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Study Feasibility Analysis of Biodiesel Energy Processing Used Cooking Oil

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Abstract

In research on renewable power plants. Fuel from petroleum, if consumed continuously, will run out over time. Research on alternative fuels to replace petroleum-based fuels continues to be carried out, one of which is research on Biodiesel/Biosol. Biodiesel is a substitute for diesel fuel derived from vegetable raw materials. The advantage of biodiesel over diesel is that it is more environmentally friendly. Biodiesel has started to be produced and marketed in Indonesia. Used cooking oil is easy to obtain, therefore the production of biodiesel from used cooking oil can be carried out by small industries. The process of producing biodiesel from used cooking oil uses the transesterification method. This research is expected to provide benefits as a business opportunity for small industrial-scale biodiesel production, provide economic value to used cooking oil, overcome household and industrial waste disposal, provide input to the industry so that they can produce fuel independently, and provide input to local governments so that they can producing biodiesel so that it becomes an energy-independent area. The physical test results of biodiesel from used cooking oil showed a density of 0.8780 gr/ml, a viscosity of 6.118 mm 2/s, a flashpoint of 178 oC, a carbon residue of 0.0006 %Wt, an ash content of 0.0397% WT, and a gross heating value of 19400 BTU/lb. In general, biodiesel has physical properties similar to diesel so it can be used as a mixture of diesel or diesel fuel substitutes.

Keywords
new energy, biodiesel, cooking oil

I. Introduction

Diesel Power Plant (PLTD) is a power plant that uses a diesel engine as a prime mover. Prime mover is equipment that has the function of producing the mechanical energy needed to rotate the generator rotor. PLTD is a power plant installation consisting of a generating unit and generating facilities. In a diesel engine, fuel energy is converted into mechanical energy by the combustion process in the engine itself. Indonesia is one of the oil-producing countries in the world, but until now it still imports fuel oil (BBM). Biodiesel from vegetable oil is an alternative fuel specially formulated for diesel engines (Ogolmagai, 2013).

The purpose of this study is to analyze and determine the effect of using pure diesel fuel with biodiesel B15 and B20 on the performance of the Komatsu SAA6D107E-1 engine. The research was carried out through several stages, namely from data collection, to following the process of installing the engine to the dyno test. The researcher took data when the engine was operating using the Taylor Dynamometer DX 34 test tool. From the testing process, several parameters were used, namely the comparison of performance between torque and power to engine speed. Based on these parameters, a performance comparison is calculated. The test results obtained through a dyno test on the Komatsu SAA6D107E-1

engine that uses B15 biodiesel fuel has decreased maximum torque performance by 8.7%, maximum power loss is 2.7%, while for biodiesel B20 fuel has decreased maximum torque by 10, 3% and a maximum power loss of 6.1% (S. Aryza et al., 2018).

Biodiesel production in Indonesia is currently carried out by large industries. The raw materials used are generally derived from palm oil. In addition to processing palm oil into cooking oil, the industry also processes it into biodiesel which is then distributed to government fuel oil distributors such as Pertamina and private distributors such as Shell, Total, and Petronas. Solar currently being sold is subsidized by the government. The price of diesel also rises and falls along with the rise and fall of world fuel prices (Leevijit et al., 2017). However, biodiesel production will continue to be carried out by the biodiesel mandatory outlined in the Minister of Energy and Mineral Resources Regulation No. 20/2014 which requires 20% biodiesel content (B20) in 2016 (Shofiatul, 2017).

To enjoy the electricity we use today, it all starts with a power plant. Generators are generators, these generators produce electricity and that electricity is delivered by transmission and distribution lines to our homes. One of the most economical, easy, and safe ways to transmit energy is through the form of electrical energy. At the power plant, primary energy resources such as fossil fuels (oil, natural gas, and coal), hydro, geothermal, and nuclear are converted into electrical energy.

Nur Sasongko (2018) also said that the depletion of petroleum reserves in the world as well as in Indonesia, one of which is triggered by our dependence on energy consumption from petroleum. This situation is also driven by the increasing demand for oil energy in the transportation sector as well as the growth of the industrial sector in Indonesia. This forces us to seek, utilize and develop new renewable energy sources as a substitute for petroleum fuel. One alternative renewable energy is Biodiesel. Indonesia has great potential as a producer of biodiesel because sources of biodiesel, namely sugarcane, cassava, sweet potatoes, jatropha, etc. are widely available and easy to develop in Indonesia. As an alternative to renewable energy, biodiesel can help in minimizing the world's dependence on fossil fuels (Solly Aryza, n.d.).

Then Magfirotunnisa, et al (2018) stated that the content of biodiesel B15 and B20 still met the standards or specifications of diesel fuel that had been set by the government. Judging from the parameter table, the cetane number of each fuel is increasing so that the combustion can be said to be complete and the flashpoint of the fuel is getting higher. In exhaust emissions, the SOx content in biodiesel fuel is lower than diesel fuel, thereby reducing damage to the surrounding environment and helping the ozone layer in the atmosphere (Iskandar et al., 2014).

Used cooking oil is used oil that has been used for household purposes and has undergone changes, both physically and chemically. One of the efforts that can be done to reduce the adverse effects of used cooking oil is to convert used-cooking oil into biodiesel. In this study, the manufacture of biodiesel from used cooking oil was carried out using a transesterification reaction such as making biodiesel in general (Phoungthong et al., 2013).

Jauhari (2019) said that biodiesel can be made from vegetable oils, animal fats, and algae. The utilization of vegetable oil as raw material for biodiesel has several advantages, including the source of vegetable oil is easy to obtain and the conversion rate of vegetable oil into biodiesel is high (up to 95%). Vegetable oils have different fatty acid compositions depending on the type of plant. The main constituents of fats (both vegetable and animal) are triglycerides, namely trimester glycerol with fatty acids (C8 – C24). The fatty acid composition in vegetable oil determines the properties of the oil.

Furthermore, Magfirotunnisa, et al (2018) also stated that various studies on direct testing of biodiesel as diesel engine fuel have been carried out and will be described as follows. This research analyzes the comparison of diesel fuel with biodiesel B20 on engine performance. The results of the research conclude that the reduction in engine torque using biodiesel B20 fuel compared to diesel fuel is 0.985 % and the engine power reduction is 2.256%. Engine performance using B20 biodiesel fuel from jatropha, from the conclusion of the study, the maximum power value was 1432.82 HP at 1901 rpm engine speed and a maximum torque value of 4929.3 lb. ft at 1301 rpm engine speed (solly Aryza, 2017).

Energy is a very important human need that is needed in large quantities but is expected at a low cost. The most important facility and infrastructure for Indonesia is the provision of electrical energy. Indonesia has provided this source of electrical energy in almost all of Indonesia, but there are still areas that have not been reached by the PLN network so that they have not received electricity supply. Electrical energy comes from two sources, namely renewable energy and non-renewable energy. Included in renewable energy is solar power, ocean wave energy, wind energy but requires research for its development in Indonesia. The types of non-renewable energy are hydroelectric power plants, wind power plants, diesel power plants, gas power plants, and nuclear power plants. The use of non-renewable energy must be considered in quantity because it will greatly disrupt these energy forces in the future if used excessively.

II. Review of Literatures

2.1. Bio Gas

The year 2025 targets the use of alternative fuels for biofuels by twenty-five percent. the five percent target was achieved in 2010, increasing to 20 percent by 2020, and 25 percent by 2025.

By the end of 2004, the total area of oil palm plantations in Indonesia had reached 5.3 million hectares (ha) with crude palm oil (CPO) production of 11 million tons. The development of oil palm plantations is still ongoing and it is estimated that in the next five years Indonesia will become the largest CPO producer in the world with a total production of 15 million tons per year.

One of the downstream products from palm oil that can be developed in Indonesia is biodiesel which can be used as an alternative fuel, especially for diesel engines. With the recent high price of oil, it is time for Indonesia to start developing biodiesel, both for domestic consumption and export. The price of pure biodiesel is very dependent on the price of CPO which is always fluctuating. For a large scale, at a CPO price of US$ 400 per tonne, the biodiesel price is estimated to reach around US$ 560 per tonne, so the price of B-10 (a mixture of 10 percent biodiesel and 90 percent diesel) becomes Rp 2,400 per liter, a price that is not too high. higher for more environmentally friendly fuels. With Indonesia's diesel demand of around 23 million tons per year (7.2 million tons of which are imported), the use of B-10 will require 2.3 million tons of biodiesel or the equivalent of 2.415 million tons of CPO that can be produced from around 700,000 ha of coconut plantations. oil palm, and can support about 350,000 oil palm farming families, assuming land ownership of 2 ha per family. There are many advantages of using biodiesel.

This type of fuel does not contain sulfur and carcinogenic benzene compounds, so biodiesel is a cleaner fuel and easier to handle than diesel. The difference between biodiesel and diesel is mainly in their composition. Biodiesel consists of vegetable fatty acid methyl esters, while diesel is a hydrocarbon. There is no need to modify the diesel engine if the fuel uses biodiesel.

Biodiesel even has a cleaning effect on fuel tanks, injectors, and hoses. Biodiesel does not add to the greenhouse effect like diesel does because the carbon produced is still in the carbon cycle. The energy produced by biodiesel is similar to diesel, so the engine torque and horsepower produced are also similar. In addition, biodiesel produces a higher level of engine lubrication compared to diesel.

2.2. Biodiesel Quality Standard

Biodiesel Quality Requirements according to SNI (SNI National Standardization Agency. 2015. Jakarta) are compiled by referring to biodiesel quality requirements standards in the United States, Europe, and Australia and taking into account the conditions of Indonesia. Parameters of Biodiesel Quality Requirements according to SNI consist of 2 groups, among others:

1. Parameters whose values are more representative of the level of processing perfection are kinematic viscosity, flash point, copper blade corrosion rate, acid number, alkyl ester content, total glycerol, phosphorus, sulfur, sulfated ash, water, and sediment.
2. Parameters whose values are determined by the fatty acid composition of the raw material are cetane number, iodine number could point, carbon residue, Halphen test, density, and distillation temperature.

According to Shofiatul ula (2017), diesel currently being sold is subsidized by the government. The price of diesel also rises and falls along with the rise and fall of world fuel prices. However, biodiesel production will continue to be carried out by the biodiesel mandatory outlined in the Minister of Energy and Mineral Resources Regulation No. 20/2014 which requires a biodiesel content of 20% (B20) in 2016. The abundance of raw materials and overcoming waste used cooking oil requires the process of making biodiesel from used cooking oil. The process of producing biodiesel from used cooking oil by small industries requires tools that can be operated easily at affordable prices.

In addition, the biodiesel production process from used cooking oil also requires other ingredients besides used cooking oil, therefore it is necessary to research the feasibility of small industrial-scale biodiesel production processes.

2.3. Cooking Oil

Used cooking oil is cooking oil that has been used for frying several times. Used cooking oil is one of the potential biodiesel raw materials to be used in Indonesia. This can be seen from the production of used cooking oil in Indonesia, which can reach 4,000,000 tons/year. Based on the results of the feasibility evaluation of biodiesel, the type of vegetable oil that is most suitable to be used as biodiesel raw material is used cooking oil, because, considering the large amount of used cooking oil that has not been utilized optimally, the best technology that can be applied is reprocessing used cooking oil that has become waste so that it will benefit the community (Adhari, 2016).

According to Hadrah et al (2018), one of the efforts that can be done to reduce the adverse effects of used cooking oil is to convert used-cooking oil into biodiesel. Biodiesel is one type of fuel that is produced using vegetable oil or animal fat through a transesterification process or an esterification process with the help of alcohol and a catalyst.

The use of used cooking oil or used cooking oil as raw material for biodiesel is because there are still similarities in characteristics with palm oil: it still contains triglycerides, in addition to free fatty acids. Economically, used cooking oil of very low quality, such as its black form, can now be obtained for free because it is waste that is no longer used. Statistical data shows that there is a tendency to increase cooking oil production. In addition to its relatively abundant availability, used cooking oil is a waste that has the potential to pollute

the environment in the form of increased levels of COD (Chemical Oxygen Demand) and BOD (Biological Oxygen Demand) in the waters, besides that it also causes a foul odor due to biological degradation (Joni Prasetyo, 2018).

2.4. Factors Affecting Transesterification Reaction

Factors Affecting the Transesterification Reaction According to Arpiwi (2015), the factors that influence the transesterification reaction are as follows:

a. Reaction Time

The longer the reaction time the more products are produced because this situation will provide an opportunity for the reactant molecules to collide with each other. However, after equilibrium is reached the additional reaction time does not affect the reaction.

b. Ratio

Comparison of alcohol or methanol with oil the molar ratio between alcohol and vegetable oil greatly affects the methyl ester produced. The more alcohol used, the more ester conversion produced. The molar ratio between alcohol and vegetable oil which is commonly used in industrial processes to obtain methyl ester production greater than 98% by weight is 6:1.

c. Type of Catalyst Catalyst

A substance that functions to speed up the rate of a reaction by lowering the activation energy, but does not shift the position of equilibrium. The addition of a catalyst aims to speed up the reaction and reduce operating conditions. Without a catalyst, the new transesterification reaction can run at a temperature of 250oC. When the reaction is complete, we will get the same mass of catalyst as we initially added. The catalyst that can be used can be homogeneous or heterogeneous.

d. Temperature

The speed of the transesterification reaction will increase at temperatures close to the boiling point of the alcohol used. The temperature during the transesterification reaction can be carried out in the temperature range of 300C - 65°C and is maintained throughout the process, depending on the type of oil used. In the transesterification process, the change in reaction temperature causes the molecular movement to accelerate so that it can overcome the activation energy. Temperature affects viscosity and density because viscosity and density are two important physical parameters that affect the utilization of biodiesel as a fuel. The higher the temperature causes the molecules to move faster or the kinetic energy of the reacting molecules gets bigger so that the collisions between reactant molecules also increase.

e. Stirring

Increasing the speed of stirring increases the rate of reaction because stirring will accelerate the movement of molecules and increase the chances of collisions between molecules.

f. Length of Settling Time

The time of deposition affects the 2-stage transesterification process, namely the transesterification process twice. Precipitation aims to separate glycerol and biodiesel. The time of deposition of the methyl ester affects the acid number. When the deposition is longer, it is assumed that the oxidation level in the two-stage process is higher than in the one-stage process. This results in a higher acid number.

g. Water Content

Excessive water content can cause some reactions to turn into soap or saponification reactions which will produce soap, thereby increasing viscosity, forming gels, and making it difficult to separate glycerol and biodiesel.

h. Methanol

The types of alcohol that are always used in the transesterification process are methanol and ethanol. Methanol is the most preferred type of alcohol in the manufacture of biodiesel. Methanol (CH3OH) has the advantage of being easier to react or more stable than ethanol (C2H5OH) because methanol has one carbon bond while ethanol has two carbon bonds, so it is easier to obtain glycerol separation compared to ethanol. ethanol. The amount of methanol does not affect the density of biodiesel but the amount indicates that the density of the biodiesel produced has met the requirements of the biodiesel oil specification, which is 0.87 gr/ml.

III. Research Methods

The research method used is an experimental research method where research is conducted to determine the feasibility of a used cooking oil processing machine into biodiesel.

In the research procedure, several steps will be carried out, namely testing to determine the feasibility of the tool, the working principle of a tool, and the effectiveness of the tool. A more detailed explanation of the research methodology will be presented as follows:

3.1 Research Time and Place

This research was carried out within 6 months starting from October 2, 2020, to March 20, 2021. Starting with the approval of this proposal until the completion of the research. The research site is in the fifty-coal district, North Sumatra. Precisely on a chicken farm.

3.2 Tools and Materials

The electronic equipment and components used in this research are:

1. Personal laptop used as input for data collection.
2. The multimeter functions as a measuring instrument for the electrical voltage produced.
3. Digital scales function to weigh the caustic soda.
4. Measuring tube serves as a gauge.
5. Stopwatch as a timer.
6. The fan functions as a load.
7. Cable as generator connector
8. Incandescent lamp serves as a load.

1. The materials used in this research are:

1. Baking soda (NaOH)
2. Methanol-ethanol
3. Cooking oil
4. Biosolar (B-20)
5. Shark. Diesel Engine
6. Generator 1 Phase

3.3. Hardware Design

Each part of the component system has an important role according to their respective functions so that the system can run as planned. Each of the components will be connected to the Arduino Mega. The schematic diagram of the system can be seen below:

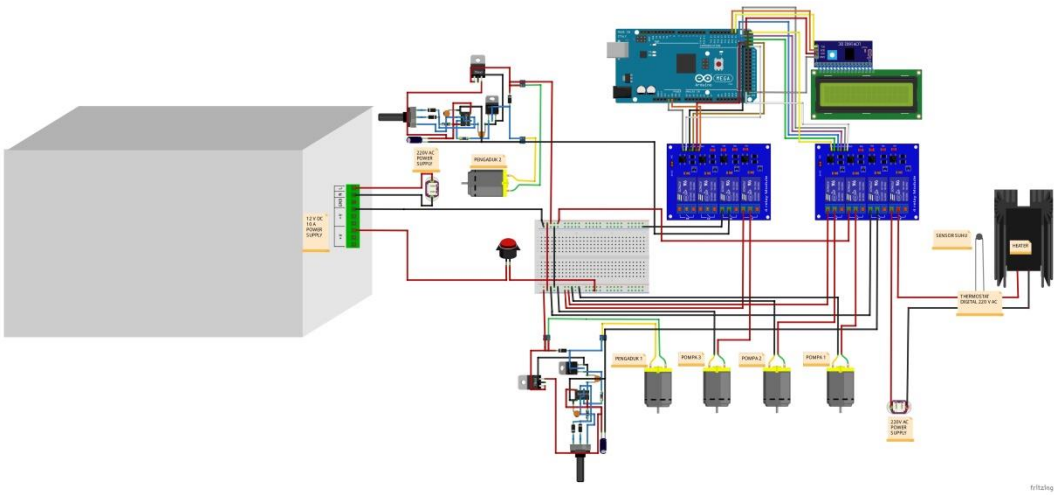

Figure 1. *A Series of Biodiesel Processing Machines Using Used Cooking Oil Based on Arduino Mega*

The circuit above was made using the ISIS program on the Proteus 8 software. The function of the schematic drawing of the experimental system circuit is to make it easier to understand the circuit by looking at the connected component paths.

3.4. Experiment Stage

Experimental stages can be carried out using the procedures that have been carried out. The stages carried out in carrying out this final project include the following:

1. Determine the theme by conducting a literature study to obtain various theories and concepts to support the research to be carried out.
2. Prepare research materials and tools.
3. Designing research tools and control programs for Arduino Mega.
4. Conducting trials of research tools.
5. Analyzing the test results of the research tool.
6. Print the test results of the research tool.
7. Done.

IV. Discussion

4.1. Starting

The results of the analysis of the feasibility study for the design and manufacture of biodiesel processing machines using cooking oil based on Arduino Mega

In this research, the analysis of the feasibility study for the design and manufacture of a biodiesel engine using Arduino-based cooking oil consists of several tools and materials that will be used as research material. The tools and materials are as follows:

a. Cooking Oil

Used cooking oil will be the main ingredient in making biodiesel in this study. Used cooking oil, which is still easily available from traders, will be used as new and renewable energy, namely biodiesel.

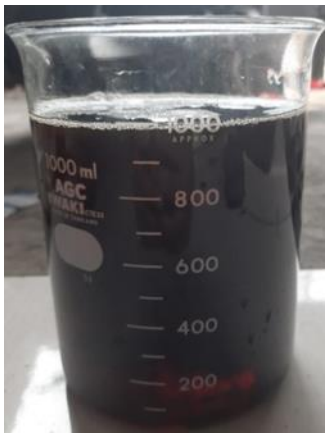

Figure 2. *Used Cooking Oil for Frying*

b. Methanol

The types of alcohol that are always used in the transesterification process are methanol and ethanol. Methanol is the most preferred type of alcohol in the manufacture of biodiesel because methanol (CH3OH) has the advantage of being easier to react or more stable than ethanol (C2H5OH) because methanol has one carbon bond while ethanol has two carbon bonds, so it is easier to obtain glycerol separation compared to ethanol. ethanol. A drop from the mixture was spotted on a microscope slide in the presence or absence of methanol extracts and covered with a cover slip (Ngunde, 2019).

Figure 3. Methanol

4.2 The Process of Making Biodiesel in A Biodiesel Processing Machine Using Used Cooking Oil Based on The Arduino Mega Controller

The initial preparation in this process is to prepare a program from the Ardunio IDE software, here are the steps taken:

1. Prepare the Arduino connecting cable so that it can be connected to the laptop.

2. Prepare the laptop as a place to code the Arduino program.
3. Prepare the Arduino program application on the laptop, which can be downloaded on the internet.
4. Open the Arduino application that has been downloaded.
5. Connect the arduino to the laptop with the connecting cable.
6. Setting the program for the tool.
7. After the program settings are complete, click confirm then click upload, wait a few moments.
8. The system works.

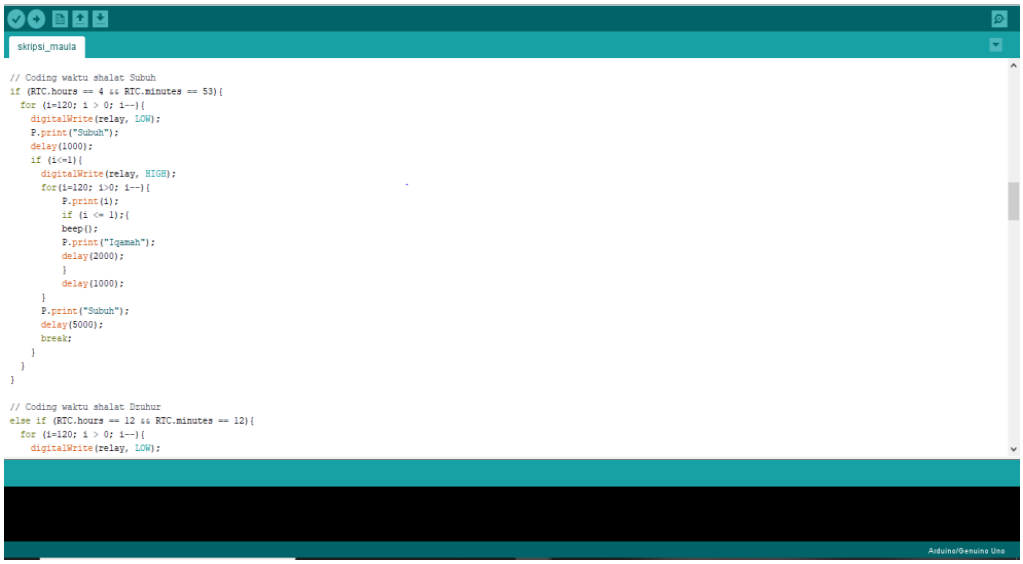

Figure 4. *Arduino Program Display for Controlling Biodiesel Processing Equipment*

It can be seen from the picture above is a series of programs from the Arduino IDE Software which is applied to a biodiesel processing machine using used cooking oil based on the Arduino Mega controller.

The contents of the program settings for the tool are as follows:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,20,4);
void setup()
{
  pinMode(22,OUTPUT); // heater
  pinMode(23,OUTPUT); // mixer 1
  pinMode(24,OUTPUT); // pump 1
  pinMode(25,OUTPUT); // pump 2
  pinMode(26,OUTPUT); // Pump 3
  pinMode(27,OUTPUT); // stirrer 2

  lcd.init();
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print("CREATING");
  lcd.setCursor(0,1);
  lcd.print("BIODIESEL");
```

```
  digitalWrite(22,HIGH);
  digitalWrite(23,HIGH);
  digitalWrite(24,HIGH);
  digitalWrite(25,HIGH);
  digitalWrite(26,HIGH);
  digitalWrite(27,HIGH);
  delay(3000);
}
void loop()
{
  delay(120000);
  lcd.clear();
  digitalWrite(23,LOW);
  lcd.setCursor(0,0);
  lcd.print("HEATER ON");
  lcd.setCursor(0,1);
  lcd.print("Timer = 10 Minutes");
  delay(600000); // WARMING UP
  digitalWrite(23, HIGH);
  lcd.clear();
  delay(1000);
  digitalWrite(22,LOW);
  lcd.setCursor(0,0);
  lcd.print("Stirring");
  lcd.setCursor(0,1);
  lcd.print("Timer = 20 Mins");
  delay(1200000); // Stirring
  digitalWrite(22,HIGH);
  lcd.clear();
  delay(1000);
  digitalWrite(24, LOW); // pump 1 on
  lcd.setCursor(0,1);
  lcd.print("PUMP 1 ON");
  delay(25000); // long time the pump is running
  digitalWrite(24,HIGH);
  lcd.clear();
  delay(1000);
  lcd.setCursor(0,0);
  lcd.print("Precipitation");
  lcd.setCursor(0,1);
  lcd.print("Timer = 24 Hours");
  delay(86400000); // 1 night deposition
  lcd.clear();
  delay(1000);
  lcd.setCursor(0,0);
  lcd.print("PUMP 2 ON");
  digitalWrite(25, LOW);
  delay(25000);
```

```
  digitalWrite(25, HIGH);
  lcd.clear();
  delay(1000);
  lcd.setCursor(0,0);
  lcd.print("PUMP 3 ON");
  digitalWrite(26, LOW);
  delay(25000);
  digitalWrite(26, HIGH);
  lcd.clear();
  delay(1000);
  lcd.setCursor(0,0);
  lcd.print("Stirr 2 ON");
  lcd.setCursor(0,1);
  lcd.print("Timer = 20 Mins");
  digitalWrite(27, LOW);
  delay(1200000);
  digitalWrite(27, HIGH);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("PROCESS COMPLETE");

  while();
}
```

4.3. Mixing

In the initial process of making biodiesel, this is called mixing where methanol will be reacted with caustic soda (NaOh), caustic soda will be dissolved into a container containing methanol until it is completely dissolved. In this mixing process, it should not be carried out in an open container because the oxygen content will affect the reaction process. After that the used cooking oil is heated to 60°C, and mixed again with the caustic soda and methanol solution, here the transesterification process occurs when the trigerilsides are met. If 1 liter of cooking oil is needed, 200 ml of methanol is needed, and caustic soda (NaOh) is 300 grams. Then the three ingredients that have been mixed will be deposited for 24 hours.

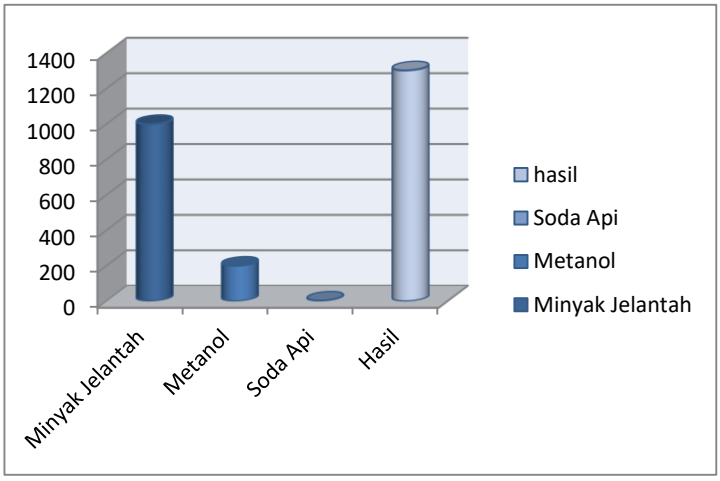

Figure 5. *The Volume of the Size of the Material in the Mixing Process*

After being deposited for 24 hours, the 3 ingredients come together and leave a solid glycerol at the bottom, and are sucked by a pump into the washing process and then part of the oil will be taken and separated from the solid glycerol. then it will be washed with water at 60°C, washed by mixing water and the reacted materials and stirred evenly so that the levels of glycerol in the material will be separated by water. Then the water and oil that have been washed will be precipitated again for 12 hours, so that the glycerol and oil levels are completely separated from the water.

At the time of the experiment of biodiesel B-40 on the Shark diesel engine and 1 Phase generator, B-40 was biodiesel that was mixed 40% with 60% diesel so that it became biodiesel with the type B-40, it can be seen the comparison of the volume of mixing diesel and biodiesel B-40 at chart below:

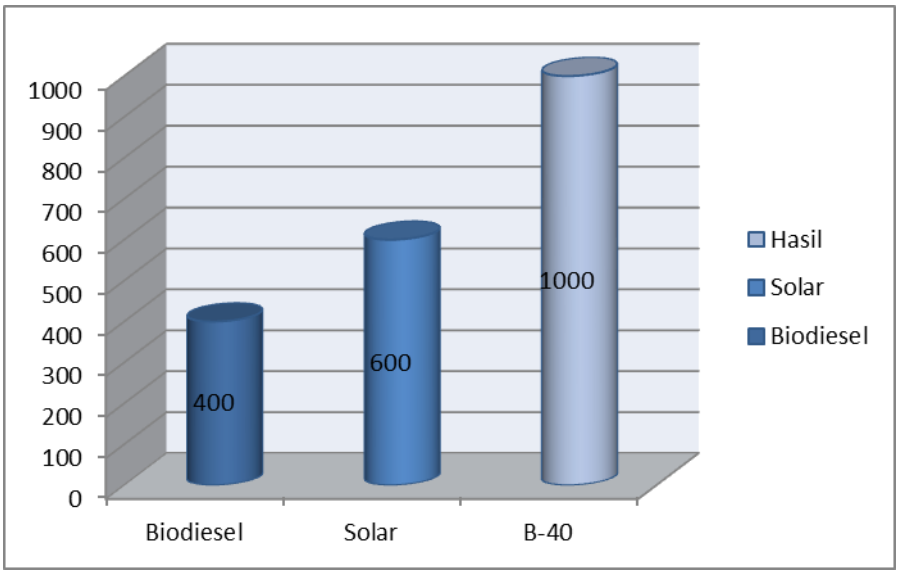

Figure 6. *Comparison of the Mixing Volume of Diesel and Biodiesel in Biodiesel B-40*

In this study, the speed generated by the 1 Phase generator will be calculated using a Tachometer, the results of the speed measurement produced by the 1 Phase generator in the form of Rpm (Rotation per Minute) units, and the voltage generated by the 1 Phase generator using a Voltmeter will also be calculated. biodiesel B-40

V. Conclusion

Based on the results of research conducted there are several conclusions, among others:

1. Biodiesel B-100 which is processed from used cooking oil can be used to fuel Shark diesel engines and 1 Phase generators and is also capable of starting a load of 990 Watts.
2. The price of biodiesel raw material B-100 to be processed from used cooking oil is Rp. 4191, while the price for biodiesel B-20 marketed by Pertamina is Rp. 5150, B-100 cheaper Rp. 959 compared to biodiesel B-20 marketed by Pertamina
3. The electrical voltage generated by the diesel engine fueled by biodiesel B-100 is unstable, the voltage rises and falls when the diesel engine power is maxed power. Biodiesel B-100 still contains water content obtained from palm plants because it is made from used cooking oil. So that the combustion of biodiesel fuel B-100 is not as good as B-20 which still contains 80% diesel.

4. Biodiesel B-100 produces lower CO emissions than biodiesel B-20 so it is very friendly to the environment, and Biodiesel B-100 also contains a high level of lubricant, making it good for cleaning components in diesel engines.
5. In the use and production of biodiesel using used cooking oil, it can be concluded from this research that the biodiesel B-100 produced still has drawbacks and of course also many advantages, and of course further research is still needed to produce biodiesel B-100 which is more feasible as alternative energy for Diesel Power Plant

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