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PROSPECT OF BIODIESEL PRODUCTION FROM WASTE OIL AND FAT IN MALAYSIA

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Bachelor of Engineering with Honours
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PROSPECT OF BIODIESEL PRODUCTION FROM WASTE OIL AND FAT IN MALAYSIA

MICHAEL SU CHUANG HUNG

Thesis is submitted to

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To my beloved family and friends

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ABSTRAK

Biodiesel adalah sejenis bahanapi alternatif yang dihasilkan daripada minyak sayur tulen atau terpakai dan lemak haiwan. Ia adalah terbiodegrasi, tenaga yang dapat dibaharui dan pembakaran bersih alternatif. Kertas ini membentangkan kajian mengenai kecekapan penukaran minyak terpakai dan lemak ke biodiesel dan penilaian biodiesel minyak terpakai dan lemak melalui prestasi enjin. Kaedah tranesterifikasi pemangkin alkali digunakan untuk menghasilkan biodiesel daripada minyak terpakai (kelapa sawit, minyak kelapa dan minyak bunga matahari terpakai) dan lemak (lemak lembu, lemak itik dan lemak ayam). Penukaran daripada minyak kelapa (97%) dan lemak itik (96.4%) menghasilkan jumlah biodiesel yang tertinggi. Manakala, penukaran daripada minyak kelapa sawit terpakai (91%) dan lemak ayam (94%) ke biodiesel menghasilkan jumlah biodiesel yang terendah. Prestasi enjin jangka pendek dijalankan untuk menguji mesin diesel yang berisi campuran biodiesel minyak terpakai atau lemak daripada B0 ke B50. Ditemukan juga bahawa campuran biodiesel minyak terpakai dan lemak menunjukkan penurunan dalam keluaran kuasa mesin, kekuatan enjin dan efisiensi mekanik. Sebaliknya, konsumsi bahan bakar spesifik meningkat dengan peratusan pencampuran. Manakala mengisi enjin diesel dengan biodiesel minyak kelapa terpakai atau minyak lembu akan menghasilkan penurunan kekuatan enjin dan efisiense mekanik yang terendah. Secara keseluruhan, campuran biodiesel B20 untuk semua minyak sayur terpakai dan lemak binatang menghasilkan variasi yang lebih rendah dalam prestasi. Disarankan bahawa kajian lebih lanjut perlu dilakukan untuk meningkatkan kekuatan enjin, keluaran kuasa enjin dan pengurangan konsumsi bahan bakar spesifik.

ABSTRAK

Biodiesel is one of the alternative fuels which are derived from straight or used vegetable oils and animal fats. It is a biodegradable, renewable energy and clean burning alternative. This paper presents a comparative study on efficiency of conversion of waste oil and fat to biodiesel and the performance of diesel engine using waste oil and fat biodiesel. The base-catalyzed transesterification method was used to produce biodiesel from waste oils (waste palm oil, waste coconut oil and waste sunflower oil) and fats (beef tallow, duck tallow and chicken fat). The conversion of waste coconut oil (97%) and duck tallow (96.4%) to biodiesel produced the highest yield. However, the conversion of waste palm oil (91%) and chicken fat (94%) to biodiesel resulted in lowest yield. Short-term engine performance tests were carried out on test diesel engine fuelled with waste oil or fat biodiesel blends from B0 to B50. It was found that waste oil and fat biodiesel blends showed a decrease in engine power output, brake horse power and mechanical efficiency. Conversely, the specific fuel consumption increased with blending percentage. While fueling diesel engine with waste coconut or beef oil biodiesel, it resulted in lowest drop in engine power output and mechanical efficiency. Overall, B20 biodiesel blend for all waste oils and fats resulted lower variation in engine performance when fueling in diesel engine. It is recommended a further research should be taken to improve the brake horse power, power output and reduction in the specific fuel consumption.

TABLE OF CONTENTS

Content
Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A	-	Ampere
ASTM	-	American Society for Testing and Materials
B0	-	Biodiesel Blend with 0% Biodiesel and 100% Diesel
B5	-	Biodiesel Blend with 5% Biodiesel and 95% 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
BFO	-	Biodiesel from Beef Fat
BHP	-	Break Horse Power
BTU	-	British thermal unit
^0C	-	Degree Celsius
CFO	-	Biodiesel from Chicken Fat
CI	-	Compression Ignition
CO	-	Carbon monoxide
CO_2	-	Carbon Dioxide
CPO	-	Crude Palm Oil
DFO	-	Biodiesel from Duck Fat
EU	-	European Union
EPA	-	Environment Protection Agency
EPAct	-	Energy Policy Act
FFA	-	Free fatty acid

HC	-	Hydrocarbons
KOH	-	Potassium hydroxide
NaOH	-	Sodium hydroxide
NBB	-	National Biodiesel Board
U.S.	-	United States
RPM	-	Revolution per minute
s	-	Second
SFC	-	Specific Fuel Consumption
THC	-	Lower levels of unburned hydro-carbons

CHAPTER 1

INTRODUCTION

1.1 Background

Biodiesel is a form of mono alkyl esters of long chain fatty acids which is produced from renewable lipid feedstock such as vegetable oils or animal fats (Titipong *et al.*, 2006). Biodiesel is a biodegradable, renewable energy and clean burning alternative diesel that offer substantial benefits for the nation and state in the area of energy security, economic development and environment quality. Before World War II, biodiesel has been introduced in South Africa to power heavy-duty machine. However, due to the recent environment and domestic economic concerns, use of biodiesel is revived throughout the world (Saifuddin & Chua., 2004).

After the crisis of World's Oil in 1971, every country have excited and tried to find a new energy that can replace petroleum by using their district energy which is vegetable oil. Nevertheless, the vegetable oil cannot be used directly in diesel engine because of the problem associated with it of the using pure vegetable oils as fuels in diesel engines. Methyl esters and ethyl ester of vegetable oils have several outstanding advantages among other renewable and clean fuel alternatives. There are more than 350 oil bearing crops identified, among which only sunflower, soybean, cottonseed, rapeseed and peanut oils are considered as potential alternative fuels for diesel engines. A potential diesel oil substitute is biodiesel, consisting of methyl ester of fatty acids produced by the transesterification reaction (Charoenphonphanich, 2004).

1.2 Production of Biodiesel

Biodiesel is made through the chemical processes on new or used vegetable oils and animal fats. One of the common vegetables from which biodiesel are being produced is soya bean. At the end of the chemical process methyl esters, which are the chemical name for biodiesel, and glycerin, are formed (Haresh Khemani, 2008).

The chemical process of the formation of biodiesel is called transesterification. During the chemical process reaction of natural oils is carried out with alcohol, the mixture formed this way is further refined to form biodiesel molecules. The byproduct of the chemical reaction is glycerin, which can be used as personal care products or for carrying out various chemical reactions (Haresh Khemani, 2008).

1.3 Future Prospect of Biodiesel

Biodiesel has number of benefits and it one of the most viable alternate fuels for the vehicles. Biodiesel is very easy to replace the petroleum diesel in the modern day engines without carrying out any changes in it. In the present times when the oil prices are increasing every day and air-pollution has risen to alarming rates, there is more and more awareness for using biodiesel. Further, due to various subsidies biodiesel is becoming cost competitive with the petroleum diesel and till now millions of people have enjoyed the benefits of biodiesel (Khemani, 2008).

The most important factor that is going to lead the development and future growth of biodiesel is its cost. The cost of biodiesel will depend on the ability of the world to produce large scale renewable feed stocks of vegetable oil and animal fats without disturbing the ecosystem. Making the use of biodiesel sustainable will provide the world an excellent renewable fuel that can be used for the long-time to come without disturbing the environment and reducing dependence on petroleum fuels (Haresh Khemani, 2008).

1.3.1 Prospect of Biodiesel Production in Malaysia

Nowadays, the biodiesel production in Malaysia is mainly from the CPO (Crude Palm Oil). On 16 December 2007, Malaysia opened its first biodiesel plant in the state of Pahang, which has an annual capacity of 100,000 tonnes and also produces by-products in the form of 4,000 tonnes of palm fatty acid distillate and 12,000 tonnes of pharmaceutical grade glycerine. Neste Oil of Finland plans to produce 800,000 tonnes of biodiesel per year from Malaysian palm oil in a new Singapore refinery from 2010, which will make it the largest biofuel plant in the world, and 170,000 tonnes from its first second-generation plant in Finland from 2007-8, which can refine fuel from a variety of sources (Biodiesel - Malaysia , 2008).

For example, one of the companies in Malaysia Sime Darby Biodiesel Sdn Bhd is responsible for the production of palm biodiesel in Malaysia and its distribution to overseas. Two plants in Selangor, are currently placed under its scope, one in Carey Island and another in Teluk Panglima Garang. The plant in Carey Island has an annual capacity of 60,000 tonnes while the one in Teluk Panglima Garang has an annual capacity of 30,000 tonnes (Biodiesel - Malaysia , 2008).

However, in year 2008, the Malaysian government has increased the cost of petrol from RM1.92 to RM2.70 and diesel from RM1.58 to RM2.58 (Badawi, 2008). In response to the unstable palm oil price and fast depletion of fossil fuels, Malaysian government has formed the National Biofuel Policy in august 2005 which has encouraged the Malaysian biodiesel industry.

Since the established of this policy, biodiesel production in Malaysia is 158 thousands tonnes (200 million liters) in 2006 and 1.3 million tonnes (1.7 billion liters) in 2007. The government has approved licenses for 32 bio-diesel plants with a prospective annual capacity of 2.6 million tonnes (3.3 billion liters) (Ohga, 2007).

Before this, Malaysia has primarily concentrated on consolidating its export market in CPO (Crude Palm Oil). Thus, encourage the need to bring diversity into biodiesel. In future, Malaysia success in the global bio-diesel market will be driven mostly by cost and quality. The cost of raw material contributed about 80 percent of the total cost in Malaysia. This total cost will increased depend on the demand of palm oil utilized for bio-diesel (Ohga, 2007).

One of the new sources of biodiesel in Malaysia is Jatropha Curcas Linn, in Malay known as pokok jarak pagar. In has been discovered to have a potential in being processed commercially into environment-friendly biodiesel and biopetrol. In transport sector, it can be used as an alternative fuel production and help government to decrease its subsidy in fuel. According to Antonio Vergara, president of the Davao City Multi-Culture Development Corporation, said that the project will initially