INVESTIGATION ON DIESEL ENGINE PERFORMANCE USING THE SECOND GENERATION OF BIODIESEL AND ITS BLEND

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis 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-Fluids)"

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Date: 1 July 2013

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: 

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DEDICATION

Special for the beloved parents and siblings who have a lot of support in order to complete this study may all appreciate the sacrifice you are rewarded by Allah SWT.

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ABSTRACT

In the present investigation the high viscosity of the jatropha oil which has been considered as a potential alternative fuel for the diesel engine was decreased by blending with diesel. The blend of varying proportions of jatropha oil and petroleum diesel were prepared, analysed and compared with petroleum diesel fuel. The effect of fuel blend on the viscosity and calorific value was also studied. The performance of the engine using fuel blend between jatropha biodiesel oil with petroleum diesel was evaluated in single cylinder direct injection diesel engine. The brake specific fuel consumption, brake thermal efficiency, hydrocarbon emission, carbon dioxide emission and power produced from the combustion of engine was studied. Based on the investigation between B5, B10 and B20 fuel blend, the acceptable fuel blend in this investigation is B5. B5 fuel blend is considered as an acceptable fuel blend because their viscosity and calorific value is nearly with petroleum diesel. In addition, based on the investigation, the value of brake thermal efficiency is better than petroleum diesel, B10 and B20. The brake specific fuel consumption from the engine test also near with the value using petroleum diesel.

ABSTRAK

Dalam kajian ini, tahap kelikatan yang tinggi oleh minyak jatropha, iaitu minyak yang telah dianggap sebagai salah satu bahan api yang mempunyai potensi untuk kegunaan enjin diesel boleh digunakan dengan menggabungkan antara campuran bahan api petroleum diesel bersama jatropha biodiesel. Gabungan pelbagai nisbah jatropha minyak dan diesel petroleum telah disediakan, dianalisis dan dibandingkan dengan bahan api petroleum diesel. Kesan daripada campuran bahan api pada kelikatan dan nilai kalori juga dikaji. Prestasi enjin dengan menggunakan campuran bahan api antara minyak jatropha biodiesel dengan diesel petroleum telah dinilai dengan menggunakan silinder suntikan terus enjin diesel tunggal. Antara kajian yang dijalankan melalui penggunaan enjin adalah brek kecekapan haba, brek penggunaan bahan api tertentu, kadar pelepasan hidrokarbon, kadar pelepasan karbon dioksida serta nilai kuasa yang mampu untuk dihasilkan daripada proses pembakaran bahan api tersebut. Berdasarkan kajian antara campuran bahan api B5, B10 dan B20, campuran bahan api yang boleh diterima dalam kajian ini adalah B5. Campuran bahan api B5 dianggap sebagai campuran bahan api diterima pakai kerana kelikatan dan nilai kalori adalah hampir dengan petroleum diesel. Di samping itu, berdasarkan kajian ini juga, nilai brek kecekapan haba yang diperolehi terhadap ujian bahan api dalam pembakaran enjin juga adalah lebih baik daripada petroleum diesel, B10 dan B20. Nilai brek penggunaan bahan api tentu dari ujian enjin juga berhampiran dengan nilai yang menggunakan diesel petroleum.

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N	=	Rotational Per Minute, rpm
P	=	Power, W
τ	=	Torque, Nm
r	=	Fuel consumption Rate, g/s
ω	=	Angular Velocity, rad/s

LIST OF ABBREVIATION

BSFC	=	Brake Specific Fuel Consumption
ASTM	=	American Society for Testing and Materials
FAME	=	Fatty Acid Methyl Ester
BTE	=	Brake Thermal Efficiency
HC	=	Hydrocarbon
CO_2	=	Carbon dioxide

CHAPTER I

INTRODUCTION

1.1 RESEARCH BACKGROUND

Biodiesel is a non-petroleum based diesel fuel which consists of the mono alkyl esters of long chain fatty acids derived from renewable lipid sources. Biodiesel is typically produced through the reaction of a vegetable oil or animal fat with methanol in the presence of a catalyst to yield glycerine and biodiesel (chemically called methyl esters). Biodiesel is one alternative energy source that is used at present. The demand for petroleum and growing increasingly scarce resources is a key factor to the increase in oil prices in the market. Therefore, users are now looking for alternative sources of energy to reduce the increasing costs. The purposes of this research are to investigate the properties of second generation biodiesel oil, which is jatropha biodiesel after blend with petroleum diesel with certain rate of blend. Secondly, the blend of oil will be tested in the combustion process using a direct injection engine diesel engine. In addition, the study is also made of the impact of gas emissions result from the combustion engine to the fuel blend. As a result of this research are expected to find the suitable rate of blend between petroleum diesel with jatropha biodiesel that use to the engines which are able to provide acceptable range for engine performance and able to reduce the pollution to the environment compared to petroleum diesel usage.

Thus, this chapter will cover on the problem statement, objective and scope due to the research. Furthermore, the information of the research will be stated clearly to enhance the understanding as a method to achieve the project goal. In this research, the focus is given on the study of engine performance and properties for the fuel blend between petroleum diesel with jatropha biodiesel.

1.2 PROBLEM STATEMENT

Based on the increasing of oil prices in the world from time to time as well as the environmental impact caused by emissions resulting from the combustion process, it has become a necessity to find an alternative fuel that can be used in diesel engines. Previous research has shown that the fuel from vegetable oil was able to be used in diesel engines. Nevertheless, there are few problems to replace vegetable oil as a fuel in the engine. Among the main problems are related to the rate of the viscosity of vegetable oil. The high viscosity is due to the large molecular mass and chemical structure of vegetable oils which in turn leads to problems in pumping, combustion and atomization in the injector systems of a diesel engine. Due to the high viscosity, in long term operation, vegetable oils normally introduce the development of gumming, the formation of injector deposits, ring sticking, as well as incompatibility with conventional lubricating oils. Thus, as one way to overcome this problem, a study on the applicability of jatropha oil is carried. Previous studies have also shown that jatropha oil is able to be used as one of the ingredients that can be used in diesel engines. Therefore, the research done on the engine performance and emission rates produced by the combustion process in a diesel engine using a fuel blend of petroleum diesel with jatropha biodiesel.

1.3 OBJECTIVE

Those objectives evaluated are to assist and complete on this study;

a. To determine the appropriate blend of second generation of biodiesel (jatropha biodiesel) with petroleum diesel for engine use.
b. To identify the effect of fuel blend from second generation of biodiesel (jatropha biodiesel) with petroleum diesel on engine performance.
c. To identify the effect of emission of fuel blend from second generation of biodiesel (jatropha biodiesel) with petroleum diesel due to the combustion process.

1.4 SCOPE

The scope of this study had been identified. The problem characteristics will be on;

a. Conducting experimental procedures on the engine to get performance produced by the engine as a result for a blend of second generation biodiesel (jatropha biodiesel) with petroleum diesel.
b. Testing of second generation biodiesel (jatropha biodiesel) blend with petroleum diesel based on the number parameters set by American Society for Testing and Materials (ASTM).
c. Study the feasibility of fuel blend between second generation biodiesel (jatropha biodiesel) with petroleum diesel on engine.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter includes an overview of the project consists of a description of introduction about biodiesel and petroleum diesel, conversion process for second generation biodiesel, biodiesel quality test parameters, engine performance characteristic test parameters, advantages and limitations of biodiesel and previous research summary about the second generation of biodiesel.

2.2 ABOUT BIODIESEL AND PETROLEUM DIESEL

Petroleum diesel is produced from fractional distillation of crude oil between 200°C (392°F) and 350°C (662°F) at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule.

Biodiesel is produced using a transesterification process, "reacting vegetable oils or animal fats catalytically with a short-chained aliphatic alcohol (typically methanol or ethanol)." Glycerol is a by-product of this transesterification process. Biodiesel is defined under the standard of ASTM D6751 as "a fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats." Biodiesel is also referred to as FAME (fatty acid methyl ester) or RME (rape seed methyl ester) in Europe.

Biodiesel can even be made from recycled cooking grease. Although biodiesel can be used in its pure form, it is usually blended with standard diesel fuel. Blends are indicated by the abbreviation Bxx, where xx is the percentage of biodiesel in the fuel blend. Much attention has been focused on the thought of it one day replacing fossil fuels as the world's primary transport energy source. Biodiesel is safe and can be used in diesel engines with few or no modifications needed.

Many of the problems associated with first generation biodiesel can be addressed by the production of biodiesel manufactured from agricultural and forest residues and from non-food crop feedstocks. Where the ligno-cellulosic feedstock is to be produced from specialist energy crops grown on arable land, several concerns remain over competing land use, although energy yields (in terms of GJ/ha) are likely to be higher than if crops grown for first generation biodiesel (and co-products) are produced on the same land. In addition poorer quality land could possibly be utilized. These second generation biodiesel are relatively immature so they should have good potential for cost reductions and increased production efficiency levels as more experience is gained. Depending partly on future oil prices, they are therefore likely to become a part of the solution to the challenge of shifting the transport sector towards more sustainable energy sources at some stage in the medium-term.

Production of first generation biodiesel, particularly sugarcane ethanol, will continue to improve and therefore they will play a continuing role in future biodiesel demand. The transition to an integrated first generation and second generation biodiesel landscape is therefore most likely to encompass the next one to two decades, as the infrastructure and experiences gained from deploying and using first generation biodiesel is transferred to support and guide second generation biodiesel development. Once second generation biodiesel technologies are fully commercialized, it is likely they will be favored over many first generation alternatives by policies designed to reward national objectives such as environmental performance or security of supply.

2.3 CONVERSION PROCESS FOR SECOND GENERATION BIODIESEL

Most of the country uses a system known as factor "B" as an indicator that states the amount of biodiesel content in the fuel. If the label given to a fuel blend is B20, it means that the fuel mix is composed of 20% biodiesel and 80% more fuel made from petroleum diesel. If the label is the B100 fuel, then it means that the fuel is made from 100% biodiesel without any mixture of petroleum diesel.

There are two main routes available for producing liquid biofuels from biomass; one involves thermochemical processing and the other biochemical processing. Thermochemical processing defines the conversion of biomass into a range of products, by thermal decay and chemical reformation, and essentially involves heating biomass in the presence of different concentrations of oxygen. The clear advantage of thermochemical processing is that it can essentially convert all the organic components of the biomass compared with biochemical processing which focuses mostly on the polysaccharides. Figure 2.1 show the conversion of biomass in order to produce biofuel.