UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPLICATION OF MICROWAVE ENERGY FOR BIODIESEL PRODUCTION USING RUBBER SEED OIL

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Kajian yang dijalankan adalah untuk mengkaji kesan kepada parameter (tindak balas suhu, masa tindak balas, kuasa gelombang mikro, peratusan berat pemangkin dan nisbah minyak kepada metanol), hasil pengeluaran dan peralatan pengeluaran bagi minyak biji getah dengan mengunakan sisa kerang sebagai pemangkin. Ciri-ciri bahan mentah seperti asid lemak bebas, nilai asid, ketumpatan, kelikatan kinematik, dan komposisi titik kilat yang mempengaruhi ciri akhir biodiesel juga dikaji. Sisa kulit kerang telah dikalsin pada suhu 900 °C untuk tempoh 4 jam dan berfungsi sebagai sumber kalsium oksida.. Analisa XRF digunakan dalam analisis ciri-ciri pemangkin. Pengunaan biodiesel akan memberikan pengunaan bahan api tertentu yang tinggi berbanding bahan bakar biodiesel. Pengunaan bahan api tertentu yang tinggi adalah lebih besar kepada enjin kerana ia akan meningkatkan prestasi enjin. Kondisi reaksi maksimum dalam reaktor kelompok gelombang mikro ialah nisbah molar minyak ke metanol 15:1, 12 wt% pemangkin, 7 minit masa tindak balas dengan 300 watt kuasa gelombang mikro. Biodiesel yang terhasil, B100 adalah dikaji dengan merujuk kepada piawaian ASTM D6751 dan EN 14124.

ABSTRACT

An experimental investigation was conducted to study the effects of process variables (reaction temperature, reaction time, microwave power, catalyst weight percentage and methanol to oil ratio), production yield and apparatus embodiment of crude Rubber Seed Oil (RSO) using waste cockles as catalyst. The feedstock characteristics such as free fatty acid, acid value, density, kinematic viscosity and flash point composition that may influence the final properties of the biodiesel also being observed. The waste cockle was calcined at 900 ℃ for 4 hours and was employed as a source of calcium oxide. XRF was used to analyze the catalyst characterization. The uses of biodiesel will produce high specific fuel consumption compare to the diesel fuel. At the end, the best parameter for the maximum yield production was recorded at 300 W of microwave power, 12 wt% of catalyst concentration, 15:1 methanol to oil molar ratio and 7 minutes of reaction time. All the produced biodiesel B100 were tested and referred with the ASTM D6751 and EN 14124 standards.

DEDICATION

This report is dedicated to my beloved parents, my siblings and my friends, who always support me during this final year project work. Last but not least, my final year report group mates who were always with me to complete my final year project research.

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LIST OF SYMBOLS

m	-	Mass
g	-	Gram
kg	-	kilogram
m^3	-	Volume
L	-	Litre
mL	-	Millilitre
°C	-	Degree Celcius
V	-	Volume
W	-	Watt

LIST OF ABBREVIATIONS

RSO	Rubber Seed Oil
FFA	Free Fatty Acid
CaO	Calcium Oxide
$CaCO^3$	Calcium Carbonate
CO^2	Carbon Dioxide
H_2SO_4	Sulphuric Acid
NaOH	Sodium Hydroxide
KOH	Potassium Hydroxide
CH_3ONa	Sodium Methoxide
FAME	Fatty Acid Methyl Ester
FAEE	Fatty Acid Ethyl Ester
TGs	Triglycerides
GCMS	Gas Chromatography-mass Spectrum
GC	Gas Chromatography
TLC	Thin Layer Chromatography
FTIR	Transform Infrared Spectroscopy

Ruang kosong lagi????

CHAPTER 1

INTRODUCTION

1.1 Background

Biodiesel is a fuel that is delivered from natural elements. For example plants, vegetables, and reusable materials. This kind of fuel is good to the atmosphere compare to the other fuels because it does not give off harmful chemicals which effect the environment negatively. The popularity of biodiesel fuel is increasing consistently as people search out alternative energy resources. According to A.M. Doyle et al., 2016, the natural sources that are first utilized as fuels over a century prior by Rudolf diesel is vegetable oils. However, this sources of fuel is supplanted by a less expensive oil divisions that are transformed to diesel using heterogeneous catalyst.

In the development of bioenergy such as biodiesel which act as an alternative fuel, has being an interesting issues because the characteristic of fuels are eco-friendly and biodegradable properties. S.Nurdin et al, 2015, stated that numerous vegetable oils can be used as biodiesel sources like canola oil, soybean oil, castor oil and many more. Biodiesel is gotten from straight transesterification of vegetables oil or animal fat that reacts with small molecule of alcohol with the help of catalyst. In any case, due to the continuous and expansive scale production of biodiesel from edible oils has become the great concern since they compete with nourishment material. In this way, in the generation of biodiesel, non-edible plant oils have been observed to be promising crude oils. In developing countries, the usage of non-edible oils is essential because of the

enormous demand for edible oils as food and that they are too costly to possibly use as fuel in the future (W.Roschat et al, 2017).

In order to generate the biodiesel with competitive prices as those for diesel, the technology used is extremely important other than the costs of the crude materials. J.Milano et al., 2018, expressed that the production of biodiesel from conventional antacid catalyzed transesterification require long reaction times which is commonly over an hour because of the heat exchange from the warming surfaces to the oil by conduction, convention and radiation. Thermal conduction is the method of heat exchange between the surface and the inside of the material. In order to accomplish a high transformation of crude oil into biodiesel, the chemical response is subject to the heat exchange proficiency, which is the reason the conventional heating subjected to long reaction time. In this way, it is important to use a proper technology to create the biodiesel. Hence, the proper technology that can be used to create biodiesel is by using microwave.

Microwave irradiation is a productive method that has been widely used, to extract oils from biomass, vegetable feedstock and animal fats. Some advantages by using this method are, it is financially savvy and can be effortlessly scaled-up. Averagely, by comparing the creation cost using this two types of method, the uses of microwave heating is 66% not as much as that by conventional heating. Furthermore, microwave irradiation has high response rate (A.Buasri and V.Loryuenyong, 2017).

According to W.Roschat et al, 2017, the transesterification process was conducted in the batch reactor. A 250 ml 3-neck round base flask furnished with a reflux condenser is used to blend methanol, catalyst and rubber seed oil. The reaction of blending was warmed at certain temperature and mixing rate. Waste coral section, sodium

silicate granule, calcium oxide (CaO) based eggshell and CaO are the heterogeneous catalysts utilized for the transesterification of the rubber seed oil. Prior to the investigation of the biodiesel yield, the blended solution of 0.5 ml was examined, and afterward the excessive amount of methanol was evaporated in an oven to monitor the reaction progress. The terms of percent fatty acid methyl ester (% FAME) as a function of time is used to determine the transformation of rubber seed oil to biodiesel.

Generally, the production of biodiesel can be incorporated through transesterification of triglycerides (TGs) with methanol using homogeneous basic or acidic catalyst. However, many problems obtain when using the homogeneous catalyst such as formation of soap, corrosion of reactor, having trouble to reuse the catalysts and the creation of substantial measure of waste water, which builds the cost of biodiesel production. Since the uses of heterogeneous catalysts has promoted benefit to environment and lessen the production cost, it has turned out to be more favourable and prepared to be scaled up to a modern level. The CaO is chosen among the solid catalysts because of its low in cost, high activity, and plenitude in nature.

Palm oil is a significant crude material which is used in the biodiesel generation in Thailand. However, palm oil has been utilized for fundamental use and food industry which is if constantly use for the generation of biodiesel, will make the deficiencies edible oil consumption and increment the cost of the palm oil in the nation. Further research found that Jatropha Curcas plants is promoted as crude material for biodiesel production as it plants effortlessly, grows quickly and offer high return of oil. Be that as it may, Jatropha Curcas are lacking to be a feedstock in biodiesel creation because of the restricted estate region. There are a few works reported on biodiesel production using

rubber seed oil that can possibly be chosen as an elective diesel fuel since it is non-edible oil that can deliver adequate quantity of oil to the industry (W.Roschat et al, 2017).

CaO as a heterogeneous catalysts is broadly used as a part of the exploration as a result of its low production cost. According to K.Colombo et al., 2017, the results of their study demonstrates that the production of biodiesel through transesterification process by using CaO as catalysts provides a maximum conversation of 95% when all of the parameters are optimized, essentially the response time and molar ratio. The time of chemical reaction can be reduce, increases biodiesel yields, enhances the separation process and decreases the energy use to generate biodiesel when using the microwave irradiation. Rubber seed oil is selected among various feedstock as the rubber seed are readily available throughout the year.

1.2 Problem Statement

The uses of fuels in every engine is important to make sure that the parts can work towards their desired function. However, the depletion of petroleum as a base for fuels production has bring to the searching on alternatives way to produce fuels which is by producing biodiesel from natural resources. This study is focusing on the uses of oil from the rubber seed in the production of biodiesel by using transesterification reaction in the presence of waste cockles as catalyst.

1.3 Objectives

i. To study the effects of process variables (temperature of reaction, time of reaction, catalyst weight percentage, microwave power input and the

molar ratio of methanol to the oil), production yield and apparatus embodiment.

ii. To study the production of biodiesel from rubber seed oil using waste cockle as catalyst.

iii. To study the feedstock characteristics such as free fatty acid, acid value, density, kinematic viscosity and flash point composition that may influence the final properties of the biodiesel.

1.4 Scopes

In order to reach the objectives, a few scopes have been drawn:

i. Analyse and investigate the effect of using different parameters in order to get the best parameters for biodiesel production.

ii. The biodiesel studied is produced by using extracted rubber seed oil prepared in the laboratory with the help of waste cockle as the natural heterogeneous catalyst.

iii. The feedstock characteristics such as the FFA composition were studied by using some calculations through the acid values of the feedstock and how the properties such as density, flash point and kinematic viscosity may influence the final yield product.