STUDY ON TYPICAL EMISSION FROM DIESEL ENGINE FUELED WITH BIODIESEL

NAIM HUSNI BIN LATIF

This report was submitted in accordance with the partial requirements for the honor of Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2009

'I/We* admit that have read this dissertation and in my/our* opinion this dissertation is Satisfactory in the aspect of scope and quality for the bestowal of Bachelor of Mechanical Engineering (Automotive)'

Signature : .....

Supervisor I Name : Mr. Mohd Haizal Bin Mohd Husin

Date : 18th May 2009

Signature : .....

Supervisor II Name : Mr Ahmad Fuad Bin Abd Ghani

Date : 18th May 2009

"I verify that this report is my own word except summary and extract that every one of it I have clarify the resource"

Signature : .....

Author Name : Naim Husni Latif

Date : 10th April 2009

For loving father and mother and also other family members.

ACKNOWLEDGEMENTS

All praises to Allah the Almighty that by His blessings I have been able to complete Projek Sarjana Muda II (PSM II), which the course requirement that in Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor of Mechanical Engineering (Automotive).

My most gratitude goes to those individuals who have contributed immeasurable amount of guidance, advice and assistance along the project period; the first person that really helps in my research is my dedicated supervisor, Mr. Mohd Haizal Bin Mohd Husin who has supportively guiding and teaching a lot of valuable knowledge, also for the opportunities he has given me in exposing myself to research and development environment.

The second person is Mr Rupandi from Malaysian Palm Oil Board (MPOB), Research Station, Bangi which helps me through out the project which consist of experiments and guided me through everything. Also, those dedicated staffs in Faculty of Mechanical Engineering for the time, their valuable advice and guidance when solving problems.

A million thanks expressed to my family, especially my parents who has been the backbone of everything I done. Also the supportive course mate fellows for lending their hands and giving continuous support during my project period to achieve the objective of study and everyone else which may help in this project.

With the full cooperation from the people above, I have successfully achieved the objectives of PSM II.

ABSTRAK

Biodiesel ialah salah satu bahan bakar kenderaan alternatif yang boleh menggantikan diesel untuk keharmonian masyarakat dan kelestarian alam sekitar. Isu ini selalu dibincangkan seluruh negara, termasuklah kesan rumah hijau dan pemanasan global. Diesel melepaskan gas-gas yang bahaya kepada alam sekitar dan menggugat nyawa manusia termasuklah gas nitrogen oksida (NO_x), sulfur oksida (SO_x) dan hidrokarbon yang belum terbakar. Dengan ini, kehadiran bahan bakar alternative dapat mengurangkan gas-gas ini kepada alam sekitar. Di dalam projek ini, kaedah eksperimentasi akan dilakukan kepada kedua-dua bahan bakar, iaitu diesel dan biodiesel dan dengan menggunakan enjin diesel yang sama. Biodiesel pilihan ialah menggunakan ekstrak minyak kelapa sawit dan keputusan kedua-duanya akan dibandingkan. Kajian di masa hadapan dalam bidang ini patut dilakukan untuk kelestarian alam sekitar sepanjang masa dan bahan bakar alternatif ini boleh dijadikan sebagai bahan bakar yang boleh digunakan semula sepanjang masa.

ABSTRACT

Biodiesel is one of the current alternative fuels that can take over conventional diesel for better environment and better for human living. This is currently being talked about all over the world, the effect of greenhouse and global warming. Conventional diesel releases an emission that consists of gases such as oxides of nitrogen (NO_x), oxides of carbon (CO_x) and unburned hydrocarbons. With this, alternative fuel needed to reduces those harmful emissions. In this report, experiment will be conducted using diesel engine and fueled with both diesel and biodiesel. The choice of biodiesel in this project is extract from pal oil and the results will be compared. Further study in this area should be done in terms of having environmental friendly surroundings all the time and having renewable resource of fuel at most time.

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CHAPTER 1

INTRODUCTION

In this chapter, we will be discussing the background on diesel engine, combustion and emission and also problem of statement; which tells us the problem that we are facing nowadays with diesel engine. With the problems identified, the purpose of study or the reason why this study is conducted will also be given in this chapter. In addition, objective and the significance of study will have to be stated and this is to know what are the target and what are the importance of this study that is going to be conducted.

With the scope of study, the study will be more focus and in the end of this project, we will determine whether all that mentioned above had been achieved or otherwise by referring to the objectives and scopes of this study.

1.1 Background

The diesel engines of today are refined and improved versions of Rudolf Diesel's original concept. They are often used in submarines, ships, locomotives, and large trucks and in electric generating plants. Diesel engine is the most efficient power plant among

all known types of internal combustion engines. Heavy trucks, urban buses, and industrial equipment are powered almost exclusively by diesel engines all over the world. In Europe, diesel powered cars have been increasingly popular. The diesel engine is a major candidate to become the power plant of the future. Before that happens, however, further progress in diesel emission control is needed.

Internal combustion engines are significant contributors to air pollution, which has a damaging impact on our health and the environment and is suspected to cause global climate changes. Environmental benefits of diesels, such as low greenhouse gas emissions, are balanced by growing concerns with emission of nitrogen oxides and diesel particulates. Increasingly tighter environmental regulations worldwide call for advanced emission controls and near-zero diesel emission levels in the years to come. Emission from these compression ignition engines can harm the environment and also the people that are breathing through the gas.

Diesel engines produce very little carbon monoxide as they burn the fuel in excess air even at full load, at which point the quantity of fuel injected per cycle is still about 50% lean of stoichiometric. However, they can produce black soot (or more specifically diesel particulate matter) from their exhaust, which consists of unburned carbon compounds. This is caused by local low temperatures where the fuel is not fully atomized. These local low temperatures occur at the cylinder walls and at the outside of big droplets of fuel. At these areas where it is relatively cold, the mixture is rich (contrary to the overall mixture which is lean). The rich mixture has less air to burn and some of the fuel turns into a carbon deposit.

Emissions are gases and particles released into the air as by products of a natural or man-made process. One of these processes is the burning of fuels to create electricity and other forms of energy. The emissions from burning fossil fuels contribute significantly to global warming and poor air quality. A small set of emissions are responsible for the majority of human impacts on climate change and health. These

gases and particulates come from a variety of sources and can be categorized as greenhouse gas emissions (that affect climate change) and air quality emissions. Clean energy typically produces no emissions, which is one of its most significant benefits.

Particles of the size normally called PM10 (particles of 10 micrometres or smaller) have been implicated in health problems, especially in cities. Some modern diesel engines feature diesel particulate filters, which catch the black soot and when saturated are automatically regenerated by burning the particles. Other problems associated with the exhaust gases (nitrogen oxides, sulfur oxides) can be mitigated with further investment and equipment; some diesel cars now have catalytic converters in the exhaust.

All diesel engine exhaust emissions can be significantly reduced by the use of biodiesel fuel. Oxides of nitrogen do increase from a vehicle using biodiesel, but they too can be reduced to levels below that of fossil fuel diesel, by changing fuel injection timing.

In the meantime, biodiesel came up as a alternative fuel to replace the diesel. Biodiesel has a long history of use in diesel engines, especially in Europe. In his engines demonstrated at the 1900 World's Fair, Rudolf Diesel used peanut oil for fuel and thought that oils from locally grown crops would be a primary fuel for his engines.

However, early durability tests indicated that engines could fail prematurely when operated on simple vegetable oils, however engines burning vegetable oils transesterified with alcohols (i.e., biodiesel) exhibited no such problems and even performed better by some measures than engines using petroleum diesel.

The formulation of what is now called biodiesel came out of those early experiments, although biodiesel was eventually supplanted by lower cost petroleum diesel fuel. In Malaysia, there are quite small productions of biodiesel but Malaysia has

been the mass production of palm oil whereby this is one of the kinds of biodiesel blend that can be produced as Malaysian marketable fuel in the future.

1.2 Problem statement

In a diesel engine, combustion would lead to emission of a few types of gases and particulate matter. This study is to measure and identify a few types of gases from the emission of biodiesel combustion; by using the same diesel engine without any modification, that might gives us environmental effect by reducing the dangerous gases that a normal combustion diesel would emit. The results will be compared with the emission of diesel combustion.

1.3 Purpose Of Study

The main particulate fraction of diesel exhaust consists of small particles. Because of their small size, inhaled particles may easily penetrate deep into the lungs. The rough surfaces of these particles make it easy for them to bind with other toxins in the environment, thus increasing the hazards of particle inhalation.

Exposures have been linked with acute short-term symptoms such as headache, dizziness, light-headedness, nausea, coughing, difficult or labored breathing, tightness of chest, and irritation of the eyes and nose and throat. Long-term exposures can lead to chronic, more serious health problems such as cardiovascular disease, cardiopulmonary disease, and lung cancer.

The purpose of this study is to measure and compare emissions of Nitrogen Oxides (NO and NO_2, together called NO_x), Sulphur Oxides (SO and SO_2, together called SO_x), Carbon Monoxide (CO), Carbon Dioxide (CO_2), and hydrocarbons from a small stationary engine generator operating on both standard petroleum diesel against B100 biodiesel and B20 biodiesel produced from palm oil.

1.4 Objectives Of Study

Biodiesel fuel has a number of potential emissions benefits relative to petroleum diesel fuel including lower particulate matter (PM) and SO_x emissions, but concerns linger that it could potentially lead to slightly higher NO_x emissions. This concern has generated a number of earlier studies to measure NO_x emissions from various biodiesel mixtures. A major finding from this work was that B20 biodiesel can significantly reduce emissions of PM, CO, and HCs, but lead to a slight increase in NO_x emissions. Thus, this project is to measure and identify gas emission from biodiesel combustion, using the same diesel engine without any modification.

1.5 Significance Of Study

While earlier studies of biodiesel fuels showed a small increase in Nitrogen Oxides (NO_x) production relative to petroleum diesel, none of these studies were definitive, especially for stationary engine applications. By focusing on vehicle engines and duty cycles, little data existed specifically related to the use of biodiesel in reciprocating engines driving a generator for stationary power production.

Malaysia is one of the countries that listed as the main mass production country for palm oil. Palm oil can be used as biodiesel fuel and experiments and comparison from these biodiesel blends will definitely brings people to know the alternate fuel that have potential in Malaysia.

1.6 Scope Of Study

This study will include the comparison on gas emission from diesel and biodiesel fuel especially the emissions of Nitrogen Oxides (NO_x), Sulphur Oxides (SO_x), Carbon Monoxide (CO), Carbon Dioxide (CO_2), and hydrocarbons. Comparison will be in the range of percentage of difference from the emission retrieved using diesel as fuel.

Engine performance also will be covered in this scope since preliminary studies said that engine performances is important in deliberating the best alternative fuel to replace diesel. Engine performance will be measured in terms of power and torque in Watt (W) and Newton meter (Nm) unit respectively. Then, the percentage difference of power and torque will also be given in range of percentage.

CHAPTER 2

LITERATURE REVIEW

In this chapter, we will review every single part of diesel and biodiesel, starting from the introduction until the disadvantages of biodiesel. With this, we will know that by conducting this project and having the result, whether the results is still valid or not due to the previous and preliminary study that has been conducted before.

2.1 Introduction to Biodiesel

Biodiesel refers to a non-petroleum-based diesel fuel consisting of short chain alkyl (methyl or ethyl) esters, made by transesterification of vegetable oil or animal fat (tallow), which can be used (alone, or blended with conventional petroleum diesel) in unmodified diesel-engine vehicles.

Biodiesel is distinguished from the straight vegetable oil (SVO) (sometimes referred to as "waste vegetable oil", "WVO", "used vegetable oil", "UVO", "pure plant oil", "PPO") used (alone, or blended) as fuels in some converted diesel vehicles. "Biodiesel" is standardized as mono-alkyl ester and other kinds of diesel-grade fuels of biological origin are not included.

Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix: fuel containing 20% biodiesel is labeled B20, while pure biodiesel is referred to as B100.

It is common to see B99, since 1% petrodiesel is sufficiently toxic to retard mold. Blends of 20 percent biodiesel with 80 percent petroleum diesel (B20) can generally be used in unmodified diesel engines. Biodiesel can also be used in its pure form (B100), but may require certain engine modifications to avoid maintenance and performance problems. Blending B100 with petro diesel may be accomplished by:

1. Mixing in tanks at manufacturing point prior to delivery to tanker truck
2. Splash mixing in the tanker truck (adding specific percentages of Biodiesel and Petro Diesel)
3. In-line mixing, two components arrive at tanker truck simultaneously.

2.2 Biodiesel Properties

Biodiesel has better lubricating properties than today's lower viscosity diesel fuels. Biodiesel addition reduces engine wear increasing the life of the fuel injection equipment that relies on the fuel for its lubrication, such as high pressure injection pumps, pump injectors (also called unit injectors) and fuel injectors.

Biodiesel is a liquid which varies in color, between golden and dark brown depends on the production feedstock. But properties of biodiesel may be varied due to the physical and chemical properties that exists in the earlier product of making the biodiesel.

2.3 Biodiesel Types

Biodiesel fuels can be derived from a wide variety of naturally produced fats and oils including soybean oil, vegetable oils, or animal fats through the transesterification process. Conventional vehicle applications for biodiesel fuels involve a blend of biodiesel and petroleum diesel. Typical vehicle fuels incorporating biodiesel blend relatively small concentrations of biodiesel into petroleum diesel with 2% and 20% biodiesel being most common. These fuels are referred to as B2 and B20 respectively.

2.4 Biodiesel Emissions

The major emissions from biodiesel engines are similar to those from other internal combustion engines using diesel as a fuel (Diesel Fuels, Chunshan Song, 2000):

1. Oxides of Nitrogen (NO_x)
2. Particulate Matter
3. Hydrocarbons (HC)
4. Oxides of Carbon (CO_x)

According to Ulrich Pfahl, Werner Hirtler and Thomas Cartus (2003) from AVL List GmbH Austria, a simultaneous reduction of above 50% for NO_x and PM approximate 90% with a lean NO_x-adsorber and diesel particulate filter.

Based on research by Jason D. Hawirko and M. David Checkel (2003) from University of Alberta, there are factors other than temperature that is important in emission analysis.

Based on the same research also, it stated that the vagaries of on road testing, such factors could include:

1. Variability in the driving conditions to which the vehicle was exposed
2. Variability in the vehicle's response to the same driving conditions
3. Random uncertainties in the measurement and emission factor calibration system

2.4.1 NO_x Emissions

Based on Houston Research Advance Center (HRAC) on 2007, they have the following major findings including NO_x emission from the combustion of biodiesel fuels are about 10% higher compared to petroleum diesel fuel, NO_x emission from biodiesel fuels are higher than diesel at most engine loads, but at 75% engine load, no statistically significant difference was measured between diesel and biodiesel and a relatively large standard deviation of emission measurement was obtained in the NO_x emission rate for diesel, which reduces somewhat the predictive significance of the results.

2.4.2 Hydrocarbons

Hydrocarbons are formed by incomplete fuel combustion. When combined with NO_x in the presence of sunlight, HC's produce ground-level ozone or "smog," which can irritate eyes, damage lungs, and aggravate respiratory problems. Symptoms include coughing, shortness of breath, and decreased lung function. Many hydrocarbons are also considered hazardous air pollutants.

2.4.3 Particulate Matter

Based on research by Kenneth T. Knapp and Silvertre B. Tejada (2003) from US Environmental Protection Agency on emission at winter and summer condition, average PM emission rates were significantly higher from the winter vehicles (27.6 mg/mi) than the summer vehicle (10.6 mg/mi). The primary reason is probably differences in the two conditions, that the heat and surroundings temperature that one of them is really cold and the other one is quite normal.

According to Timothy V. Johnson (2003) from Corning Incorporated from United States of America (USA), oxidation catalyst or filters will need to take out only about 10% - 20% of the particulate matter in the cleanest engines.

Recent studies have shown an association between particulate matter and premature mortality from respiratory and cardiovascular disease, and increased incidence of respiratory illness, particularly in children and the elderly. For adults with heart or lung conditions, exposure to fine particulate matter can cause more illness and in some cases premature death. More than 90 percent of the particulates found in diesel exhaust are fine particles.

2.4.4 CO_x Emissions

According to Choo Yuen May, Maah Ngan, Chan Kook Weng and Yusof Basiron in the Journal of Palm Oil, one main benefit derived from this renewable source of energy is the reduction in emission of GHG such as carbon dioxide. The production and consumption of palm diesel form a closed carbon cycle.