Faculty of Mechanical and Manufacturing Engineering Technology

TAN ZHENG JING
B091810359

BACHELOR OF Mechanical ENGINEERING TECHNOLOGY (Automotive Technology) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

Fuel Properties Of The Biodiesel Blends Produced From Waste Cooking Oil (WCO)

TAN ZHENG JING

Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

2022

Fuel Properties Of The Biodiesel Blends Produced From Waste Cooking Oil (WCO)

TAN ZHENG JING

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this Choose an item. entitled " Fuel properties of the biodiesel blends produced from waste cooking oil (WCO)" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : TAN ZHENG JING

Date : 28/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

Signature : ....

Supervisor Name : PN SUSHELLA EDAYU BINTI MAT KAMAL

Date : 28 January 2022

DEDICATION

My dissertation is dedicated to my family and many friends. I owe a special debt of appreciation to my beloved parents, whose words of encouragement and insistence on perseverance still sing in my ears. This dissertation is also dedicated to my numerous friends and church family members who have helped me during the process. Sasidharan for the grammar checking and correction, Low Yee Huat for the helping hand when I am facing problem with my laptop and my internet connection, and Jonathan for some assist for using words.

Abstract

Biodiesel is a good alternate to replace or reduce the use of commercial diesel. It has a very good characteristic which make it suitable and has potential to be implement and to be use in Malaysia. Biodiesel can reduce the pollution created by commercial diesel. However, in order to prove that it is suitable to be use, it's properties must be find out and compared with the test standards. It has capability issues with certain materials, is inherent, instable and highly corrosive. In this study, the fuel properties (acid value, density, flash point) of the biodiesel blends produced from waste cooking oil (WCO) was carried out. Biodiesel used in the experiment are in pure form (B100), and blended with commercial diesel in the form of B10 (10 percent biodiesel, 90 percent commercial diesel), B20 (20 percent biodiesel, 80 percent commercial diesel), B30 (30 percent biodiesel, 70 percent commercial diesel). From the result, we know that only B10 pass the acid value test which is lower than 0.5mhKOH/g. For the density test, all of the biodiesel blends have passed with all of it lower than the reading of 880 kg/m^3. And for the flash point, the result seems promising where all of them falls around 88°C to 98°C.it is also found that the BHT added to the B10 biodiesel blend improve the properties of the biodiesel blend produced from waste cooking oil (WCO).

ABSTRAK

Biodiesel adalah alternatif yang baik untuk menggantikan atau mengurangkan penggunaan diesel komersial. Ia mempunyai ciri yang sangat baik yang menjadikannya sesuai dan berpotensi untuk dilaksanakan dan digunakan di Malaysia. Biodiesel boleh mengurangkan pencemaran yang dihasilkan oleh diesel komersial. Walau bagaimanapun, untuk membuktikan bahawa ia sesuai untuk digunakan, sifatnya mesti diketahui dan dibandingkan dengan piawaian ujian. Ia mempunyai masalah keupayaan dengan bahan tertentu, adalah wujud, tidak stabil dan sangat menghakis. Oleh itu, ujian sifat bagi biodiesel dan bahan tambahan dijalankan untuk mencari nilai asid, ketumpatan dan takat kilatnya. Biodiesel yang digunakan dalam eksperimen adalah dalam bentuk tulen (B100), dan diadun dengan diesel komersial dalam bentuk B10 (10 peratus biodiesel, 90 peratus diesel komersial), B20 (20 peratus biodiesel, 80 peratus diesel komersial), B30 (30 peratus). biodiesel, 70 peratus diesel komersial).

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to our final year project supervisor, Pn Sushella Edayu Binti Mat Kamal whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project especially in writing this report.

Furthermore, I would also like to acknowledge with much appreciation the crucial role of the staff of Universiti Teknikal Malaysia Melaka, whom gave the permission to use all the required equipment and the necessary materiasl to complete the task “Fuel Properties of The Biodiesel Blends Produced from Waste Cooking Oil (WCO)”.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

Mt	-	Megatonne
Mha	-	Million-hectare meter
Kg	-	kilogram
ha	-	hectare
mgKOH/g	-	Acid value
Kg/m^3	-	Kilogram per meter cube
ppm	-	parts per million
°C	-	Degree celsius
FFA	-	Free fatty acid
BHT	-	Butylated hydroxytoluene
WCO	-	Waste cooking oil
B100	-	Pure biodiesel
B2	-	Diesel with 2 percent of biodiesel blended
B5	-	Diesel with 5 percent of biodiesel blended
B10	-	Diesel with 10 percent of biodiesel blended
B20	-	Diesel with 20 percent of biodiesel blended
B30	-	Diesel with 30 percent of biodiesel blended
D2	-	Euro 2 petroleum diesel

LIST OF APPENDICES

APPENDIX **TITLE**

PAGE

CHAPTER 1

INTRODUCTION

1.1 Background

In order to prevent pollution on the planet, more and more products focused on the issues of earth health are being developed these days. Biodiesel is an example of a product that was developed to replace commercial diesel and minimize pollution. Straight vegetable oil, animal oil/fats, tallow, and waste cooking oil are all used to make biodiesel. Transesterification is the process of converting these oils into Biodiese l. Oil crops such as rapeseed, palm, and soybean provide the largest available source of usable oil. The majority of biodiesel currently generated comes from waste vegetable oil supplied from restaurants, chip shops, and industrial food processors. Despite the fact that oil directly from the agricultural business has the greatest potential, it is not produced commercially since the raw oil is too expensive. It is simply too expensive to compete with fossil diesel if the cost of conversion to biodiesel is included in. Waste vegetable oil is frequently available for free or at a low cost if it has already been processed. In addition, the waste oil collected must be processed to remove contaminants before being converted to biodiesel. As a result, biodiesel made from waste vegetable oil has the potential to compete with fossil fuel.

In comparison to petroleum diesel, biodiesel emits fewer hazardous chemicals and greenhouse gases. It can be used in its pure form or blended with petroleum-based diesel in the following forms: B2 (2 percent biodiesel, 98 percent petroleum diesel), B5 (5 percent biodiesel, 95 percent petroleum diesel), B20 (20 percent biodiesel, 80 percent petroleum diesel), B30 (30 percent biodiesel, 70 percent commercial diesel) and B100 (pure biodiesel). Emissions and greenhouse gas reduction with lower exhaust emissions of biodiesel is helping to reduce pollution and improve health. Biodiesel's lower CO2 emissions also help to mitigate the effects of global warming. Although biodiesel can help with some of the issues, it will also exacerbate others, such as food scarcity. Because biodiesels are derived from animal and vegetable fat, increased demand for these food products will likely drive up costs, causing a food crisis in some areas. Because biodiesel gels in cold weather, it may not be suited for certain of the world's colder climates. However, the temperature at which it gels is dependent on the oil or fat that was used to manufacture it. In addition, biodiesel can destroy various engine parts, necessitating more frequent engine replacements than those who use conventional diesel. For example, it can considerably damage the rubber houses of the engines, such as the oil seals on the fuel pump.

1.2 Problem Statement

As a renewable, sustainable and alternative fuel for compression ignition engines, biodiesel instead of diesel has been increasingly fuelled to study its effects on engine performances and emissions in the recent 10 years. In general, biodiesel are made from natural, renewable sources such as new/used vegetable oils and animal fats using a transesterification process to further obtaine pure biodiesel. Biodiesel can be used in its pure form or blended with petroleum-based diesel in the following forms: B2 (2 percent biodiesel, 98 percent petroleum diesel), B5 (5 percent biodiesel, 95 percent petroleum diesel), B20 (20 percent biodiesel, 80 percent petroleum diesel), B30 (30 percent biodiesel, 70 percent commercial diesel) and B100 (pure biodiesel).However, it has an compatibility issues with certain materials, is inherent instable and highly corrosive in nature and it is found that the direct use of biodiesel and its blends could cause higher wear and corrosion to the metal parts and the rubber components of the engine when in contact. Sporadic efforts have been carried out to understand the aforementioned issues, however significant knowledge has not been obtained until yet, especially on stability of biodiesel and its behaviour. Thus, the properties of waste cooking oil (WCO) as biodiesel and their blends with diesel and additives needs to be evaluated in order to assess their potential use in automotive engine whereb y a proper understanding on the properties of the biodiesel blends is necessary in order to implement the use of biodiesel blends in our country.

1.3 Research Objective

1. To investigate the acid value, density, and flash point of D2 diesel and pure biodiesel made from waste cooking oil (WCO).
2. To investigate the acid value, density, and flash point of biodiesel blend with D2 diesel fuel at three different ratios (B10, B20 and B30).
3. To evaluate the effects of Butylated hydroxytoluene (BHT) added to the waste cooking oil (WCO) produced B10 biodiesel blends, after adding a different amount Butylated hydroxytoluene (BHT) into it.

1.4 Scope of Research

In this project, we are carrying out various test to investigate properties of biodiesel which includes the acid value, density, and flash point. First, the biodiesel made of waste cooking oil properties is studied. This substance needs to have almost the same chemical properties as commercial diesel in order to maintain its performance while in usage. In order to improve the performance of biodiesel, a few percentages of are mixed with commercial diesel and test is then conducted to find the most suitable percentage of biodiesel and commercial diesel to be used.

The test method we will be using are titration method for the acid value, pycnometer for density, and Pensky Martens flash point test for flash point. Test is done to D2 diesel, B10 biodiesel blend, B20 biodiesel blend, B30 biodiesel blend, and B10 biodiesel blend with Butylated hydroxytoluene (BHT) added.

CHAPTER 2

LITERATURE REVIEW

2.1 Biodiesel

Biodiesel is a form of diesel fuel manufactured from plant or animal-derived long-chain fatty acid esters. It's a drop-in biofuel, which means it'll work with existing diesel engines and distribution systems, as opposed to the vegetable and waste oils that were previously used to power converted diesel engines. Biodiesel is frequently blended with Petro diesel because most engines cannot run on pure Biodiesel without modification (typically to less than 10 percent).

Triacylglycerols are the main components of vegetable oils and animal fats. A chemical molecule made composed of fatty acid esters and glycerol is known as triacylglycerol. The triacylglycerol of vegetable oils and animal fats contains a number of different fatty acids. As a result, a single glycerol backbone might be used to link a variety of fatty acids. The numerous fatty acids contained in triacylglycerols make up the fatty acid profile of vegetable oil or animal fat. Because different fatty acids havevarying physical and chemical properties, the fatty acid profile is arguably the most essential factor influencing the attributes of a vegetable oil or animal fat.

Transesterification is a chemical reaction that is used to make biodiesel from vegetable oil or animal fat. To make the necessary alkyl esters of the fatty acid mixture found in the original vegetable oil or animal fat, the vegetable oil or animal fat is reacted with an alcohol (usually methanol) in the presence of a catalyst.

2.1.1 Feedstock for Biodiesel Production

a) Soybean

Soybean is one of the world's most significant crops, owing to the high quality of its protein meal. Although the seed's oil content (18–20%) is smaller than its protein level (36–40%), the resulting oil volume is considerable due to the massive amount of soybean meal required to feed meat animals (EMBRAPA 1994). Soybean oil was produced in around 45 Mt in 2014, second only to palm oil in terms of global production. In reality, soybean oil dominated vegetable oil production until the last decade, and it may do so again in the not-too-distant future. In 2013, Argentina produced 49.31 Mt of soybeans on 19.42 Mha with a productivity of 2539 kg/ha, Brazil produced 81.72 Mt on 27.91 Mha with a productivity of 2929 kg/ha, and the United States produced 89.48 Mt of soybeans on 30.7 Mha with a productivity of 2915 kg/ha. New industries such as bioenergy and oil chemistry, in addition to the food market for humans and pets, have expanded the horizons of soybean demand, raising annual growing rates since 1990, when worldwide production (108 Mt) was just one-third of current (315 Mt) production. Over the last 20 years, the average annual growth rate has topped 8 Mt. (Faostat 2015).

b) Oil Palm

It is also known as African palm and hails from the Gulf of Guinea in west central Africa. Although it has been known and used for millennia, commercial cultivation began in Malaysia in the first decade of the twentieth century. Palm is the oil crop that generates the most oil per hectare, accounting for 57 million tonnes of the global 170 million tonnes of vegetable oils produced. It accounts for almost 60% of global vegetable oil output, alongside soybean oil, yet when comparing the 2015 average oil yield of each crop, one hectare of palm oil delivers the same amount of oil as ten hectares of soybeans. Because of its high oil output, palm oil takes up only 8% of the world's oil crop land but produces over a third of all vegetable oil. Palm oil is grown in the humid tropics, as well as Southeastern Asia, Northwestern South America, and parts of Central America, due to its tropical origins. Asian countries now account for roughly 90% of the world's agricultural land. The main producers are Indonesia, Malaysia, and Thailand. Asia is also home to the world's largest importers. Palm oil is employed in bioenergy production, however it is most commonly used in the nutrition and cosmetics industries.

Biodiesel made from palm oil has a very favourable energy balance (input/output), sometimes as high as 1:8. The land that is now used for palm oil agriculture in Southeastern Asia was formerly covered with natural forest, resulting in massive deforestation and the collapse of the rainforest in nations like Indo nesia within a decade. Brazil, on the other hand, has the world's largest reserve of suitable land for palm cultivation, estimated to be around 50 million hectares (Mha), but only cultivates 0.16 million hectares due to restrictions imposed by Brazilian environmental legislation for Amazonian lands, which limits the size of a given farm to 20% of its total area, preserving 80% of the biome. As a result, Brazil is the 9th largest producer of palm oil (0.37 Mt), resulting in continual palm oil imports. Palm oil is a large and perennial oil-producing plant.

However, after oil extraction, the wastes have little or no commercial use. Palm oil wastes are mostly used as organic fertiliser or to generate power by burning the trash. Palm oil is extracted from the pulp of palm oil fruits, and palm kernel oil is extracted from the fruit kernel. The oil fraction accounts for around 22% of the weight of the palm bunch, with palm kernel oil accounting for only 3%. Palm oil, which makes up the majority of palm kernel oil, is nearly devoid of lauric acid.

c) Rapeseed

Rapeseed is a member of the Brasscicaceae (previously Cruciferae) family, which includes mustard, broccoli, and cauliflower. The word canola comes from a contraction of "CANadian Oil Low Acid," a rapeseed variety developed in the 1970s by Canadian scientists from the University of Manitoba who selected cultivars with low erucic acid oil (toxic for humans and animals). The high quantities of erucic acid and glucosinolate in the grains distinguish rapeseed from canola. Brassica oilseed variants are among humanity's earliest cultivated plants, with evidence of their use dating back to 4000 B.C. in India and 2000 B.C. in China and Japan. During World War I, rapeseed oil was in great demand due to its lubricating charac teristics, as it was needed to supply the growing number of steam engines in naval and merchant ships. After the war, the demand for lubricants fell precipitously, and new uses for oil emerged. Canola is currently the most widely produced rapeseed variety on the planet.

Canola is best known for its oil, but its meal is also highly sought for animal feed formulation due to its high protein content. According to De Morietal., canola seeds have a high oil content (38–45%), and the volume of oil produced worldwide is only surpassed by palm and soybean oil. Canola oil has a low proportion of unsaturated fatty acids, with palmitic (16:0) having the highest content (4 percent). The monounsaturated oleic (18:1) (63%) is the most abundant fatty acid in canola, followed by polyunsaturated linoleic (18:2) (20%) and linolenic (18:3) (18:3). (9 percent).

Canola biodiesel is expensive for the market and for supporting public policy due to high canola oil costs. In terms of the energy balance of biodiesel from canola oil, it was determined that for each input energy unit throughout the life cycle, 2.9 energy units are obtained; when only oil production is considered (without accounting for energy on the meal), this relationship reduces to 1:1.4. In 2014/15, global canola grain production was 72 Mt, allowing for the extraction of 26 Mt of oil, accounting for 16 percent of global vegetable oil production. The European Union (24.0 Mt) is the most productive region, followed by China (14.7 Mt), Canada (14.45 Mt), India (7.5 Mt), and Japan (2.0 Mt). Canola grain has about 40% oil, and it grows best in warm climates far from the Equator.

d) Sunflower

Sunflowers originated in the Southwest United States and Northern Mexico, from where they spread across the continent. It was most likely domesticated in that region, where evidence of North American Indian agriculture dates back over 3000 years. Biofuels: Feedstocks 27 Sunflower's rise to prominence as a globally important crop was largely due to Russia's efforts. Sunflower's importance as a source of edible oil was only discovered in the 1920s. Sunflower, on the other hand, rose to the forefront of oil crop production following WWII. In 2014, the global sunflower cultivated area was roughly 18 Mha, with an overall production of 40 Mt grain, 16 Mt oil, and 17 Mt meal, placing it fourth among the world's most important oils and meal producers. Sunflower vegetable oil accounts for roughly 7.5 percent of global production, trailing palm oil (34%), soybean oil (30%), and canola oil (30%). (16 percent). The seeds' oil content is around 45 percent, which is virtually entirely consumed as edible oil because to its high quality, and the protein level is between 28 and 32 percent.

Sunflower, according to Ungaro, requires an insensitive photoperiod and may be grown everywhere from the equator to latitudes over 40°. The ideal temperatures for efficient plant growth are between 27 and 28 °C, but it grows well fro m 8 to 34 °C, making it a suitable off-season crop and an essential agronomic alternative for rotation with soybeans, corn, and wheat. Unsaturated fatty acids are abundant in the oil, with monounsaturated oleic (18:1) accounting for 16 percent and polyunsaturated linoleic accounting for 72 percent; significant saturated fatty acids include palmitic (16:0), accounting for 6 percent, and stearic (18:0), accounting for 4 percent. Sunflowers are grown as ornamental plants, and its nectar is used to feed domestic bees and sillage (animal fodder).

Sunflower oil has a nutritional content similar to canola oil, making it ideal for biodiesel manufacturing. Gazzoni et al. calculated the energy efficiency of biodiesel synthesis from sunflower oil using Life Cycle Analysis methodologies. They found that for each energy unit input to the system, 2.69 units of energy were obtained with the entire grain destination (meal for nutrition, oil for biodiesel). When meal was not taken into account, the relationship was lowered to 1.61 units of energy received through biodiesel consumption for each unit of input energy.

e) Waste cooking oil

Due to the resultant increase in demand for vegetable or edible oil and unnecessary clearing of forests for plantation, the use of a food sourc e (edible oil) to produce biodiesel at the expense of the millions of people facing hunger and starvation around the world has received harsh criticism from several non-governmental organisations worldwide. Animal and plant habitats will be disrupted by deforestation.

These problems could be reduced if WCO is used as a biodiesel feedstock. Plus, there is rising worry about the impact on the environment of increased WCO production in homes and restaurants. WCO is obtained after frying numerous times with edible vegetable oils such as palm, sunflower, and corn oils. Because of the changes that occur during frying, the chemical and physical properties of WCO differ slightly from those of fresh oils. Due to the rapid growth of the human population, the amount of WCO produced by homes and restaurants is rapidly increasing. Furthermore, increased food consumption has resulted in massive volumes of WCO being produced. WCO is produced in the United States alone in the amount of 10 million tonnes per year, necessitating a cost-effective and ecologically beneficial disposal solution, such as using it as a fuel for biodiesel synthesis.

WCO is 2 to 3 times less expensive than fresh vegetable oil, resulting in a significant reduction in total processing costs. Furthermore, unlikethe usage of virgin edible oils, the use of WCO does not deplete food supplies, removing any potential controversy in the area. One disadvantage of using WCO for biodiesel production is that it contains various contaminants, such as free fatty acid and water, which must be removed prior to transesterification due to their major negative impacts on the process. The acid and saponification levels of WCO are used to determine its quality. If the free fatty acid level in the oil is greater than 3%, transesterification failure may occur.