



Design of Polypropylene Distillation Fuel Generator (PDFG) as an effort to create alternative energy for standar engine

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Abstract .Technologies Energy like fossil energy belong to renewable energy are growing. one of the example is to recycle of waste plastic as fuel .Some types of waste that we often see are plastic bottles such as plastic cups, plastic bottle caps, toys and margarine etc., which is one type of PP Polypropylene waste. Each unit of heavy plastic can produce 70 percent oil, 16percent gas, 6 percent carbon solid and 8 percent water. And for PP type plastic Polypropylene has melting point of 70celcius degree until 80celcius degree [5][11][12]. The calorific value of pure Polypropylene Liquid Plastics BBPP is 25.97 KJ per gram. Proving that plastic waste has a high enough heat content it can be developed to become one of the alternative sources of energy that uses renewable natural materials renewable resources, although in previous studies the calorific value obtained was still below the standard reference fuel value of 48 KJ per gram. So it still cannot be used on motor vehicles. This study aims to increase the calorific value of liquid polypropylene fuel from the results of Pyrolysis so that the calorific value is closer to the standard by using the distillation process and absorption method or purification process of purifying the Polypropylene liquid fuel. Liquid fuel Polypropylene is introduced into the Absorption Distillation reactor and evaporated using a heater to a temperature near 70celcius degree until 90celcius degree. and subsequently condensed by using a pure water medium with a temperature of 20celcius degree until 25 Celsius degree. The calorific value resulting from the absorption distillation is 44.35 KJ per gram. The results are close to the standard premium fuel calorific value.

1.Introduction

The increasing use of fossil fuels is increasing year by year and also increasing plastic waste as a result of people's consumption makes the government have to think hard to Solve it. Energy renewal continues to be explored by scientists to be able to create a safe and environmentally friendly renewable energy. One of the alternative energy that is still being developed includes biogas, geothermal energy, solar cell energy,. and reprocessing plastic waste into useful materials such as waste-fueled power plants, and others.[2][4][5]

Seeing this, it is necessary to provide the latest breakthroughs regarding renewable resources. one of them utilizes plastic waste as fuel. The large number of uncontrolled users of plastic waste will cause environmental pollution such as soil pollution, garbage burning pollution that can affect the surrounding air. Thus further action is needed regarding the treatment of plastic waste. One of them is by turning plastic waste into liquid fuel.[1-7]

Some types of garbage that we often encounter are plastic bottles, for example plastic cups, plastic bottle caps, children's toys and margarines, etc., which is one of the PP (Polypropylene) types of garbage. Based on the above background, several formulations of the problem formulated from this study are formulated:

- a. How is the purification process of Distillation absorption from Polypropylene plastic liquid fuel
- b. What is the increase in heating value of the Distillation Process can be in accordance with the standard engine requirements.

2. Material and Methods

2.1. Research Methods

In this study using an experimental approach (*Research Method*), Data collection is done by conducting research directly on the object of research. The data taken are calorific value data and characteristics of liquid Polypropylene fuel. Furthermore, the data that has been generated is analyzed using statistical analysis of bar. charts for treatment before being inserted into the Absorption Distillation apparatus and after being fed to the Absorption Distillation Apparatus.[1][3][4]

2.2. Polypropylene Liquid Fuel from Pyrolysis

The main material used in this research is the Polypropylene liquid fuel from the initial refinery or Pyrolysis. Where the Pyrolysis liquid fuel is still containing lead and blackish brown color. So it needs another refining process using a PDFG (Polypropylene Distillation Fuel generator) or Distillation Absorption device.



Figure 1. Polypropylene Fuel from Pyrolysis

2.3. PDFG (Polypropylene Distillation Fuel Generator)

PDFG (Polypropylene Distillation Fuel Generator) Absorption Distillation Tool consists of several parts, namely the condenser tube, oil flow pipe, distillation tube Absorption, thermometer and drain valve.

The process of purifying Polypropylene fuel from Pyrolysis in the PDFG (Polypropylene Distillation Fuel Generator) is as follows. Liquid Polypropylene fuel is inserted into the PDFG device through an inlet pipe of 5 liters. Then it enters the condenser tube. In the condenser tube there is water heated at a temperature of 80 to 100 degrees Celsius. Hot liquid fuel evaporates and enters the tube Absorption

distillation and steam falls through Desiccant or filter in the form of salt to filter dirt from the fuel vapor. Steam The fuel that condenses again becomes clearer and cleaner liquid oil.[14][15]



Figure 2. Polypropylene Distillation Fuel Generator (PDFG)

2.4. Research Flowchart

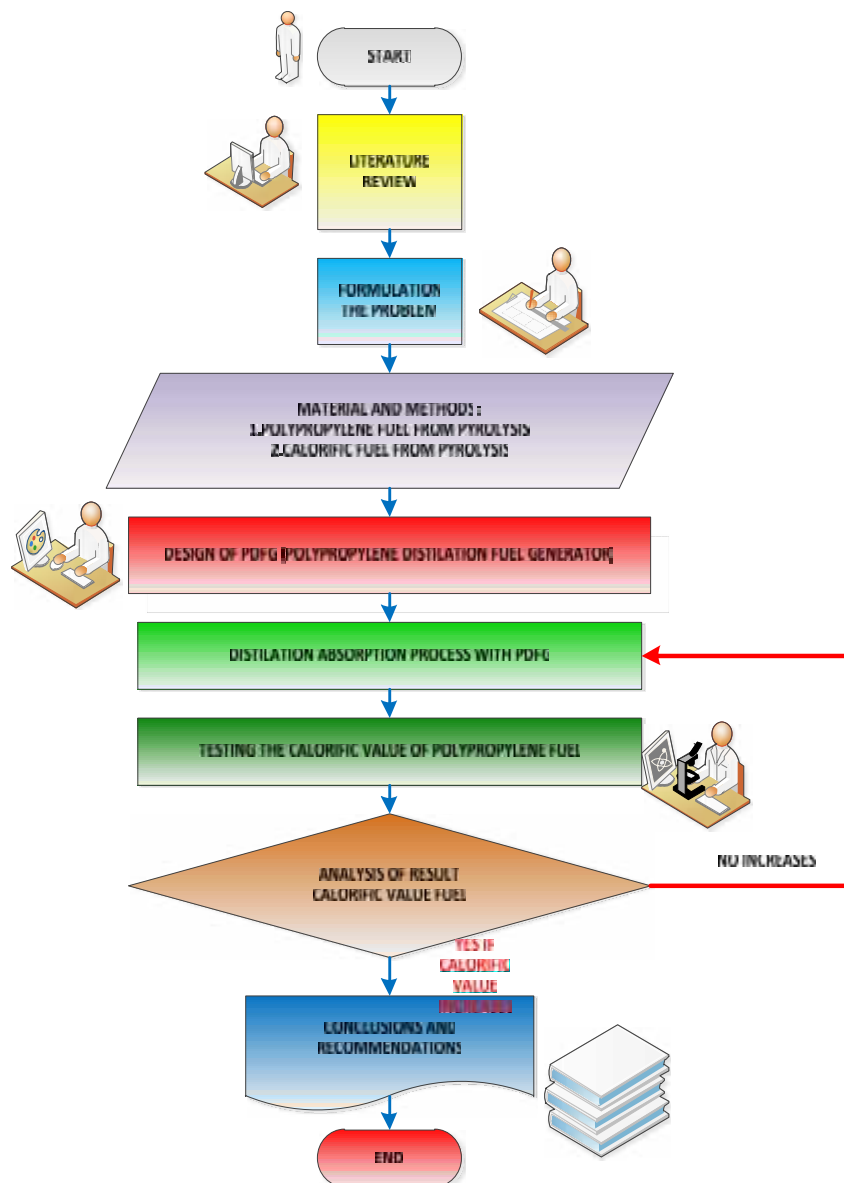


Figure 3. Flowchart Of Polypropylene Distilation Fuel Generator (PDFG)

2.5. Calorific Value Fuel Testing Device

Testing the Calorific Value of Polypropylene fuel as a result of purification by means of absorption or PDFG device is a Bomb Calorimeter in the Brawijaya University Malang, mechanical engineering laboratory.



Figure 4. Bomb Calorimeter

2.6. Research Design

The process diagram of the purification of liquid polypropylene from Pyrolysis results is as follows:

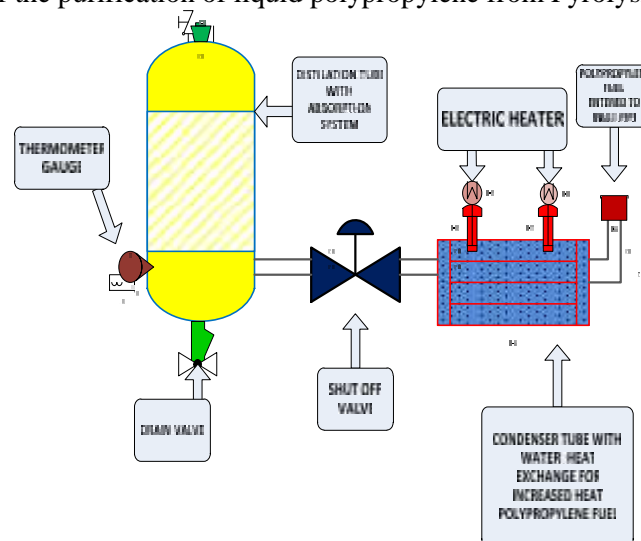


Figure 5. Research Design

Explanation of the diagram above is as follows:

Polypropylene fuel produced by Pyrolysis is inserted into the PDFG tool through the Inlet Pipe. Then through the condenser. Where in the liquid fuel condenser that still contains dirty is heated with a heat transfer process. The heating of the fuel uses two electric heaters that heat the water around the pipe through which the fuel oil passes. The pipe in the condenser is passed by the Polypropylene fuel and then passed to the Absorber distillation tube by passing the open close valve. Heating process with Electric Heater until the maximum heating temperature. In the past experiment the maximum heating temperature was reached at a temperature of 97 degrees Celsius. Heating by electric heater is used because to avoid the occurrence of auto ignition by the liquid fuel of polypropylene so that it can cause a fire. At a temperature of up to 97 degrees Celsius, there will be hot steam flowing into the Absorber distillation tube which will pass through hot Polypropylene liquid fuel.

After the heat vapor of the Polypropylene fuel enters the tube Absorption Absorption, the heat vapor of the Polypropylene fuel is condensed to become liquid droplet again. The points of the liquid fall down through a filter in the form of salt. The liquid that falls through the salt filter falls down the tube

Distillation absorber. And the last process is the process of removing oil that has been condensed by the drain process under the tube Absorption Absorption.[4][6][14][15]

3.Parameter Measurement

3.1.Dependent variables and observed variables

3.1.1.Dependent Variables

1. Volume of Polypropylene liquid fuel
2. Fuel heating temperature
3. Fuel catalyst mixture during the refining process

3.1.2.Observed variables

1. The heating value and characteristics of the fuel before being processed in the purification device of Distillation absorbs or PDFG (Polypropylene Distillation Fuel Generator)
2. The calorific value and characteristics of the fuel after being processed in a purification device for distillation absorbs or PDFG (Polypropylene Distillation Fuel Generator)

4.Result and Discussion

From the results of testing in the Motor Fuel laboratory of Malang Brawijaya University, the following results were obtained:

4.1. Density Test

Density test is carried out in a Piknometer device by weighing the initial and final weight in the piknometer. First the piknometer is weighed at the initial weight in an empty state. And then weighing is done when there is a Polypropylene oil test sample.

Density Formula :

$$\rho = \frac{m}{V} \dots\dots\dots[8]$$

Information :

ρ = density (gr/ml)

m = mass of test object (gr)

V = piknometer Volume (mL)

Test results of Density Value of Polypropylene fuel from purification using Absorption Distillation or PDFG (Polypropylene Distillation Fuel Generator) are as follows:

Table 1. Density Test

Fuel	Density (gr/mL)	Standar Density(gr/mL)
Premium	0.77	0.75
Pertalite	0.77	0.75
Pertamax	0.77	0.75
Polypropylene temperature 80 Celcius degree	0.76	0.75
Polypropylene temperature 97 celcius degree	0.748	0.75

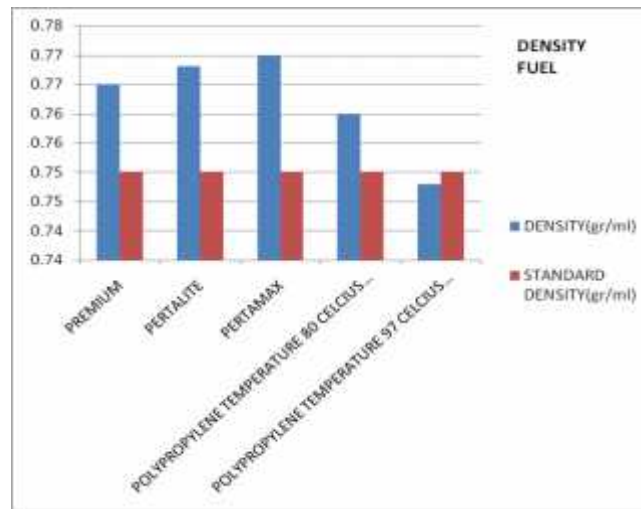


Figure 6. Density Test Graphic

From the graph above it can be seen that the ratio of the Density value of various fuels ranging from Premium fuel, Peralite, Pertamina, Polypropylene at temperatures of 80 degrees Celsius and Polypropylene at a temperature of 97 degrees Celsius is the same average between 0.74 gr / ml to 0.75 gr / ml compared to the standard average value of fuel density of 0.75 gr / ml. The quality and quantity of fuel is affected by temperature. Therefore, fuel oil can shrink or even rise based on different levels of temperature influence. In Polypropylene fuel is purified at a temperature of 80 and 97 degrees Celsius so that the density decreases to 0.748 gr / ml.

4.2. Calorific Value Fuel Test

The calorific value is the amount of energy released for each unit of mass of fuel that through an oxidation process in the fuel. (Ekky.2016).

The results of the fuel heating value test are as follows:

Table 2. Calorific Value Fuel test		
Fuel	Standard calorific value(KJ/gr)	Calorific value (KJ/gr)
Premium	48.00	43.80
Pertalite	48.00	44.20
Pertamax	48.00	48.00
polypropylene temperature 80 celcius degree	48.00	43.4
polypropylene temperature 97 celcius degree	48.00	44.3

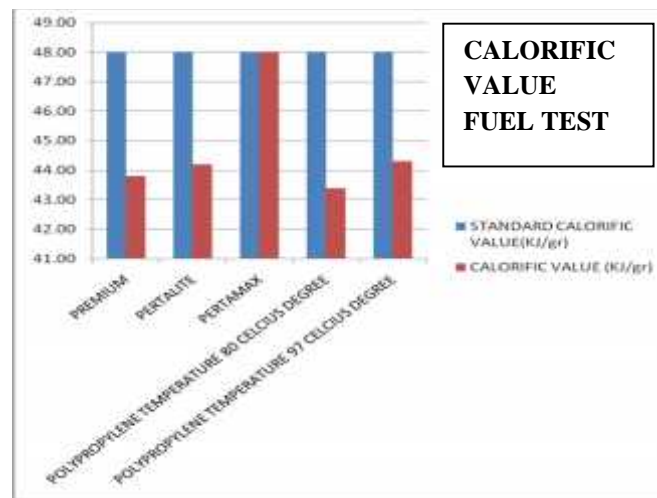


Figure 7. Calorific Value Fuel Test Graphic

Explanation of the table and graph above is that the heating value of the Polypropylene fuel is liquefied from the purification process by using an Absorption Distillation or PDFG (Polypropylene Distillation Fuel Generator) Its heating value increases with the addition of temperatures of 80 to 97 Celcius degrees , but it is still below the high standard fuel heating value ie pertamax of 48 KJ / gr. While the heating value of Polypropylene fuel from the purification of Absorption Absorption Tool is 43.4 KJ / gr at a temperature of 80 degrees celsius and 44.3 KJ / gr at a temperature of 97 degrees Celsius. The heating value of liquid Polypropylene fuel combustion results from purification with the Absorption Absorption device increases with increasing combustion temperature, this is because during the heat release process in the environment it takes a large amount of heat energy through a complete combustion reaction of mass union or fuel volume.

5. Conclusion

And from the results of its purification with a PDFG tool (Polypropylene Distillation Fuel Generator). There is an increase in heating value which is equal to 44.3 KJ / gr. This happens because there is heat absorption or absorption system in the distillation device by Desiccant salt. With heat reaching temperatures of 97 degree Celsius the remains of plastic waste burn completely. The Polypropylene liquid fuel evaporates into the absorber tube and the steam condenses down through the desiccant of salt into liquid oil that is clear and clean.

6. Acknowledgements

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