PRODUCTION AND CHARACTERIZATION OF BIODIESEL DERIVED FROM PALM OIL AND WASTE COOKING OIL

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This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering (Thermal-Fluid)

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JUNE 2016

DECLARATION

I declare that this project report entitled "Production and Characterization of Biodiesel Derived from Palm Oil and Waste Cooking Oil" is the result of my own work except as cited in the references

Signature	:	....
Name	:	NUR SAIDATUL AKMAL BINTI ROSLAN
Date	:	....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluid).

Signature	:.	....
Name of Supervisor	:	MD ISA BIN ALI
Date	:	....

DEDICATION

To my beloved mother and father, Kakyong, Abalang dan Adik.

ABSTRACT

Depletion of fossil fuel has become a serious issue recently and thus leading to a research and production of alternative fuels in a way that is better than conventional ones. A study was performed on biodiesel derived from palm oil and waste cooking oil. Both feed stocks undergo the transesterification process by means of methanol and potassium hydroxide. The objective is to produce and compare the performance of the biodiesel palm oil and waste cooking oil in terms of characteristics. The operation variables used were methanol to oil molar ratio (4:1, 6:1, 8:1), reaction temperature (55˚C, 60˚C, 65˚C), reaction time (60 min, 90 min, 120 min) and catalyst concentration (0.50%, 0.75%, 1.00%). The biodiesel was characterized by its density, high heating value, cloud and pour points, flash points and acid number based on ASTM Standard. The biodiesel with the best properties was obtained using a methanol/oil molar ratio of 4:1, potassium hydroxide as catalyst (0.50%), and 65°C temperature. The biodiesel yield percentage of palm oil methyl ester is higher than waste cooking oil methyl ester where its highest yield is 86.9% while the highest yield for waste cooking oil methyl ester is 83.3%. In terms of its characteristics, palm oil biodiesel also shows the better results.

ABSTRAK

Pengurangan bahan api fosil telah menjadi satu isu yang serius baru-baru ini yang seterusnya membawa kepada penyelidikan dan pengeluaran bahan api alternatif dengan cara yang lebih baik daripada bahan api konvensional. Satu kajian telah dilakukan ke atas biodiesel berasal dari minyak sawit dan sisa minyak masak. Kedua-dua jenis bahan mentah menjalani proses transesterifikasi dengan menggunakan metanol dan kalium hidroksida. Objektifnya adalah untuk membandingkan prestasi biodiesel daripada minyak kelapa sawit dan sisa minyak masak berdasarkan ciri-cirinya. Pembolehubah operasi yang digunakan adalah nisbah metanol/molar minyak (4: 1, 6: 1, 8: 1), suhu tindak balas (55ºC, 60ºC, 65ºC), masa tindak balas (60 min, 90 min, 120 min) dan kepekatan pemangkin (0.50%, 0.75%, 1.00%). Biodiesel yang dicirikan oleh ketumpatan, nilai kalori, takat awan dan takat curah, takat kilat dan nilai asid berdasarkan Piawaian ASTM. Biodiesel dengan ciri-ciri yang terbaik telah diperolehi dengan menggunakan nisbah molar metanol / minyak 4: 1, kalium hidroksida sebagai pemangkin (0.50%), dan suhu 65°C. Peratusan hasil biodiesel daripada minyak sawit adalah lebih tinggi daripada peratusan hasil biodiesel daripada sisa minyak masak dengan hasil peratusan tertingginya 86.9% berbanding hasil peratusan tertinggi biodiesel sisa minyak masak iaitu 83.3%. Dari segi ciri-ciri biodiesel pula, metil ester minyak sawit juga menunjukkan hasil yang lebih baik berbanding metil ester sisa minyak masak.

ACKNOWLEDGEMENT

I would like to thank Allah Who makes all things happen. And I wish to express my sincere gratitude to Universiti Teknikal Malaysia Melaka (UTeM) for giving me such opportunity to experience and get done my final year project. The project had been such a nice platform for me to develop my skills and learn the real experience to conduct my own research. I also want to express my special appreciation to those individuals who had spent their time to help and guide me while conducting the project.

Much appreciate goes to my family especially my wonderful mom and dad for their endless support. The appreciation also goes to my supervisor, Mr Md Isa bin Ali for his patient guidance and help. Then, I would like to thank a master student named Lee Shing Chuan for spending his time to guide me. Also, I would like to thank laboratory assistant, Mrs. Rusni binti Hasan for her kindness in suggesting me the suitable time to use laboratory equipment.

Last but not least, to my faculty (FKM), all lecturers and friends for the ideas, motivations and moral supports throughout the days.

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LIST OF ABBEREVATIONS

WCO	Waste Cooking Oil
UTeM	Universiti Teknikal Malaysia Melaka
NaOH	Sodium Hydroxide
KOH	Potassium Hydroxide
FFA	Free Fatty Acid
FAME	Fatty Acid Methyl Ester
ASTM	American Standard Testing Method
POBD	Palm Oil Biodiesel
WCOBD	Waste Cooking Oil Biodiesel
AN	Acid number
CV	Calorific value
CP	Cloud point
PP	Pour point

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Depletion of fossil fuels in the near future has become a burning issue in recent times. Moreover, the ever fluctuating volatile fuel pricing is another major concern. Therefore, the search for renewable fuels has stimulated an intense research thrust to the area of biofuel (Yap et al., 2014). Another thing that matter is that the demand of energy has increased rapidly with growing of world population. While the reserves of fossil fuel are being depleted, the environmental problems caused by their use have also become serious. Thus, the renewable energy has been promptly developed (Manh et al., 2011). Biodiesel is a notable alternative to the widely used petroleum-derived diesel fuel since it can be generated by domestic natural resources such as palm oil, soybeans, rapeseeds, coconuts and even recycled cooking oil. Interest in biodiesel has been expanding recently due to government incentives and high petroleum prices (Eman et al., 2013). Biodiesel has recently attracted huge attention in different countries all over the world because of its availability, renewability, non-toxicity, better gas emissions, and its biodegradability (Demirbas, 2009).

In this study, biodiesel will be derived and produce from palm oil and waste cooking oil. The results and performance of both biodiesel produce from both sources will be compared.

Palm oil is selected because it is easy to find. Nevertheless, there will be some problems with choosing palm oil as source of biodiesel because it is usually for cooking.

So, feedstock problem will arise from there. Another source that is waste cooking oil seems more affordable because it is easier to find as it can be recycled after being used. Instead of being wasted into the drain, it is more environmental-friendly to be collected and used as one of the biodiesel feedstock. However, the performance and characteristics of biodiesel derived from both sources will be investigated and compared in this study.

Biodiesel from both sources will be obtained via tranesterification process. Transesterification or alcoholysis is the displacement of alcohol from an ester in a process similar to hydrolysis, except that alcohol is used instead of water. The reaction is one of the reversible reactions (Yap et al., 2011). Raw material will be mixed with the methanol with addition of some alkaline catalyst to obtain biodiesel.

Many studies have shown that transesterification with methanol is more practical than with ethanol. Methanol is preferable because of its low cost and its physical and chemical advantages (Demirbas, 2005). Another advantage of using methanol is the separation of glycerine, in which can be obtained through simple decantation (Nagi et al., 2008). Currently, most biodiesel is produced by using homogenous base catalyst, such as sodium hydroxide (NaOH) or potassium hydroxide (KOH) (Felizardo et al., 2006). These catalysts are commonly used because of few reasons; able to catalyse reaction at low reaction temperature and atmospheric pressure and high conversion can be achieved in a minimal time (Lotero et al., 2005).

1.2 Problem statement

Apart from the conventional diesel is non-renewable source of energy, due to the depletion of fossil diesel fuels, the prices are also increasing day by day ultimately it leads to the economic recession in the various developing countries (Math et al., 2010). Thus, an alternative biodiesel has been developed as it is a renewable energy and more environmental-friendly (Sayyed et al., 2013).

As one of the renewable energy as well as an alternative fuel for diesel engines, biodiesel derived from palm oil and waste cooking oil will be studied and compared to determine its performance. Its characteristics that make it a better fuel than conventional diesel will also being investigated. Palm oil and waste cooking oil had chosen to be the raw material for the biodiesel production because of its availability. Parameters like molar ratio of methanol to raw oil, reaction temperature, reaction time and concentration of catalyst will be investigated to obtain the biodiesel density, cloud point, pour point, flash points, acid number and calorific value where these physical characteristics of biodiesel can determine its performance which known to be a better fuel than the conventional diesel.

This research is important to study parameters suitable to gain the best characteristics to produce a higher performance biodiesel and also to study the weakness of biodiesel produced from the researchers before as well as giving a good solution to a problem caused by conventional diesel.

1.3 Objective

In this study, the objectives to be achieved are as follows:

1. To investigate and compare the performance of biodiesel derived from palm oil and waste cooking oil.
2. To study and compare the characteristics of biodiesel derived from palm oil and waste cooking oil.

1.4 Scope of study

The scopes of this research are:

1. To investigate five important characteristics that influence the performance of biodiesel as a fuel which includes density, flash point, cloud point, pour point, calorific value and acid number.
2. To study the process variables that influences the transesterification of triglycerides such as catalyst concentration, molar ratio of methanol to raw oil, reaction time and reaction temperature.
3. To compare the results and performance for both biodiesel derived from palm oil and waste cooking oil with diesel fuels.

1.5 Benefits of Study

There are several benefits that can be obtained by doing this research. Among its benefits are as follows:

1. The proper method of biodiesel preparation can be studied to obtain biodiesel with better performance.
2. The characteristics of biodiesel which make it a better fuel for diesel engine can also be investigated.
3. The quality of biodiesel produced can be improved from time to time.
4. The study can also be an awareness campaign to other people to be more concern about the renewable energy.

CHAPTER 2

LITERATURE REVIEW

2.1 Historical Background on Biodiesel Production

The idea of utilizing biofuels as a part of diesel motors was started from the show of the first diesel motor by the designer of diesel motor "Rudolf Diesel" at the World Exhibition in Paris in 1900 by utilizing nut oil as a fuel. On the other hand, because of plenteous supply of petro-diesel, R&D exercises on vegetable oil were not truly sought after. It got consideration just as of late when it was understood that petroleum fills were waning quick and environment-accommodating renewable substitutes must be distinguished (Agarwal and Das, 2000). In a customary biodiesel process, an abundance methanol is recouped by utilizing a refining segment and a by-item glycerol is isolated from biodiesel by a decanter. The item biodiesel is initially purged by utilizing a refining with halfway condenser and after that a balance reactor is utilized to evacuate the staying homogenous impetus. Taking into account the thermodynamic understanding examination of all parts in the biodiesel creation handle, another outlined procedure is proposed. To recuperate the abundance methanol in rough biodiesel item, a blaze segment is picked; water and methyl laurate are the light and substantial key segments. The light key item is sent to a refining segment keeping in mind the end goal to particular methanol and water and after that the recuperated methanol from the segment is reused to the biodiesel generation process. The overwhelming key item from the blaze division comprises of generally biodiesel, glycerol and unreacted blended triglyceride. From the ternary stage graph for methyl oleate (an agent of blended methyl esters), methanol, glycerol framework, two fluid stage area is watched, which suggests that the blended methyl ester can break up in glycerol. Along these lines, the substantial result of the glimmer section is sent to a decanter to independent a light stage segment (e.g., blended methyl ester and methanol) from an overwhelming stage part (e.g., water, glycerol and methanol). The second and third refining segments are utilized for further decontamination of blended methyl esters from methanol and blended triglycerides, individually (Simasatitkul et al., 2012).

2.2 Biodiesel Feedstock

2.2.1 Palm Oil

There are several sources which are used as feed stock for biodiesel production such as soybean, sunflower, palm, canola, cotton seed, Jathropa, rapeseed and soybean oil. Palm oil however has far better advantage and potential as feed stock for biodiesel production as compared to the other vegetable oil (Singh & Singh, 2009). Unlike soybean and rapeseed, palm oil is a perennial crops where the production of oil is continuous and uninterrupted although annual production has its seasonal peak and down cycle. Palm oil is the best source to produce biodiesel because it has the highest yield hectare than any other crops (Ong et al., 2011).

2.2.2 Waste cooking oil

For the most part, immaculate refined vegetables oil is utilized as feedstock for biodiesel generation. Be that as it may, the utilization of waste cooking oil (WCO) as feedstock is the most ideal option for its minimal effort as utilizing immaculate refined vegetables oil can expand the biodiesel creation cost (Canakci and Gerpen, 2001). By utilizing waste broiling oil, the crude material expense evaluated can be lessened as much as reduced cost of virgin oil. The reuse of the waste cooking oil likewise minimized the issue of pollution on the grounds that use of this waste can help the administration's weight to arrange and treat it (Encinar, 2005). Waste cooking oil created from eateries, fast food outlets, nourishment handling industry consistently and all around on the planet could be reused to be a potential crude material for biodiesel generation as the retail cost of vegetable oil is higher than diesel's (Dermibas, 2008). Arifin (2009) expressed that the benefits of utilizing waste cooking oils to create biodiesel are the minimal effort and anticipation of environment contamination. These oils should be treating before arrange to the earth to avert contamination. Because of the high cost of transfer, numerous people arrange waste cooking oils straightforwardly to the earth particularly in country territory. So that, the utilization of waste cooking oils is a viable approach to lessen the expense of biodiesel creation.

2.2.3 Rapeseed Oil

Soybean, sunflower, coconut and palm oil have been the biodiesel feedstock. However, these oils are required in refined structures to acquire quality biodiesel and, likewise, they are foodstuffs. This makes creation of biodiesel from these sources uneconomical. Non-consumable plant oils such as found in rapeseeds may give better options. Rapeseeds seeds were collected from the local area. The oil was extracted using screw expeller in local market (Awate et al., 2015).

2.2.4 Sunflower Oil

Sunflower oil, widely used in foods for cooking and frying purposes, is also gaining attention as a feedstock for biodiesel production (Umer et al., 2008). Shah et al., (2005) stated that Sunflower (Helianthus annuus L.), an individual from the Compositea family is an imperative oilseed crop around the world, yielding around 45–50% oil. In Pakistan, sunflower, considered as a non-ordinary oilseed harvest is for the most part developed in two seasons, spring and summer. In wide range climatic states of Pakistan, sunflower product fits well in the nearby intercropping frameworks and could be effectively developed in spring and fall in this manner yielding two harvests in 1 year.

2.2.5 Coconut Oil

Oguntola et al., (2010) expressed that the use of oils from coconut, soy bean, sunflower, safflower, peanut, linseed, rape seed and palm oil amongst others have been attempted. However, the major feedstock source used in the work is coconut oil, locally produced in Nigeria. It was purchased at the local market in Ayetoro, Ogun State, Nigeria. Coconut oil like some other vegetable oils and animal fats are triglycerides, naturally containing glycerine.

2.3 Biodiesel Production via Transesterification Process

Yap et al., (2011) reported that transesterification or alcoholysis is the relocation of alcohol from an ester in a procedure like hydrolysis, with the exception of that alcohol is utilized rather than water. Transesterification is the response of a lipid with alcohol to frame esters and a side effect, glycerol. It is, on a fundamental level, the activity of n alcohol uprooting another from an ester, alluded to as alcoholysis (cleavage by alcohol) and the response is reversible. The two-stage transesterification was superior to the one stage process (Encinar, 2005). The significant segment of vegetable oil is triglycerides. Though Meher et al., (2004) expressed that transesterification is one of the reversible responses and continues basically by blending the reactants. In any case, the vicinity of an impetus quickens the transformation of triglycerides to biodiesel. From Ehsan and Tofajjal (2014), expressed that vegetable oil comprises of triglycerides as the real segment and in single stage transesterification, triglycerides are changed over to diglyceride, monoglyceride, lastly changed over to glycerol. Responding one section WCO with three sections Methanol gives three sections Methyl Esters and one section Glycerol. The transesterification procedure stream is firstly, warming oil to 60˚C, then titrating the WCO (to decide the amount NaOH to include), blending the NaOH and methanol to make methoxide, blending the methoxide with the WCO (transesterification), depleting glycerol and to wrap things up is washing and drying biodiesel.

Encinar et al., (2005) considered that the response of transesterification was done in a 500 mL circular reactor, furnished with indoor regulator, mechanical blending, testing outlet, and build-up frameworks. The reactor was preheated to 65°C, to take out dampness, and after that 200 g of utilized fricasseeing oil was included. At the point when the reactor came to 65°C once more, the methanol and the impetus were included, in the sums set up for every trial, and the mixing framework was joined, taking this minute as time zero of the