

**EXPERIMENTAL INVESTIGATION OF ENGINE PERFORMANCE AND
EMISSION OF BIODIESEL AT VARIOUS STORAGE CONDITION**

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**EXPERIMENTAL INVESTIGATION OF ENGINE PERFORMANCE AND
EMISSION FOR BIODIESEL AT VARIOUS STORAGE CONDITION**

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**This thesis is submitted in partial fulfillment of the requirements for the
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DECLARATION

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

Signature :

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Date :

DEDICATION

I dedicate this thesis especially to my beloved parent

Mohamad Bin Abdullah

Mastaniah Binti Ahmad

My beloved siblings

My relatives and friends

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First of all, I would like to thank Allah for giving me the strength and opportunity to finish this project. I owe a lot of thanks to everyone that always be with me and helped me through my studies in Universiti Teknikal Malaysia Melaka.

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ABSTRACT

Biodiesel is a biodegradable and nontoxic renewable fuel derived from waste, plants oils or animal fats. Biodiesel is considered as a renewable resource and has the potential to reduce the carbon footprint emission.. According to previous literature value, more volume of biodiesel is used to get the same power and torque for the same engine to run. The widely use of fossil fuel nowadays has leads to air pollutants and global warming as the hazardous toxin gases emits from the exhaust. For a solution, biodiesel can be used to reduce the carbon emission from the exhaust. In this project, crude palm oil will be used as the main blending material. The type of biodiesel chosen are B5 (standard diesel), B70, B80 and B90. All these biodiesel is blended and stored at three different storage conditions which are low ($5 - 10^{\circ}C$), ambient ($25^{\circ}C$) and high ($35 - 40^{\circ}C$) temperature. Based on the best properties, one type of biodiesel is chosen to be tested in engine dyno to get the performance and emission data. All the data is recorded and evaluated to see the behavior of the engine performance and emission. Results show that performance by using biodiesel is slightly decreasing about 2-8% less of engine horse power and 4-10% less in torque. Biodiesel also produces less exhaust emission about 5-8% of carbon dioxide and hydrocarbons gases. As a conclusion, biodiesel B70 is chosen as the best blend because of its maintained and the lowest value of flash point compared to blending of B80 and B90. Biodiesel B70 can perform satisfactorily during diesel engine operation but it produces less in horse power and torque due to its lower energy compared to standard diesel. it also produces less emission of carbon dioxide and hydrocarbons compared to standard diesel. For future project, use a better gas analyzer to capture all the gases that come out from the exhaust.

ABSTRAK

Biodiesel adalah bahan api yang boleh diperbaharui dan mesra alam tanpa toksik yang dihasilkan dari sisa buangan, minyak tanaman atau lemak haiwan. Biodiesel dianggap sebagai sumber boleh diperbaharui dan mempunyai potensi untuk mengurangkan pelepasan karbon. Menurut kajian, isipadu biodiesel yang digunakan untuk mendapatkan kuasa yang sama untuk sesebuah enjin adalah lebih daripada diesel. Pencemaran udara dan pemanasan global pada masa kini disebabkan oleh gas toksin berbahaya yang dikeluarkan dari ekzos. Sebagai penyelesaian masalah, biodiesel boleh digunakan untuk mengurangkan pelepasan karbon dari ekzos. Dalam projek ini, minyak sawit mentah digunakan sebagai bahan campuran utama. Jenis biodiesel terpilih adalah B5 (diesel biasa), B70, B80 dan B90. Semua biodiesel ini diadun dan disimpan dalam tiga keadaan yang berbeza iaitu pada suhu rendah ($5 - 10^{\circ}\text{C}$), suhu ambient (25°C) dan suhu tinggi ($35 - 40^{\circ}\text{C}$). Berdasarkan sifat biodiesel yang dikaji, satu jenis biodiesel dipilih dan diuji menggunakan enjin Dyno untuk mendapatkan data prestasi dan pelepasan gas. Semua data direkodkan dan dinilai untuk melihat kelakuan prestasi enjin dan pelepasan gas. Hasil kajian menunjukkan bahawa prestasi biodiesel sedikit berkurangan kira-kira 2-8% kurang kuasa enjin dan 4-10% kurang tork. Biodiesel juga menghasilkan pelepasan dari ekzos yang kurang kira-kira 5-8% gas karbon dioksida dan hidrokarbon. Kesimpulannya, biodiesel B70 dipilih sebagai yang terbaik kerana nilai takat kilat yang sekata dan paling rendah berbanding biodiesel B80 dan B90. Prestasi menggunakan biodiesel B70 semasa operasi enjin diesel memuaskan tetapi ia menghasilkan kurang kuasa dan tork oleh kerana tenaga yang lebih rendah berbanding dengan diesel biasa. Ia juga menghasilkan pelepasan karbon dioksida dan hidrokarbon yang kurang berbanding diesel biasa. Untuk projek masa depan, gunakan mesin analisa gas yang lebih baik untuk menangkap semua gas yang keluar dari ekzos.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	SUPERVISOR DECLARATION	i
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF SYMBOLS	xiv
	LIST OF ABBREVIATIONS	xv
CHAPTER 1	INTRODUCTION	1
	1.0 Introduction	1
	1.1 Background of Study	2
	1.2 Problem Statement	3
	1.3 Objectives	3
	1.4 Scope of Study	4
CHAPTER 2	LITERATURE REVIEW	5
	2.0 Background of Study	5
	2.1 Process of Biodiesel	7
	2.2 Blending of Biodiesel	8
	2.3 Storage of Biodiesel	10

2.4	Engine Performance	11
2.4.1	Brake Specific Fuel Consumption (BSFC)	12
2.4.2	Brake Mean Effective Pressure (BMEP)	12
2.4.3	Brake Horse Power (BHP)	13
2.4.4	Mechanical Efficiency	14
2.5	Emission Testing	15
2.5.1	Nitrogen Oxide	16
2.5.2	Particulate Matter	17
2.5.3	Hydrocarbons	17
2.5.4	Carbon Monoxide	18
2.5.5	Carbon Dioxide	18
CHAPTER 3	METHODOLOGY	19
3.0	Background	19
3.1	Flowchart for Methodology	20
3.2	Preparation of Biodiesel	21
3.3	Engine Service	22
3.4	Brake Specific Fuel Consumption (BSFC)	24
3.5	Choosing the Best Biodiesel Blend	25
3.6	Engine Test	28
3.7	Emission Testing	30
CHAPTER 4	RESULTS AND ANALYSIS	31
4.0	Background	31
4.1	Performance by Horse Power	31
4.1.1	Horse Power for B5	32
4.1.2	Horse Power for B70	33
4.1.3	Graph Comparing HP between B5 and B70	34
4.2	Performance by Torque	37
4.2.1	Torque for B5	37
4.2.2	Torque for B70	38

4.2.3	Graph Comparing Torque between B5 and B70	39
4.3	Emission Data	42
4.3.1	Emission for B5	42
4.3.2	Emission for B70	43
4.3.3	Graph Comparing Emission of Carbon Dioxide	44
4.3.4	Graph Comparing Emission of Hydrocarbons	46
CHAPTER 5	DISCUSSION	50
5.0	Background	50
5.1	Blending	50
5.2	Performance	51
5.3	Emission	55
CHAPTER 6	CONCLUSION AND RECOMMENDATIONS	57
6.0	Background	57
6.1	Conclusion	57
6.2	Recommendations	58
6.2.1	Improvement on Blending Machine	58
6.2.2	Use Portable Gas Analyzer	58
	REFERENCES	59
	APPENDIX	62

LIST OF TABLES

NO.	TITLE	PAGE
3.1	Flash point for three storage conditions	26
3.2	Engine specifications	29
4.1	Horse power for B5	32
4.2	Horse power for B70	33
4.3	Torque for B5	37
4.4	Torque for B70	38
4.5	Emission for B5	42
4.6	Emission for B70	43
5.1	Percentage of differences in horse power	52
5.2	Percentage of differences in torque	54
5.3	Percentage of differences of hydrocarbons emission	56
5.4	Percentage of differences of carbon dioxide emission	56

LIST OF FIGURES

NO.	TITLE	PAGE
2.1	Process of biodiesel	8
3.1	The flowchart of methodology	20
3.2	Blending machine	21
3.3	Mixture of biodiesel blend	22
3.4	Installing the piston	23
3.5	Inside part of the engine	23
3.6	Engine run by half throttle	24
3.8	Meter of fuel consumed	24
3.9	Machine to measure flash point	25
3.10	Graph of flash point for cold storage	27
3.11	Graph of flash point for ambient storage	27
3.12	Graph of flash point for hot storage	28
3.13	DAQ system and controller box	29
3.14	Set up for emission test	30
4.1	Horse power in test 1	34
4.2	Horse power in test 2	35
4.3	Horse power in test 3	35
4.4	Horse power in test 4	36
4.5	Horse power in test 5	36
4.6	Torque in test 1	39
4.7	Torque in test 2	40
4.8	Torque in test 3	40
4.9	Torque in test 4	41
4.10	Torque in test 5	41

4.11	Emission of carbon dioxide in test 1	44
4.12	Emission of carbon dioxide in test 2	44
4.13	Emission of carbon dioxide in test 3	45
4.14	Emission of carbon dioxide in test 4	45
4.15	Emission of carbon dioxide in test 5	46
4.16	Emission of hydrocarbons in test 1	47
4.17	Emission of hydrocarbons in test 2	47
4.18	Emission of hydrocarbons in test 3	48
4.19	Emission of hydrocarbons in test 4	48
4.20	Emission of hydrocarbons in test 5	49
5.1	Graph of horse power between B5 & B70	52
5.2	Graph of torque between B5 & B70	53
5.3	Graph of horse power for B70	54
5.4	Graph of torque for B70	55

LIST OF SYMBOLS

$\%$	Percentage
g	gram
kW	kilo Watt
CO_2	Carbon Dioxide
P_b	Brake Power
η	Efficiency
V_d	Volume of Diesel
H_2O	Water

LIST OF ABBREVIATIONS

FYP	Final Year Project
PSM	Projek Sarjana Muda
ASTM	American Society for Testing and Materials
ICE	Ignition Compression Engine
B5	Standard Diesel
B100	Pure Biodiesel
BSFC	Brake Specific Fuel Consumption
HC	Hydrocarbons
SME	Sunflower Methyl Ester
CME	Crude Methyl Ester
PME	Palm Methyl Ester
BMEP	Brake Mean Effective Pressure
BHP	Brake Horse Power
ME	Mechanical Efficiency

RPM	Rotation per Minute
PPM	Particle per Million
PM	Particulate Matter
B70	70% Biodiesel + 30% Diesel
B80	80% Biodiesel + 20% Diesel
B90	90% Biodiesel + 10% Diesel
IR	Infrared
HP	Horse Power

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

In recent years, the prices for oils have been rising rapidly and there is the starting point where people concern about the availability of fossil fuels for a long term period. This continuous growing concern for the environment leads to the creation of renewable resources. That is when the idea of using vegetable oils instead of fossil fuel has been out. This idea can create a much larger market for a renewable resource. The use of vegetable oils can also be done as a way to minimize the net carbon footprint left by emissions from the Ignition Compression Engines (ICE). Unfortunately, some problems occur if the vegetable oils are used in the engine without any modification. Some of the problems are to start the engine in cold-weather area, plugging and gumming of filters lines and injectors; engine knocking; choking of injectors on piston and head of engine; carbon deposits on piston and head of engine; excessive engine wear and deterioration of engine lubricating oil.

To overcome all these problems, a chemical process called transesterification is used to convert the vegetable oils into a fuel which is more like to fossil fuel that known as biodiesel. There are many benefits by using biodiesel as an alternative fuel. Some of them are;

- i. Environmental benefits
- ii. Energy security benefits
- iii. Economic benefits

1.1 BACKGROUND OF STUDY

Biodiesel is a biodegradable and nontoxic renewable fuel. It has reduced the molecular weights, reduced viscosity and improves volatility when compared to the previous renewable resource. Most of the combustion engines can run on biodiesel without modifying the engines but it still needs to adjust the injection timing to optimize the combustion. For a short term period, there seems to be no problem detected. But there may be some problems occur for such long term period as there is no large scale of producing biodiesel and store. All the consequences of storing the biodiesel is remain unknown as they are made for short term uses. Blending of biodiesel is one way to keep the performance of the fuel in combustion engine remain great.

In this study, crude palm oil will be used as the main blending material. The type of biodiesel chosen are B5 (standard diesel), B70, B80 and B90. All these biodiesel is blended and store at three different storage condition. The condition selected for this study is the temperature of the fuels. The fuel is given a range of temperature to study the effect of temperature on the engine performance. The ranges for the temperature are 3 to 5 degree celcius for low temperature, 40 to 45 degree celcius for high temperature and let the fuel in room temperature for ambient

temperature. This study is hoped to get the correct information about the effect of different temperature of different fuel on the engine performance and emission.

1.2 PROBLEM STATEMENT

The behavior of engine performance and emission based on the variation of biodiesel storage remain unknown. How will the engine performance and emission reacts with these conditions need to be investigated. Different types of biodiesel; B5 (standard diesel), B70, B80 and B90 are stored at different storage conditions which are at ambient, low and high temperature. Their performances are evaluated using engine dyno.

1.3 OBJECTIVES

- i. To blend and store biodiesel at three storage conditions.
- ii. To run engine test for engine performance.
- iii. To measure emission data from biodiesel using analyzer.

1.4 SCOPE OF STUDY

- i. Blending process of B5, B70, B80 and B90 using blending machine. Then, storing biodiesel using storage box and varying storage condition versus time
- ii. Perform single cylinder test using engine dyno.
- iii. Obtain data for emission using portable gas analyzer.

CHAPTER 2

LITERATURE REVIEW

2.0 BACKGROUND OF STUDY

Biodiesel is a type of fuel that produces from waste and living organisms such as plants and animal fats. Biodiesel is considered as an alternative fuel in diesel engine that can be used with no modification in Ignition Compression Engine for low bending ratio. In 1895, Rudolf Diesel developed a new engine that can be run by using variety of fuels including vegetable oil. Although the diesel engine is widely acceptable, the petroleum-based diesel proved to be less expensive and be the first choice for a fuel (Pinto, 2005).

Biodiesel is commonly mixed with diesel to form a biodiesel blend. A pure biodiesel is known as B100 which means completely made by waste. While the common diesel used nowadays is B5 which indicates the 5% of biodiesel and 95% of diesel are mixed.

Some investigation has been done about the power, torque, the brake specific fuel consumption (BSFC) and emission of the exhaust of both pure diesel fuel and different types of biodiesel (B25, B50, B70 and B100) of Sunflower Methyl Ester (SME). The results show that the power and torque are maintained within the same levels as when using pure diesel oil. While the brake specific fuel consumption increases within the acceptable limits. For the emission testing, there are three types of gases considered that are nitrogen oxides, *HC* (hydrocarbons) and *CO* (carbon monoxide). The emission of hydrocarbons and carbon monoxide are decrease considerably when using the biodiesel and the concentration of nitrogen oxides are slightly below that of diesel fuel (Moreno, 1999).

Different types of biodiesel blends give different properties such as kinematics viscosity, flash point, water content and acid value. Comparing these properties will influence the performance of the fuel when run in the engine. The higher the biodiesel blends, the higher the properties stated. For an example, higher viscosity can leads to choking of injector tips which can cause the engine to lose its power (Knothe & Gerpen, 2004).