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Alternative Fuel Analysis of Polyethylene Type Plastic Waste Pyrolysis Results

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ABSTRACT

Plastic waste is a major problem faced by Indonesia, especially in big cities which have a high level of activity and density as well as rapid infrastructure development. To overcome this, environmental experts and scientists from various disciplines have conducted various studies and actions. One alternative for handling plastic waste is to carry out a recycling process (recycle) through pyrolysis. This study aims to analyze liquid fuel from the results of pyrolysis of polyethylene plastic waste. This research is an experimental research with a quantitative approach. The data analysis technique used is data analysis using descriptive techniques. The pyrolysis results obtained consisted of Premium Alternative Fuels producing a density of ± 1060 ml, Kerosene Alternative Fuels producing a density of ± 1480 ml and Alternative Diesel Fuels producing a density of ± 1700 ml.

Keywords: (Pyrolysis, polyethylene plastic waste, alternative fuels).

ABSTRAK

Sampah plastik merupakan permasalahan utama yang dihadapi Indonesia terutama di kota-kota besar yang memiliki tingkat aktivitas dan kepadatan tinggi serta pembangunan infrastruktur yang pesat. Untuk mengatasinya, para pakar lingkungan dan ilmuwan dari berbagai disiplin ilmu telah melakukan berbagai penelitian dan tindakan. Salah satu alternatif penanganan sampah plastik adalah dengan melakukan proses daur ulang (*recycle*) melalui pirolisis. Penelitian ini bertujuan untuk menganalisis bahan bakar cair dari hasil pirolisis sampah plastik dengan jenis *polyethylene*. Penelitian ini merupakan penelitian ekeperimental dengan pendekatan kuantitatif. Teknik analisis data yang digunakan adalah analisis data menggunakan teknik deskriptif. Hasil pirolisis yang didapatkan terdiri dari Bahan Bakar Alternatif Premium menghasilkan massa jenis ± 1060 ml, Bahan Bakar Alternatif Minyak Tanah menghasilkan massa jenis ± 1480 ml dan Bahan Bakar Alternatif Solar menghasilkan massa jenis ± 1700 ml.

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Kata Kunci: (Pirolisis, sampah plastik *polyethylene*, bahan bakar alternatif).

1. Introduction

Plastic is a human need in everyday life, one of which is as a place to wrap food and drinks, because plastic is practical, clean, and makes it easy to meet human needs [1-2]. The more people consume, the more plastic waste they produce. The solution from the use of fossil fuels (fossil energy) to use plastic waste to become fuel oil is clean and decent for life. This waste is now a serious environmental problem because of the increasing amount of plastic waste that exists and the level of danger that plastic waste can cause to other living things [3].

Decomposing plastic waste naturally, it takes approximately 100 years for plastic to decompose completely. While we all know, the need for plastic, especially in Indonesia, is increasing every year so that it can cause more and more waste from this plastic waste. Waste management in Indonesia is still a problem that cannot be handled properly [4].

Plastic materials in their use in human life are inevitable, most of the world's population uses plastic in carrying out their activities, plastic has many advantages compared to other materials. The increase in the use of plastic for household purposes has an impact on the increase in plastic waste piles. Plastic waste has always been a problem in several big cities. To overcome this, environmental experts and scientists from various disciplines have conducted various studies and actions. One alternative for handling plastic waste

is to carry out the recycling process (recycle). Pyrolysis of plastic waste is a form of recycling process by converting plastic into fuel. Besides being useful for reducing the amount of plastic waste, pyrolysis of plastic waste is also useful for providing fuel with a high energy value. In general, approximately 950 ml of fuel oil can be obtained from the pyrolysis of 1 kg of polyolefin plastics such as polypropylene, polyethylene and polystyrene [5].

In Indonesia, of course, it is known about the phenomenon of increasingly mounting plastic waste, which of course is very disturbing. Nowadays, especially in big cities, of course there are a lot of people's needs every day. In 2012, the waste generated was 1200 tons/day, and among the waste was PE plastic. [6].

2. Methodology of Research

The research method used in this study is an experimental research design with a quantitative approach. This study aims to analyze alternative fuels produced by pyrolysis of polyethylene plastic waste.

The details of the research procedure are as follows.

a. Plastic waste is obtained from the surrounding environment, plastic is weighed with a total mass of 8 Kg.
b. The plastic is then cleaned and cut into small pieces to facilitate the combustion process in the pyrolysis furnace.
c. The reactor was closed and locked with bolts to prevent leaks from occurring in the reactor lid which would result in not so much oil being produced.
d. Temperature measuring devices (thermocouple) and pressure gauges (pressure) installed at the bottom of the reactor lid function to determine the combustion temperature in the combustion reactor then the pressure function to determine the pressure inside the reactor.
e. The plastic pyrolysis process was carried out for ± 5 hours and the plastic condensation process oil was collected in a measuring tube and then stored in a bottle to prevent evaporation.
f. Record the results of observations in the form of temperature observation tables.
g. Filter the results of pyrolysis using sand, gravel, and cotton media.

2.1. Tools

The tools used for this research are as follows.

Table 1 Tools Used and Specifications

No	Tools Used	Amount
1	Stove/Heater	1 Unit
2	Condenser	1 Unit
3	Distiller Machine	1 Unit
4	Thermometer	1 Unit
5	Empty 1.5 Liter Bottle	4 Unit

2.2. Materials

The materials used to support this research are as follows.

Table 2. Materials Used and Specifications

No	Materials Used	Amount
1	LPG Gas 3 kg	2 Unit
2	Polyethylene plastic waste	8 kg

2.3. Research Location

The research was conducted at TPST 3R Wlingi.

2.4. Research Variables

The variables in this study consisted of independent variables, dependent variables and control variables. In detail, the three variables can be seen in Table 3 below.

Table3 Research Variables

No	Variables Type	Variables
1	Independent Variable	Polyethylene plastic
2	Dependent Variable	Alternative fuel
3	Control Variables	Pyrolysis Time Pyrolysis Filters

3. Result and Discussion

The results of this processing include the results of pyrolysis based on samples that have been obtained from various temperatures. The results of volume measurements after pyrolysis at constant time and temperature vary according to the process in the field. And for the calculation of the volume ratio after pyrolysis which can be described in tabular form. This measurement was carried out after filtering the pyrolysis results using sand, gravel and cotton media which were placed in multilevel filtering bottles and produced a medium quality flame.

Figure 1 Pyrolysis Alternative Fuel

3.1. Pyrolysis Premium

The following is a breakdown of fuels that are included in the premium category resulting from the pyrolysis of polyethylene type plastic waste.

Table 4 Pyrolysis Premium

No.	Time (minutes)	Volume after pyrolysis (ml)	Temperature (° C)	Information
1	0 - 30	± 0 ml	± 40° C	
2	30 - 60	± 0 ml	± 73° C	The fire up
3	60 - 90	± 5 ml	± 115° C	Premium is dripping
4	90 - 120	± 50 ml	± 150° C	Output Premium is fogging
5	120 - 150	± 150 ml	± 180° C	
6	150 - 180	± 250 ml	± 175° C	
7	180 - 210	± 500 ml	± 175° C	Changing LPG Gas
8	240 - 270	± 1500 ml	± 150° C	Premium is running
9	300 - 330	± 1750 ml	± 175° C	Premium is dripping
10	330 - 360	± 1760 ml	± 190° C	

Based on Table 4, it shows that the pyrolysis process for this type of PE plastic waste produces ± 1760 ml of premium alternative fuel. In order to achieve this premium alternative fuel process, the minimum temperature required is ± 115° C, while at the maximum temperature so that this premium alternative fuel can flow optimally, namely at a temperature of ± 175° C, it takes approximately 180 - 210 minutes and at a temperature ± 190° C with approximately 330 – 360 minutes to reach this type of PE plastic waste can decompose. So this type of PE plastic waste will experience the process of burning and evaporation faster in the pyrolysis process because it has a low water content.

3.2. Pyrolysis Kerosene

The following is a breakdown of fuels that are included in the kerosene category resulting from the pyrolysis of polyethylene type plastic waste.

Table 5 Pyrolysis Kerosene

No.	Time (minutes)	Volume after pyrolysis (ml)	Temperature (° C)	Information
1	0 - 30	0 ml	± 40° C	
2	30 - 60	0 ml	± 73° C	The fire up
3	60 - 90	± 5 ml	± 115° C	Kerosene is dripping
4	90 - 120	± 50 ml	± 150° C	
5	120 - 150	± 350 ml	± 180° C	
6	150 - 180	± 500 ml	± 175° C	Kerosene is running
7	180 - 210	± 1000 ml	± 175° C	Changing LPG Gas
8	240 - 270	± 2000 ml	± 150° C	
9	300 - 330	± 2350 ml	± 175° C	
10	330 - 360	± 2480 ml	± 190° C	Kerosene is running slowly

Based on Table 5, it was found that the pyrolysis of plastic waste experienced a mass increase when viewed from the mass of alternative fuels, it changed, namely Premium became ± 1760 ml and Kerosene became ± 2480 ml. To achieve this kerosene alternative fuel process, the minimum temperature required is ± 115° C in approximately 60 – 90 minutes, while at the maximum temperature so that this kerosene alternative fuel can flow optimally, namely at a temperature of ± 175° C with takes approximately 150 - 180 minutes and at a temperature of ± 190° C with approximately 330 - 360 minutes to reach this type of PE plastic waste can decompose. So this type of PE plastic waste will experience the process of burning and evaporation faster in the pyrolysis process because it has a low water content.

3.3. Pyrolysis Diesel Fuel

The following is a breakdown of fuels that are included in the diesel category resulting from the pyrolysis of polyethylene type plastic waste.

Table 6. Pyrolysis Diesel Fuel

No.	Time (minutes)	Volume after pyrolysis (ml)	Temperature (° C)	Information
1	0 - 30	± 0 ml	± 40° C	
2	30 - 60	± 0 ml	± 73° C	The fire up
3	60 - 90	± 0 ml	± 115° C	
4	90 - 120	± 10 ml	± 150° C	Diesel fuel is dripping
5	120 - 150	± 200 ml	± 180° C	Diesel fuel is running
6	150 - 180	± 1000 ml	± 175° C	
7	180 - 210	± 1500 ml	± 175° C	Changing LPG Gas
8	240 - 270	± 2000 ml	± 150° C	
9	300 - 330	± 3000 ml	± 175° C	
10	330 - 360	± 3200 ml	± 190° C	Diesel fuel is running slowly

Based on Table 6, it is found that the pyrolysis of plastic waste has increased in mass when viewed from the mass of the alternative fuel Kerosene has changed, namely diesel fuel to ± 3200 ml. To achieve this alternative diesel fuel process, the minimum required temperature is ± 150° C in approximately 90 - 120 minutes, while at the maximum temperature so that this alternative diesel fuel can flow optimally, namely at a temperature of ± 180° C with the required time. approximately 120 minutes and at a temperature of ± 190° C with approximately 330 – 360 minutes to reach this type of PE plastic waste can decompose. So this type of PE plastic waste will experience the process of burning and evaporation faster in the pyrolysis process because it has a low water content.

4. Conclusion

Pyrolysis with the composition of polyethylene type plastic waste can produce several types of alternative fuels. Among them are Premium Alternative Fuels which produce a density of ± 1060 ml, Kerosene Alternative Fuels which produce a density of ± 1480 ml and Alternative Diesel Fuels which produce a density of ± 1700 ml.

In the pyrolysis process of polyethylene type plastic waste, there are various temperatures needed to start converting plastic waste into liquid fuel, premium alternative fuels and kerosene have the same temperature, starting from ± 115° C to start dripping fuel. and for alternative diesel fuel, which is approximately ± 150° C.

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