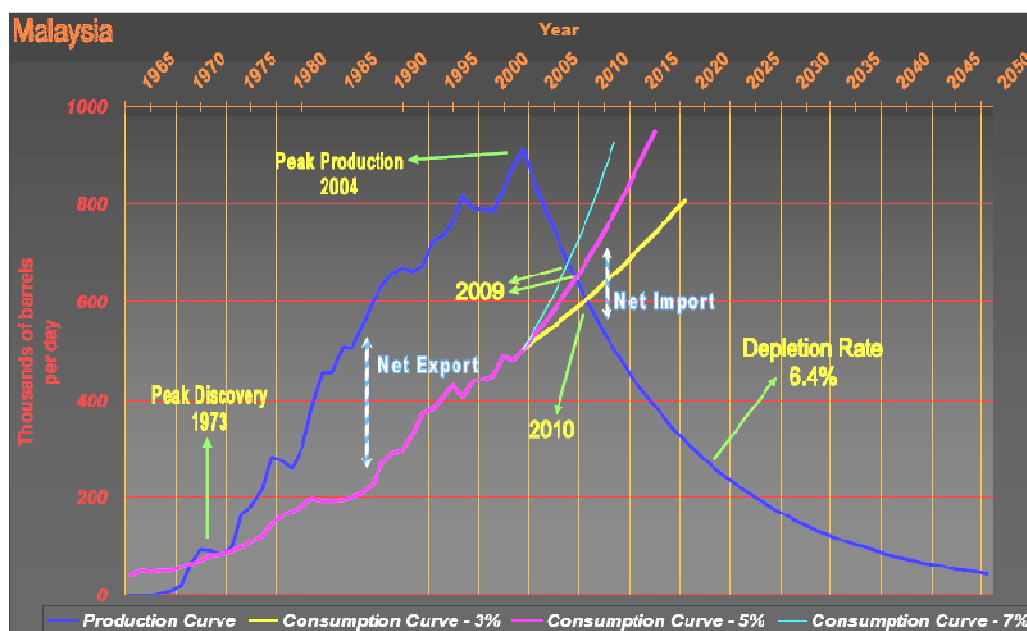
The study of alternative gasoline that has been done previously by researcher is the additional of ethanol into fossil gasoline. But the study only decrease the usage of fossil fuel but it still contributes to bad health and environment effects. By using biopetrol, the bad health and environment effects will be decrease. To produce

isooctane from oleic acid, thermal cracking process is required. Heat required should be supplied in order to breaking the oleic acid's molecular bonding, and allows the formation of new arrangements of hydrocarbon compounds including isooctane.

The sample produced will have lots of hydrocarbon chains because the heat breaks the carbon chain randomly. The sample will produce alkanes from  $C_5$  until  $C_{12}$  are which is also being categorized as gasoline, but the major component in this study will be focusing on isooctane ( $C_8H_{18}$ ). Oleic acid or 10-heptadecenoic acid ( $C_{18}H_{34}O_2$ ) is a fatty acid found in animal and vegetable oils (Omar, 2005). Further information regarding oleic acid will be discussed in literature review.

### **1.3 Problem Statement**

The petrol price is increasing dramatically year by year. It is because of the decreasing of fuel supply and also the sources are unevenly spread (most petroleum reserves are in the Middle East or West Asia, causing economic and political instabilities). Malaysia, one of OPEC (Organization of the Petroleum Exporting Countries) member also has the crisis of the declining of these mineral sources. Malaysia's oil production peaked was in 2004 and would then decline by 6.4 percent annually. Figure 1.1 shows the declining Malaysia oil's production by 2004 and it affects the global gasoline price annually. It is estimated, by 2009 to 2010 Malaysia will become a net importer and stop being the petroleum exporter. The producing petrol from the waste of palm oil will give an alternative choice to the users, especially the petrol-engine vehicles' owners. In addition, this biopetrol, which is graded 100 for the octane number, burns very smoothly so biopetrol can reduce emissions of some pollutants (Omar, 2005:3).



**Fig 1.1 : Malaysia's Looming Energy Crisis (Mohamed Noor, 2008)**

Oleic acid is the dominative component in palm oil waste. Its disposal into water supply sources causes serious water pollution. Besides that the loss of oleic acid as a useful industrial component also occurs so that it is no 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.

In this study, the concentration of isooctane produced from oleic acid and also the conversion of fatty acids to form isooctane are the main objectives. Biopetrol is defined as liquid or gaseous fuel that can be produced from the utilization of biomass substrates and can be serving partially as a substitute for fossil fuels.

#### 1.4 Objectives

- i. To analyze isooctane obtained from oleic acid
- ii. To find the concentration of biopetrol obtained from oleic acid

## **1.5 Scope of Study**

To achieve the objectives, scopes have been identified in this research. The scopes of this research are listed as below:-

- i. To describe the molecular arrangement in cracking process
- ii. To understand the thermal cracking and distillation process
- iii. To identify the composition of isooctane using Gas Chromatography method
- iv. To determine the amount of isooctane in sample obtained using Gas Chromatography

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Definition of Fuel

Fuel (from Old French *feuaile*, the combination phrase from *feu* (fire; ultimately from Latin focus fireplace, hearth) is a substance that may be burned in air (or any other oxidant-containing substance). Fuels reacts quickly with oxygen that heat and light is emitted in the form of a sustained flame. Usually 'fuel' only refer to easily flammable substances in air. Air is the oxidizer needed by a fuel to burn, and it is needed in larger quantities than fuels (Isidoro, 2007). Oxygen in the air is the basic oxidant for fuels while nitrogen is basically inert, although it combines endothermically with oxygen at high temperatures to get the unwanted NO<sub>x</sub> pollutants. Oxygen is then readily available from Earth's atmosphere that is why it is the main oxidiser. Fuels are used as convenient energy stores because of their high specific energy release when burnt with air. Primary (natural) fuels may be difficult to find in nature, and secondary (artificial) fuels may be difficult to be manufactured, but, once at hand, fuels are very easy to store, transport and use, with the only nuisance of safety (uncontrolled combustion) and pollution (toxic emissions during storage and when burnt).

#### 2.2 Uses of Fuel

Energy is a basic need to humans and is used for heat generation, for work generation, or for chemical transformations. A common problem to all human needs

(except air) is that energy is not available at the location and time we desire, and sources must be found (for energy, water, food, minerals) and transportation to a better place must be arranged, as well as storage and end-use details. Storage is sometimes the most cumbersome stage, for example for food (all food is perishable, particularly meat, fish, vegetables and fruits) and for electrical energy.

## 2.3 Fuel Types by Period of Natural Renovation

### 2.3.1 Fossil Fuels

Fossil fuels (coal, crude-oil and natural gas) were formed slowly during millions of years, mainly at certain remote epochs, not uniformly; for example American oil was formed some 90 million years ago by high-pressure-decomposition of trapped vegetable and animal matters during extreme global warming. Fossil fuels are found trapped in Earth's crust, up to 10 km depth, although large pressure might stabilize them also at higher depths and temperatures (at 300 km it might be 10 GPa and 1000 °C). They are then non-renewable energy supply at humankind periods, and will eventually be commercially depleted (Isidoro, 2007). Table 2.1 indicated the estimated reserves and the availability of fossil fuels sources. Notice that 'sources' refers to the total amount in Nature, whereas “reserves” refers to that portion of resources that can be economically recovered at today's selling prices, using today's technologies and under today's legislation.

**Table 2.1 : Estimated Reserves and Availability of Fossil Fuels (Isidoro, 2007)**

	Commercial Reserve	Reserve/Consumption
Coal	$1000 \cdot 10^{12}$ kg	250 yr
Crude oil	$100 \cdot 10^{12}$ kg	40 yr
Natural gas	$150 \cdot 10^{12}$ kg.	70 yr

### 2.3.2 Petroleum Fuels

More than 50% of world's primary energy comes nowadays from petroleum

that is all vehicle fuels, and small and medium stationary applications fuels are petroleum derivatives, obtained by fractional distillation and reforming. Main commercial fuels and their physical data are presented in Table 2.2. Petroleum refining as shown in table below is the process of separating the many compounds present in crude petroleum. This process is called fractional distillation where the crude oil is heated and the several of the compounds boil at different temperature and change to gases and are later re-condensed back into liquids.

**Table 2.2 : Main Commercial Fuels Derivatives from Crude-Oil Properties**  
(Isidoro, 2007)

	Boiling range [°C]	Carbon chain range	Density (liquid at 15 °C) $\rho$ [kg/m <sup>3</sup> ]	Viscosity at 40 °C $\nu \cdot 10^6$ [m <sup>2</sup> /s]	Main use
Liquefied petroleum gases (LPG)	<30	C <sub>1</sub> - C <sub>4</sub>	580	0.5	domestic heating, cars
Gasoline	30 - 200	C <sub>4</sub> - C <sub>12</sub>	730 - 760	0.5	cars
Kerosene	150 - 350	C <sub>10</sub> - C <sub>14</sub>	780 - 850	3	aircrafts
Diesel	200 - 300	C <sub>10</sub> - C <sub>20</sub>	820 - 880	3	cars, lorries, boats
Fuel oil distillate	300 - 500	C <sub>15</sub> - C <sub>30</sub>	840 - 930	10	industry, ships

### 2.3.3 Renewable Fuels

Renewable fuels (biomass) are formed in a year or a few years basis (synthetic fuels may come from fossil or from renewable sources):

- Gas: biogas from anaerobic fermentation or flue gas from pyrolysis of biomass.
- Liquid: alcohols, ethers, liquid paraffins (biopetrol), esters (biodiesel).
- Solid: wood, charcoal, fuel pellets (from wood or vegetable residues), agricultural residues, cattle manure, urban waste.

## **2.4 Biological Fuels**

Late in the 20<sup>th</sup> fossil fuel depletion indicators, and local and global pollution associated to fossil fuels, have been pressing to come back from 'black fossil power' to 'green renewable power', and, as fuels continue to be the best solution for energy storage, specially for transport applications, biofuels are at the stage again.

At 1999, biofuel life cycle study concluded that the biofuel reduces net CO<sub>2</sub> emissions by 78% compared to petroleum fuel from natural fossil fuels. The CO<sub>2</sub> released into the atmosphere from the combusted biofuel is recycled and reused by growing plants, which later processed into fuel (Lee, 2006).

The terms: biofuels, biomass fuels and renewable fuels, may be used indistinctly if they refer to natural or artificial fuels obtained from renewable sources, although other times distinctions are introduced and then biofuels may refer to biomass derivatives directly substituting fossil fuels for the same combustor, biomass may be restricted to unprocessed biomass (forest waste, crops and agriculture waste, animal waste, domestic waste), and renewable may include fuels like hydrogen obtained by electrolysis and not from biomass.

But the move to biofuels is not based on their short-term advantage over fossil fuels but on the long-term need to have fuels of any kind. And for the time being, living matter and their residues are a handy alternative to dying fossil fuels

## **2.5 Biofuels Production Method**

From the previous study, there is a lot of work has been done to substitute the fossil fuel. There are several methods that have been established with a scale up production for producing the biofuel. Some of the methods are listed below:

- Ethanol by fermentation of biomass sugars, starch or cellulose by yeast or bacteria. In Japan, a bacteria has been bred which produces ethanol from paper or rice-straw without any pre-treatment.
- Methane (actually a biogas mixture) by anaerobic digestion of biomass waste (manure, straw, sewage, municipal solid waste (MSW)).
- Oils (biodiesel) by reforming oleaginous plant seeds (e.g. colza, sunflower, soy).
- Methanol from wood-waste distillation.

For mobile applications, because of higher energy density and simpler infrastructure, liquid biofuels are preferred (ethanol and biodiesel), gaseous biofuels being restricted to stationary applications. As an aid in transition from fossil fuels to biofuels, mixtures of both are being progressively put on the market for old engines and combustors, and new engines and combustors are progressively developed to run on 'biofuel prototypes' derived from current fossil fuels (Isidoro, 2007)

## **2.6 Biofuels Impact on the Oil and Gas Sector**

### **2.6.1 Impact on Oil and Gas Market**

The rise of alternative fuels, the increasing fear of fuels insecurity, and a growing awareness of the need to confront global climate change will likely have some profound longer-term impacts on oil prices, refining margins, and traditional oil and gas stock selection.

The rising of biofuels production (ethanol and biodiesel) will help alleviate tightness in the supply of transportation fuels and will have a negative impact over time on conventional refined product margins.

The current trend toward diesel and hybrid vehicles, and away from pure gasoline engines, looks set to continue with some uncertainty regarding which way

the product will go. However, consumer and government choices are only one side of the equation. It is not clear at all that the global refining system could accommodate a large-scale shift toward diesel, particularly if this were to occur in the Malaysia.

Finally, concerns over emissions and potentially higher prices for CO<sub>2</sub> will at some point likely lead to projects such as the Canadian oil sands or the coal-to-liquids industry (Westlake, 2007).

## **2.6.2 Impact on Oil Demand Growth**

Global oil demand is currently growing at around 1.5% per annum. Non-OPEC (Organization of the Petroleum Exporting Countries) supply is struggling to keep pace, and even the strong investment levels in OPEC countries may not be enough to supply this level of demand growth (Westlake, 2007).

In the rest of the world, it is possible that world's oil demand could fall faster than expected, although efficiency of oil use is already relatively high. Biofuels will likely provide the impetus for lower oil demand in the rest of the world.

Natural gas substitution for oil in the rest of the world is a widespread medium-term phenomenon that should limit the growth in oil demand. This could remove 0.25% from annual oil demand growth in the rest of the world, under the right combination of investment and circumstances.

Lowering our demand growth estimates to the downside cases outlined above would produce medium-term oil demand growth of 1%, down from 1.5%. This difference would reduce estimated oil demand in 2020 by 7 MBD to 97 MBD. (2006 oil demand was 84.6 MBD.) Under this scenario, around 0.5 MBD per annum of net oil supply would not be needed (Westlake, 2007)

## 2.7 Carbon Emissions

The main products of the combustion of natural gas are carbon dioxide and water vapor, the same compounds we exhale when we breathe. Coal and oil are composed of much more complex molecules, with a higher carbon ratio and higher nitrogen and sulfur contents. This means that when combusted, coal and oil release higher levels of harmful emissions, including a higher ratio of carbon emissions, nitrogen oxides (NO<sub>x</sub>), and sulfur dioxide (SO<sub>2</sub>). Coal and fuel oil also release ash particles into the environment, substances that do not burn but instead are carried into the atmosphere and contribute to pollution as shown on Table 2.3. The combustion of natural gas, on the other hand, releases very small amounts of sulfur dioxide and nitrogen oxides, virtually no ash or particulate matter, and lower levels of carbon dioxide, carbon monoxide, and other reactive hydrocarbons.

**Table 2.3 : Main Pollutant Products from Fossil Fuels Emission (EPA, 2007)**

Fossil Fuel Emission Levels - Pounds per Billion Btu of Energy Input			
Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591
Particulates	7	84	2,744

By comparing the emissions between fossil fuel and biofuels, some conclusion has been made:

- The alternative fuels (biofuels), burns up to 75% cleaner than fossil fuels.
- Biofuels substantially reduces unburned hydrocarbons, carbon monoxide and particulate matter in exhaust fumes. Sulphur dioxide emissions are 100% eliminated (biofuels contains no sulphur).
- This alternative fuel is plant-based and adds absolutely no CO<sub>2</sub> to the atmosphere.
- Biofuels is environmentally friendly: it is renewable.
- Biofuel can reduce potential risks of cancer and birth defects cause from gas emission from fossil fuels.
- Biofuels helps preserve natural resources.

## 2.8 Overview on Petroleum Refining Process

Cracking is the most important process in petroleum industry. There is two type of cracking process, thermal cracking and catalytic cracking. Petroleum is a complex mixture of organic compounds, most of which are alkanes and aromatic hydrocarbons. It also contains small amounts of oxygen (O), nitrogen (N), and sulfur (S). Mixtures of alkanes are perfectly suitable for uses in fuels, solvents and lubricants. As from history, alchemists of the 'Middle Ages' attempted to change base metals into gold by practicing wizardry. In a sense, refiners could be regarded as the modern day heirs apparent to these medieval sorcerers by transforming crude oil into a variety of useful and valuable products. Instead of using magic, however, refiners employ chemical science and processing technology to perform their unique brand of metamorphosis. Spread out over a number of acres, a refinery is a remarkable maze of metal, machinery and manpower (Noe'l, 2002). Towers, tanks, process vessels, pipelines, pumps, heat exchangers and compressors are just some of the components of a modern refinery. Operators, engineers, researchers, technicians, craftsmen and maintenance personnel are among those needed to keep a refinery running round-the-clock. A refinery consists of a number of different units, each with a specific purpose, integrated into a processing sequence.

The petroleum industry refines crude oil to obtain useful products. Refineries and chemical plants account for about a fifth of the industry's total investment in property and equipment. The United States has about 300 refineries that range in capacity from 40 to 365,000 barrels of oil a day. The world's largest refinery is in Abadan, Iran. It can process 412,000 barrels daily when running at full capacity (Noe'l, 2002).

Hydrocarbons contain a lot of energy. Many of the things derived from crude oil like gasoline, diesel fuel, paraffin wax and so on take advantage of this energy. Hydrocarbons can take on many different forms. The smallest hydrocarbon is methane ( $\text{CH}_4$ ), which is a gas that is a lighter than air. Longer chains with 5 or more carbons are liquids. Very long chains are solids like wax or tar. By chemically cross-linking hydrocarbon chains can be everything from synthetic rubber to nylon to the