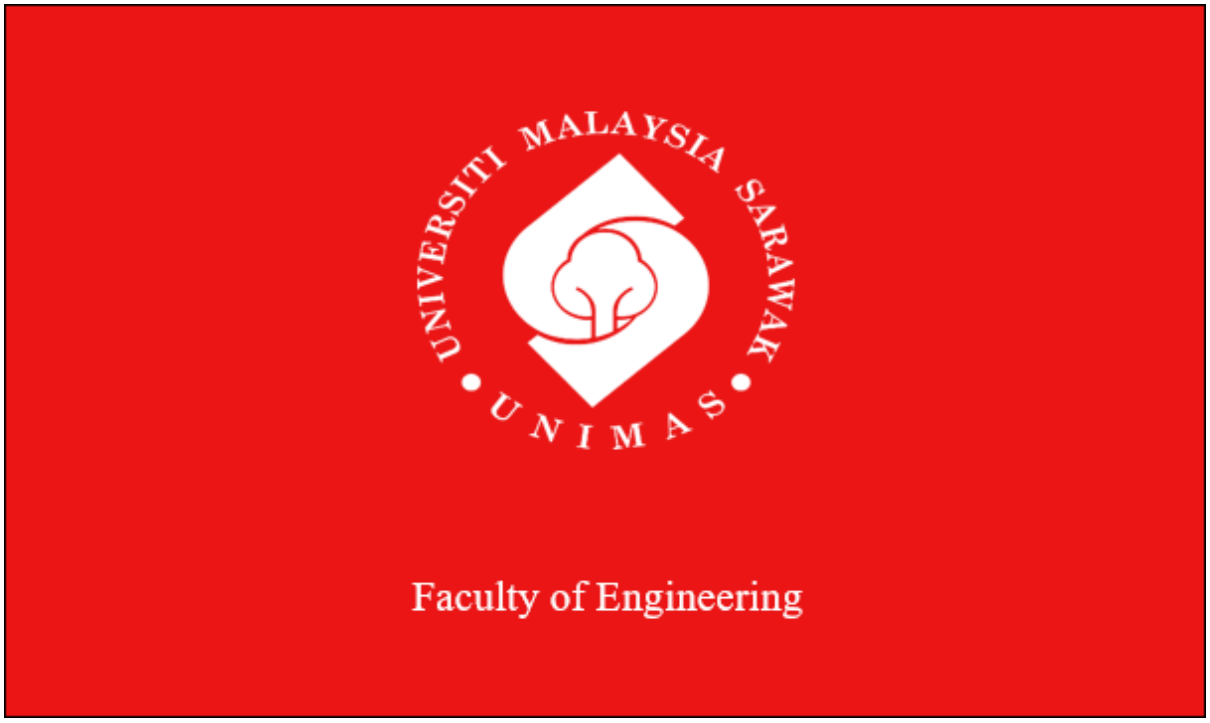

EVALUATION OF BIOETHANOL FROM WASTE PINEAPPLE AS ADDITIVE WITH DIESEL BLEND FUEL FOR DIESEL ENGINE

Mohamad Hisyam Bin Suffian

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2019

UNIVERSITI MALAYSIA SARAWAK

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This final year project report which entitled **"Evaluation of Bioethanol from Waste Pineapple as Additive with Diesel Blend Fuel for Diesel Engine"** was prepared by Mohamad Hisyam bin Suffian (45661) as a partial fulfillment for the Degree of Bachelor of Mechanical and Manufacturing Engineering is hereby read and approved by:

_____ _____

ASSOC. PROF. DR. ABU SALEH AHMED Date

(Final Year Project Supervisor)

EVALUATION OF BIOETHANOL FROM WASTE PINEAPPLE AS ADDITIVE WITH DIESL BLEND FUEL FOR DIESEL ENGINE

MOHAMAD HISYAM BIN SUFFIAN

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
Faculty of Engineering
Universiti Malaysia Sarawak
2019

Dedicated to my beloved family and friends

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ABSTRACT

Comprehensive study on the evaluation of bioethanol from waste pineapple as additive for with diesel blend fuel for diesel engine was carried out. The diesel engine considered as the major contributor to pollutant in the atmosphere. High torque, efficient and combustion efficiency at low operating cost are the reasons why diesel engines are widely used. Fuel economy policy introduced to decrease the usage of fuel consumption and increase the efficiency of the vehicle to reduce the impact towards the atmosphere. Bioethanol, which is an oxygenated compound introduced into diesel fuel to be blend to increase the efficiency and performance of the diesel engine. Bioethanol was mixed with diesel fuel and the mixing ratio of bioethanol to diesel was 0:100, 5:95 and 10:90. The effects of bioethanol fraction on engine torque, engine brake power (W_b), brake specific fuel consumption (bsfc) were investigated at variant engine speeds. The engine used to carry out these experiments is a single cylinder four-stroke diesel engine. Performance of the engine by using the diesel blend is slightly better than the conventional diesel. This experimental work on diesel engine shows the capability of bioethanol as a renewable energy sources to be used in diesel engine partially and is the need hour.

ABSTRAK

Kajian komprehensif mengenai penilaian bioethanol daripada nanas sisa sebagai aditif dalam bahan api campuran diesel untuk enjin diesel telah dijalankan. Enjin diesel dianggap sebagai penyumbang utama kepada pencemar di atmosfera. Kecekapan tinggi, kecekapan dan kecekapan pembakaran pada kos operasi rendah adalah sebab mengapa enjin diesel digunakan secara meluas. Dasar ekonomi bahan api diperkenalkan untuk mengurangkan penggunaan bahan api bagi meningkatkan kecekapan kenderaan untuk mengurangkan kesan ke arah atmosfera. Bioethanol yang merupakan sebatian oksigen yang diperkenalkan kepada bahan api diesel untuk campuran untuk meningkatkan kecekapan dan prestasi enjin diesel. Bioethanol bercampur dengan bahan api diesel dan nisbah campuran bioethanol kepada diesel ialah 0: 100, 5:95 dan 10:90. Kesan pecahan bioethanol pada tork enjin, kuasa brek enjin (Wb), penggunaan bahan bakar khusus brek (bsfc) disiasat pada kelajuan enjin variasi. Enjin yang digunakan untuk menjalankan eksperimen ini adalah enjin diesel empat lejang silinder tunggal. Prestasi enjin dengan menggunakan campuran diesel sedikit lebih baik daripada diesel konvensional. Kajian ini menunjukkan keupayaan bioethanol sebagai sumber tenaga yang boleh diperbaharui untuk digunakan dalam enjin diesel.

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LIST OF ABBREVIATION

%	-	percent
% v/v	-	percentage of volume per volume
wt%	-	weight percent
w/v	-	weight per volume
°C	-	degree centigrade
$C_6H_{12}O_6$	-	glucose
CH_3CH_2OH		ethyl alcohol
CO_2	-	carbon dioxide
FAO	-	Food and Agricultural Organization of the United Nations
g	-	gram
g/L	-	gram per liter
h	-	hours
H_2SO_4	-	sulphuric acid
mL	-	milliliter
L	-	liter
NaOH	-	sodium hydroxide
rpm	-	revolutions per minute
YPD	-	yeast extract-peptone-glucose
FT-IR	-	Fourier Transform – Infrared Spectrometer
-OH	-	alcohol group
C-H	-	single bond carbon hydrogen
C=O	-	carbonyl group
C=C	-	alkene group
B0	-	Bioethanol 0%
B5	-	Bioethanol 5 %
B10	-	Bioethanol 10%
Mj/kg	-	mega joules per kilogram

Nm	-	newton meter
kW	-	kilo watt
g/kWh	-	gram per kilo watt hour
bsfc	-	brake specific fuel consumption
W_b	-	engine brake power

CHAPTER 1

INTRODUCTION

1.1 Introduction

The earth consists of natural resources that exist freely which are water, land, soil, rock, fossil fuels and minerals. Natural resources can be divided into renewable and non-renewable .Natural resources are the basics of life on earth. All of the natural resources link to one another. The other natural resources will be affected when one of the natural resources is disturbed or decrease. This paper focuses on the non-renewable natural resources which are fossil fuels. Non-renewable natural resources are the natural resources that are going to be extinct once the available stock is exhausted. Fossil fuels are considered non-renewable even though they can renew themselves but in a few million years. Fossil fuels are one of the natural resources which decrease gradually over the year. These depleting are caused by the increase in the demand of the fossil fuels. Due to the unlimited use of fossil fuels has led to health hazards and also global environmental degradation.

The depleting of fossil fuels raises the global fuel crisis in 1970 which led to awareness amongst many countries of their incapability to oil embargoes. Global warming, limited source and high price of petroleum are the factors to generate an intense

international interest in developing alternative non-petroleum fuels for engines. Legislations have been passed in many countries, requiring diesel to contain a minimum percentage of biofuels. In Europe parliament, they declared Renewable Energy Directive to create legal frameworks. According to the Renewable Energy Directive, the energy consumption from renewable sources in transportation sector must be 10% or higher. Thus, with drastic rise in the world fossil fuels consumption, one of the possible alternative fuels for non-petroleum fuels for the engines is bio renewable energy which is Biofuels.

1.2 Background of Biofuels

Biomass is one of the most widely used renewable sources of energy nowadays. Biomass is organic material derived from plant and animal material. Biomass contains stored energy from the sun which absorbs the sun's energy called photosynthesis. These days, biomass fuels used derived in the form of dried vegetation, crop residue, wood products and aquatic product. Gashaw et. al., (2014) stated that biomass has become the leading alternative sources among other sustainable energy resources and fuel resources. In the past couple of decades, biomass show promising result that has become one of the most useable renewable sources of energy behind the hydropower in the electricity generation.

There are various ways in transforming the biomass. One of the ways includes gasification, combination of heat and power (CHP), direct combustion or anaerobic and aerobic digestion. Biofuels can be directly transformed from biomass. This biofuels is in liquid form and it can fulfilling transportation fuel needs unlike other renewable energy sources. Due to combustible and bio-renewable properties, biomass can be converted into solid, liquid or gas.

There are four generation of biofuels which are first, second, third, and fourth generation. The first generation biofuels produced directly food crops that are derived from sugar, starch, animal fats and also vegetable oils through conventional technology. The feed stocks for the second generation biofuel are usually corn, sugar and also wheat. Meanwhile, the second generation can also be produced from non-food crops such as organic waste,

wood, food crops waste, and other specific biomass. The third generation of biofuels takes convince of energy crops such as algae. The second and third generation biofuels also known as advanced biofuels developed to counter the restrains of the first generation biofuels. Lastly, the fourth generation biofuels are derived from specially engineered plants or biomass that may have higher energy yields or lower barriers to cellulosic breakdown or are able to be grown on non-agricultural land or bodies of water.

There were two biofuels that commonly used in the world which are bioethanol and biodiesel. These biofuels has high potential to replace gasoline and diesel. The similarities of gasoline and diesel with the biofuels are almost the same but the main differences are the way they produced and the feedstock. Gasoline and diesel are fossil fuels which produced millions years ago while biofuels derived from biomass which are plant materials in the form of liquid.

Table 1.1: Different generations of biofuel: major source, process and their examples (Kasturi et. al., 2014)

Generation	Feedstocks	Processing technology	Examples of biofuel
First	Edible oil seeds, food crops, animal fats	Esterification and transesterification of oils and fermentation of sugars, thermochemical process	Biodiesel, bioethanol, biobutanaol
Second	Nonedible oil seeds, waste cooking oil, Ligno-cellulosic feedstock materials: cereal straw, sugarcane bagasse, forest residues	Physical, chemical, biological pretreatment of feedstock and fermentation, thermochemical process	Bioethanol, biobutanol, biodiesel, syngas
Third	Algae	Algae cultivation, harvesting, oil extraction, transesterification, or fermentation, or thermochemical process	Biodiesel, bioethanol, biobutanaol, syngas, biohydrogen, methane
Fourth	Algae and other microbes	Metabolic engineering of algae with increases carbon entrapment ability, cultivation, harvesting, fermentation, or oil extraction, transesterification, or thermochemical process	Same as in 3rd generation

1.3 Problem Statement

Diesel engines are considered as one of the major contributors to the pollutant of the emissions is the diesel engine. The reason why diesel engines are widely used is because the engine has high torque, efficiency and combustion efficiency at low operating cost. The efficiency of the diesel engine has been improved significantly.

Many countries in the world have implemented the fuel economy policy to the car manufacturer to decrease the fuel consumption and also to increase the efficiency of the vehicle. This is to reduce the impact of using fuels to the atmosphere. The imposed on the fuel economy to meet the standards required in order to cope with the nation's energy security and also reducing the CO_2 emissions.

To solve this problem, come to the introduction of oxygenated compound as in this case, ethanol into the diesel fuel to be blend with in order to increase the efficiency and performance of the diesel engine. The ethanol and diesel blend technique is one of the techniques to be able to use ethanol without any modification in Diesel engines(Kumar, Manimaran, & Gopalakrishnan, 2013).

1.4 Research Question

These are several research questions to be investigate in this thesis which are:

I. How to produce biomass sugars by using pineapple waste as a feedstock?
II. What is the effect of fermentation period on the glucose and bioehtanol concentration?
III. Could diesel blend fuel performed better than diesel fuel?

1.5 Objectives

The main objective of this study is to evaluate the bioethanol from waste pineapple as additive with diesel blend fuel for diesel engine.

In the research, there are several specific objectives which are:

I. To produce biomass sugars from pineapple waste.
II. To produce bioethanol from biomass sugars by fermentation.
III. To analyze the performance of diesel blend fuel.

1.6 Relevancy and Significance

Malaysia has been blessed with a tropical climate which made Malaysia known as one of wealth of natural resources in agricultural and forest feedstock. This climate gives us an advantage in providing renewable resources for the production of the biofuels. In 2016, Malaysia government has introduced the Malaysia National Biofuel Policy to increase the effort in and initiative in promoting the development of the biofuels industry.

The most suitable feedstock for the production of bioethanol in Malaysia is agricultural waste. The chosen feedstock for this project is pineapple. Malaysia is known as one of the major pineapple producer and exporter. Zain et al., (2012) stated that the large quantity of pineapple production in Malaysia which reaches hundreds thousands tones which equal to 1% of the world pineapple production will result in large quantity of pineapple waste. This indicates the significance of these researches on bioethanol production from waste pineapple in Malaysia that are supported with its potential yet to be discovered.

1.7 Organization of Thesis

Chapter 1 introduces the background of biomass and bioethanol.

Chapter 2 reviews the study and researches done regarding the derivation of bioethanol and the diesel blend fuel for diesel engine.

Chapter 3 explaining in details on the methodology used in the experiment (the experiment set-up and process).

Chapter 4 analyses and presents the data gathered from experiment.

Chapter 5 concludes the study and research. Lastly, provide recommendation for future researches on the diesel blend fuel for the diesel engine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

One of the types of fuel is the biofuel which is produced geologically like the fossil fuels that were created through biological process such as anaerobic and agricultural digestion. Biofuel can be attained directly from plant and also indirectly form waste product that is created in the industrial activities, agricultural and also commercial. Biofuel correlated with the carbon assimilation process where the process converts the inorganic carbon to organic carbon by living organism such as photosynthesis process. In addition, biofuels can also be produced by using biomass or its conversion, which refers to living organisms such as plant or plant derived materials. Useful energy can be generated from its biomass by chemical, thermal or biochemical conversion, resulting in either gas, liquid or solid fuel. Thus, biofuels can be produced directly from the existing biomass.

Biodiesel, methanol, ethanol and many more are the things that can be extracted from the biomass which is in liquid form. Today, the automotive industry utilized the most of the biofuels produced compare to the other industry where bioethanol and biodiesel act as an enhancer or could also replace them. According to Jegannathan et al. (2009), by

comparing to other biofuels, the most commonly used biofuels in the world is the bioethanol, biodiesel and biogas.

2.1.1 Bioethanol

Bioethanol categorized as one of the alcohol which can be created from the carbohydrates that is found in starch or sugar crops. Yeast is then added and it is fermented to produce the bioethanol. Bioethanol are also known as the fuel additives or ethanol which fermented from renewable sources for fuel (J. Itelima et al., 2013). A. B. M. S. Hossain et al. (2010) stated that there are many different varieties of feedstock can be used to derive bioethanol from biomass such as corn, sugarcane, wood and fruits wastes that are easily accessible and reliable, renewable and sustainable resources and also can help to clean the environment from the wastes. As stated by Itelima et al. (2012), pure ethanol can be used as an alternative fuel for vehicle but it is usually used as gasoline additive or enhancer. The emission of the vehicle will be enhanced since ethanol raises the octane level. By comparing the fuel emission between gasoline and bioethanol, the emission of greenhouse gas from bioethanol is lower since it is a renewable fuel. As stated by A. War et al. (2011), the gas pollution which is carbon dioxide, CO2 can be reduced to 90% when using the gasoline produced from bioethanol). United States has been implemented the blend of bioethanol with gasoline up to 10% to be used as a transportation fuel and 22% in Brazil (Wyman et al., 1994). Bioethanol significantly can be the arrangement in diminishing the climate change due to the greenhouse gas product from daily activities.