STUDY OF BIODIESEL PRODUCTION FROM VEGETABLE OILS AND ITS APPLICATION IN DIESEL ENGINE

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Thesis is Submitted To
Faculty of Engineering, Universiti Malaysia Sarawak
In partial fulfilment of the Requirements
For the Bachelor Degree of Engineering
with Honours (Mechanical and Manufacturing Engineering) 2009

UNIVERSITI MALAYSIA SARAWAK

R13a

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Judul: **STUDY OF BIODIESEL PRODUCTION FROM VEGETABLE OILS AND ITS APPLICATION IN DIESEL ENGINE**

SESI PENGAJIAN: 2008/2009

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Dedicated to,
My beloved family and friends

ACKNOWLEDGEMENT

The author would like to express his sincere gratitude to all the individuals who have assisted and guided him during his project study.

First of all, the author would like to express his deepest appreciation to his supervisor, Dr. Abu Saleh Ahmed for his patience, invaluable advice, and restless supports for the author's Final Year Project. The author would also like to take this opportunity to thank his supervisor for his superb supervision and guidance as well as giving the author extraordinary experiences from the very early stage which has made them the backbone of the research and so to this thesis. Without the supervisor guidance, it will be a tough start for the author's research. The author would also like to thank his mentor, Mr. Nazeri Abdul Rahman for his precious opinions and motivation. The author would like to express his gratitude to the Faculty of Engineering, Universiti Malaysia Sarawak for the facilities and supports provided.

The author would also like to thank all the lab assistants who have assisted him throughout the project. The author's deepest appreciation goes to Mr. Ricky Stu Anding for his helps and supports during the ongoing research. There are many things that the author and Mr. Ricky shared and discussed among themselves throughout the research.

Finally, the author would like to thank to his family for their inspiration, encouragement and continuous support.

ABSTRAK

Biodisel ialah sejenis bahanapi alternatif yang dihasilkan melalui transesterifikasi minyak sayur. Penghasilan biodisel dengan menggunakan minyak sayur terpakai adalah penting kerana kos penghasilannya yang rendah dan keupayaannya untuk kitar semula minyak terpakai. Pengkajian ini menitikberatkan kecekapan dalam penukaran minyak masak tulen dan minyak masak terpakai ke biodisel dan penilaian biodisel minyak sayur melalui prestasi enjin. Kaedah transesterifikasi pemangkin alkali dengan minyak sawit, minyak bunga matahari, minyak kelapa dan minyak terpakai dijalankan dan kecekapan penukaran ke biodisel dinilai melalui jumlah biodisel yang dihasilkan. Disel normal B0 (iaitu 0% biodisel dan 100% disel) dan campuran biodisel yang berlainan B10, B20, B30, B40 dan B50 diuji dalam enjin disel dan prestasi enjin direkodkan. Dengan menggunakan nisbah isipadu 1:1 metanol ke minyak sayur dan pemangkin kalium hidroksida (KOH), penukaran ke biodisel minyak sawit menghasilkan jumlah biodisel yang tertinggi. Sebaliknya, penukaran ke biodisel minyak sayur terpakai menghasilkan jumlah biodisel yang terendah. Enjin disel yang diisi dengan B50 biodisel minyak kelapa menghasilkan penurunan yang terendah dalam keluaran kuasa enjin dan tambahan terendah dalam penggunaan bahan api tentu jikalau dibandingkan dengan penggunaan biodisel normal. Manakala pengisian enjin disel dengan B50 biodisel minyak sayur terpakai akan menghasilkan penurunan kecekapan mekanikal yang terendah. Walaubagaimanapun, penggunaan bahan api biodisel campuran yang lebih rendah seperti B10 dan B20 akan menghasilkan variasi enjin prestasi yang lebih rendah.

ABSTRACT

Biodiesel is one of the alternative fuels which are produced from transesterification of vegetable oil. Biodiesel production using waste vegetable oils is of great interest due to its low cost and the ability to recycle and reuse waste oils. This study concerns the efficient conversion of straight and waste vegetable oil to biodiesel and the assessment of vegetable oil biodiesel in terms of the resulted engine performance. Alkali-catalyzed transesterification of palm, sunflower, coconut and waste oils was carried out and the vegetable oil conversion to biodiesel efficiency is rated by the amount of biodiesel yield. Normal diesel B0 (i.e. 0% biodiesel and 100% diesel) and different types of biodiesel blends B10, B20, B30, B40 and B50 were tested in diesel engine and the engine performance was recorded. By using 1:1 volume ratio of methanol to vegetable oil and potassium hydroxide (KOH) catalyst, the conversion to palm oil biodiesel produced the highest yield. Conversely, conversion to waste vegetable oil biodiesel resulted in the lowest yield. Diesel engine fuelled with B50 coconut oil biodiesel blend resulted in lowest drop in engine power output and increment in specific fuel consumption if compared to using normal diesel. While fuelling with B50 waste vegetable oil biodiesel blend, it resulted in the lowest drop in mechanical efficiency. However, lower variation in engine performance is resulted when fuelling with lower biodiesel blend like B10 and B20.

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LIST OF ABBREVIATIONS

A	-	Ampere
ASTM	-	American Society for Testing and Materials
B0	-	Biodiesel Blend with 0% Biodiesel and 100% Diesel
B10	-	Biodiesel Blend with 10% Biodiesel and 90% Diesel
B20	-	Biodiesel Blend with 20% Biodiesel and 80% Diesel
B30	-	Biodiesel Blend with 30% Biodiesel and 70% Diesel
B40	-	Biodiesel Blend with 40% Biodiesel and 60% Diesel
B50	-	Biodiesel Blend with 50% Biodiesel and 50% Diesel
B60	-	Biodiesel Blend with 60% Biodiesel and 40% Diesel
B80	-	Biodiesel Blend with 80% Biodiesel and 20% Diesel
B100	-	Biodiesel Blend with 100% Biodiesel and 0% Diesel
b/d	-	Barrel per Day
Bhp	-	Brake Horse Power
$^{\circ}C$	-	Degree Celsius
CI	-	Compression Ignition
cm^2	-	Centimeter Square
CO	-	Carbon Monoxide
CO_2	-	Carbon dioxide
COCO	-	Coconut Oil
EN	-	European Standard for Product and Services
EPA	-	Environmental Protection Agency

EU	-	European Union
F	-	Fahrenheit
FFA	-	Free Fatty Acid
g	-	Gram
GHG	-	Greenhouse Gas
HP	-	Horse Power
HSU	-	Hartridge Smoke Unit
Ihp	-	Indicated Horse Power
IEA	-	International Energy Agency
kg/kW.hr	-	Kilogram per Kilowatt power per Hour
kgf/cm^2	-	Kilogram-force per Centimeter Square
KOH	-	Potassium Hydroxide
kW	-	Kilowatt
l	-	Length of Stroke
M	-	Million
MJ/kg	-	Mega Joule per Kilogram
MeOH	-	Methyl Ester
ml/s	-	Milliliter per Second
ml/kW	-	Milliliter per Kilowatt
mmb/d	-	Millions Barrel per Day
	-	Speed in rpm (revolution per minute)
N	-	Number of Strokes Diesel Engine is running
NaOH	-	Sodium Hydroxide
$NaOCH_3$	-	Sodium Methoxide

Nm	-	SI unit for Torque
NO_x	-	Nitrogen Oxides
OECD	-	Organization for Economic Co-operation and Development
PALM	-	Palm Oil
ppm	-	Parts per Million
pH	-	Measure of Acidity and Basicity of a Solution
psi	-	Pound per Square Inch
rpm	-	Revolution per Minute
s	-	Second
SBO	-	Soybean Oil
SFC	-	Specific Fuel Consumption
SO_X	-	Sulfur Oxides
SUN	-	Sunflower Oil
US$	-	US Dollars
U.S	-	United States
US	-	United States
V	-	Volt
VOCs	-	Volatile Organic Compounds
WVO	-	Waste Vegetable Oil
$	-	Dollar
	-	Mechanical Efficiency

CHAPTER 1

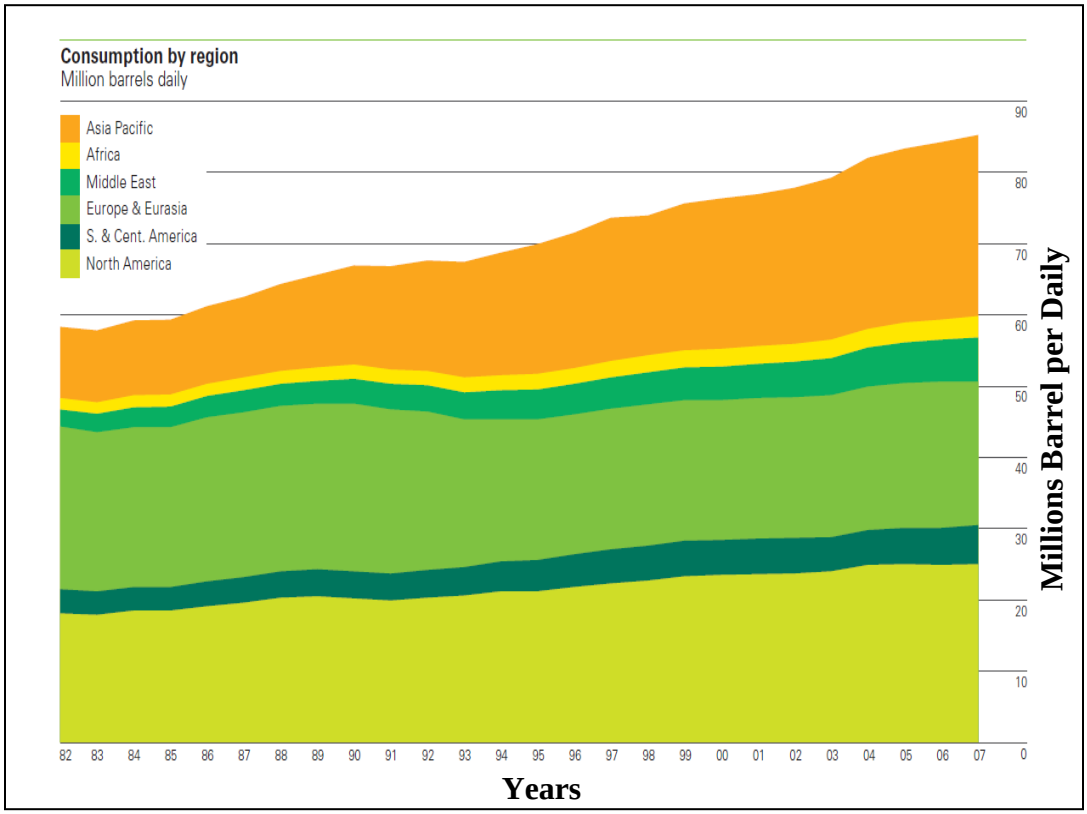
INTRODUCTION

1.1 Background

Biodiesel is one of the sustainable types of energies which can be produced from oil or fats through the process called transesterification (Tabe *et al*., 2003). Before the World War 2, biodiesel has been introduced in South Africa with the purpose of powering heavy-duty vehicles. Due to the recent environmental and domestic economic concerns, the use of biodiesel is revived throughout the world (Saifuddin & Chua, 2004).

The increases in industrialization and population have causes the energy demand in world to increase continuously. Mainly, these energy demands are fulfilled by basic energy sources like fossil fuels, hydro and nuclear (Hossain *et al*., 2007).

Statistically, the global oil consumption grew by 1.1% in year 2007 (comparing to the year before) which is 1 million barrels per day. While the global natural gas and coal consumption was reported grew by 3.1% and 4.5% respectively in year 2007 (BP, 2008). What worry the global is the increasing trend of fossil fuels consumption will result in drastic atmospheric pollution and a substantial decrease in fossil fuel reserves (Hossain *et al*., 2007).



Additional Facts: World oil consumption rose about 1mmb/d (million barrels per day) in 2007, just below the 10-year average. Organization for Economic Co-operation and Development (OECD) member countries consumption declined nearly 400,000b/d (barrel per day). China accounted for the largest increment to consumption even though the growth rate was below average. Consumption in oil exporting regions was robust (BP, 2000)

Figure 1.1: World's Region Oil Consumption by Million Barrels Daily (BP, 2008).

During the fuel crisis, the soaring cost of oil is burdening motorists and consumers the world over (AlJazeera, 2008). While the world is searching for remedies, biodiesel has appeared to be one of the solutions for the crisis. Operationally, biodiesel performs very similar to low sulfur diesel in terms of power, torque, and fuel without major modification of engines or infrastructure. The low emissions of biodiesel make it an ideal fuel for use in many applications (Biodiesel Association of Australia, n.d.).