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FACULTY OF CHEMICAL ENGINEERING
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BIODIESEL FROM RENEWABLE BASED MATERIALS: METHODS OF PROCESSING

SUPERVISOR'S NAME: DR. AHMAD ROZAIMEE BIN MUSTAFFA

GROUP MEMBERS: EH110 5B

Name	Student ID	Signature
Nur Amyra Syafiqah Binti Norhisham	2018267734	
Ainin Sofiya Binti Abdull Halim	2018422164	
Nor Fatin Fatihah Binti Zulkifli	2018215026	
Ahmad Ziad Bin Rasidi	2018245116	

BIODIESEL FROM RENEWABLE BASED MATERIALS: METHODS OF PROCESSING

Dr. Ahmad Rozaimee Bin Mustaffa, Ainin Sofiya Binti Abdull Halim[1], Ahmad Ziad Bin Rasidi[2], Nor Fatin Fatihah Binti Zulkifli[3], Nur Amyra Syafiqah Binti Norhisham[4]

Abstract

The realization of energy and environmental concerns associated with the burning of fossil fuels has driven many researchers to explore the possibility of using alternative and renewable sources of energy. Among them, biodiesel which is one of the types of biofuel has received a lot of attention. Biodiesel is defined as mono-alkyl esters of long-chain fatty acids that are derived from various generations, dependent on the type of feedstock used. In particular, the first-generation biofuels are produced from edible plant oils like soybeans, corn, sugarcane, palm oil and rapeseed. Meantime, second-generation biofuels are processed from lignocellulosic biomass from natural plants, agricultural waste and energy crops such as Jatropha, Miscanthus, switchgrass and willow. Plus, third-generation biofuels are developed by using micro-and-macroalgae in line with the development of research. The term biofuel refers to a primarily biomass-derived liquid, gas and solid fuels. The demand for the use of renewable and sustainable energy to replace fossil fuels is growing. The main reason is that burning of fossil fuel that is used in transportation such as gasoline, liquified petroleum gas, diesel fuel and natural gas contributes to the increase in the carbon dioxide (CO_2) or greenhouse gas (GHG) level in the atmosphere. Therefore, it leads to global warming that becomes more concerning at this day and age. Also, increasing energy demand will pose challenges to the security of supply as resources are scattered around the globe. However, advances in technology have significantly improved the quality of life of the human population. In an attempt to meet these demands, researchers are exploring different approaches to delivering affordable clean energy from the abundant biomass in our environment. Therefore, a review on the production of biodiesel from soybean, sugarcane, palm oil and microalgae are presented. The objective of this work is to review and compare the most effective method of processing biodiesel using soybean, sugarcane, palm oil and microalgae, along with presenting the various parameters for its continued application as a viable manufacturing method. Biodiesel can be processed by three methodologies that are pyrolysis or thermal cracking, micro-emulsification and transesterification. Collectively, the most effective method for producing biodiesel is via the transesterification process and is discussed in-depth. The results mainly discussed comparative findings of its parameters and fatty acid methyl ester (FAME) from respective feedstocks. In short, the approach to sustainability and reducing fossil fuel consumption remains a healthy and economically viable one and the future of biodiesel may not be focused solely on one generation but, can be a mixture of several generations in line to meet global demand.

Keywords: Biodiesel, biofuel, biomass, microalgae, palm oil, soybean, sugarcane, transesterification, Fatty Acid Methyl Ester (FAME)

Table of Contents

1. Background of Study

1.1 Introduction

The term biofuel refers to a primarily biomass-derived liquid, gas and solid fuels. From the numerous biomass resources, a variety of fuels can be produced, including biodiesel, bio-alcohol, biogas, bio-oil, bio-char and biohydrogen. Periodically, the demand for the use of renewable and sustainable energy to replace fossil fuels is rapidly growing due to the environmental and energy security considerations as well as the rural socio-economic issues. With that, the application of liquid biofuels are mostly used to fuel vehicles, fuel engines or fuel cells for electricity generation [1].

The advantages of biofuels are that they are readily accessible from common sources of biomass. Also, they reflect a combustion cycle of carbon dioxide, have substantial eco-friendly potential and, they have many benefits for the atmosphere, for the economy and consumers as well as they are biodegradable and contribute to sustainability. Other than that, biomass feedstock also contributes to the demand for biofuel production. It is attributed to its sustainable resource that could be sustainably produced in the future. Besides, it appears to have tremendously positive environmental characteristics, resulting in no net carbon dioxide emissions and low sulphur content. Also, if fossil fuel prices increase from time to time, it remains a considerable economic potential [1].

However, globally, the realization of energy and environmental concerns associated with the burning of fossil fuels has driven many researchers to explore the possibility of using alternative and renewable sources of energy instead of oil and its derivatives. Among them, biodiesel that is one of the types of biofuel has received a lot of attention [2-3]. It is owing to its beneficial reasons that are that are readily biodegradable and has minimal toxicity. Furthermore, it can substitute diesel fuel in several different applications, such as boilers and internal combustion engines without significant modifications. Also, the emissions of sulphates and other chemical compounds that are hazardous to the atmosphere are approximately nil [2].

Biodiesel defines as mono-alkyl esters of long-chain fatty acids derived from vegetable oils, animal fats or other sources like microalgae. Also, by a presence of alcohol with or without a catalyst. Other than that, biodiesel contains no sulphur, no net carbon dioxide, less carbon monoxide, particulate matter, smoke and hydrocarbons, and more oxygen compared to diesel fuel. Hence, it contributes to more free oxygen that leads to total combustion and reduced emissions [2].

As for the catalyst, studies show that the alkaline catalytic method is the fastest and most economical catalyst than other catalysts. An alkaline catalyst works at about 4000 times faster than with the same amount of acid catalyst. Besides, this method can achieve high biodiesel product purity and yield in a short time of around 30-60 minutes.

1.2 Problem Statement

Despite the advances in technology have significantly improved the quality of life of the human population, the need for more energy to sustain our modern social life and power has led to the rapid burning of fossil fuels that are used in transportation such as gasoline, liquified petroleum gas, diesel fuel and natural gas [4-5]. However, fossil fuel burning is a contributing factor to the increase in the carbon dioxide (CO_2) or greenhouse gas (GHG) level in the atmosphere, which is directly associated with global warming that has been reported in recent decades [6].

The global warming then leads to a climate change that is currently the most critical environmental issue. Up to one million species could become extinct and hundreds of millions of people could risk their lives if the average global temperature rises by more than 2°C [2]. Moreover, increasing energy demand will pose challenges to the security of supply as resources are scattered around the world. Particularly, biofuels help to enhance and safeguard energy security by reducing the world's dependence on fossil energy sources. Accordingly, biomass is a resource that is more evenly distributed across the globe [7].

Hence, the research into renewable and environmentally friendly energy sources has become crucial gradually [8].

1.3 Objectives

Thus, the objective of this work is to review and compare the most effective method of processing biodiesel using soybean, sugarcane, palm oil and microalgae, along with presenting the various parameters for its continued application as a viable manufacturing method.

1.4 Scope of Study

Generally, the biofuels are classified in various generations, dependent on the type of feedstock used. Firstly, the first-generation biofuels are produced from edible and cash crops like soybeans, corn, sugar cane as well as palm oil and rapeseed, respectively. Secondly, lignocellulosic biomass from natural plants, agricultural waste and energy crops such as Jatropha, Miscanthus, switchgrass and willow are used in second-generation biofuels. Thirdly,