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Engineering Design Of Fuel Reactor Pirolysis Incinerator (IPFR) Processing Plastic Waste into alternative Fuel with Residual Oil Heating

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Abstract. In Indonesia, plastic waste has become an important problem at this time, because it causes environmental pollution problems. One of which is by converting waste into liquid fuel. Some types of rubbish that we often encounter are plastic bottles such as plastic cups, plastic bottle caps and others, which is one of the types of PP (polypropylene) waste. Polypropylene type plastic is the type of plastic that is most widely used in daily life because it has good mechanical properties with low density, heat and moisture resistance, and has good dimensional stability, Technology using the method of high temperature (Thermal Cracking). In this study, researchers designed a Thermal cracking device, namely an Incinerator, a plastic waste smelter with high temperature, where the modification of this tool is to use used fuel oil or residual oil. In this study, the researcher analyzed the burning time, the amount of waste mass needed for the melting process in the Incinerator. In this research, a fuel equivalent of 1.5 liters of premium fuel was produced with 10 kg of plastic waste burned in the incinerator with a burning time of 125 minutes of the pyrolysis process, with a combustion temperature of 180-250 degrees Celsius.

1. Introduction

In Indonesia, plastic waste has become an important problem at this time, because it causes environmental problems such as health and soil pollution. So many people do not use plastic waste to be processed again, but instead it is destroyed by burning which causes air pollution so that it can endanger the community.

Some types of waste that we often encounter are types of plastic bottles, for example plastic cups, plastic bottle caps, children's toys and margarines, etc., which is a type of PP (polypropylene) waste [1] [4] [7] [8]].

Polypropylene plastic is the type of plastic that is most widely used in everyday life because it has good mechanical properties with low density, heat and moisture resistance, and has good dimensional stability. [5] [7] [13]

Polypropylene PP plastic cracking process is one way to handle plastic waste. There are three types of cracking processes, namely the cracking process using hydrogen (hydro cracking), the cracking process using high temperatures (thermal cracking) and the cracking process using a catalyst (catalytic cracking).In this research, the researcher designed a tool for melting plastic waste, namely the Incinerator. The process used is still used the pyrolysis process. This Incinerator uses fuel from residual oil or used oil.

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2. Material and Methods

2.1. Research Methods

The method used in this study is to use experimental methods. The experimental method is a research method used to test the effect of a treatment carried out on the object under study by comparing it with no treatment. This experimental method can also mean comparing testing several variations of treatment with testing without variation as a comparison.

2.2. Incinerator Pirolisis

Incinerator is a furnace used to process solid waste into gaseous matter and ash (bottom ash and fly ash). Incineration of waste processing can reduce volume and mass and reduce the hazardous nature of infectious waste. Factors that play an important role in incineration are the combustion temperature and the burning time of the waste [14].

Utilization of incineration heat energy is identical to combustion, which can produce energy that can be utilized. An important factor that must be considered is the quantity and continuity of waste to be supplied. The quantity must be sufficient to generate energy continuously so that the energy supply is not cut off [14].

2.3. Incinerator Pirolysis Design

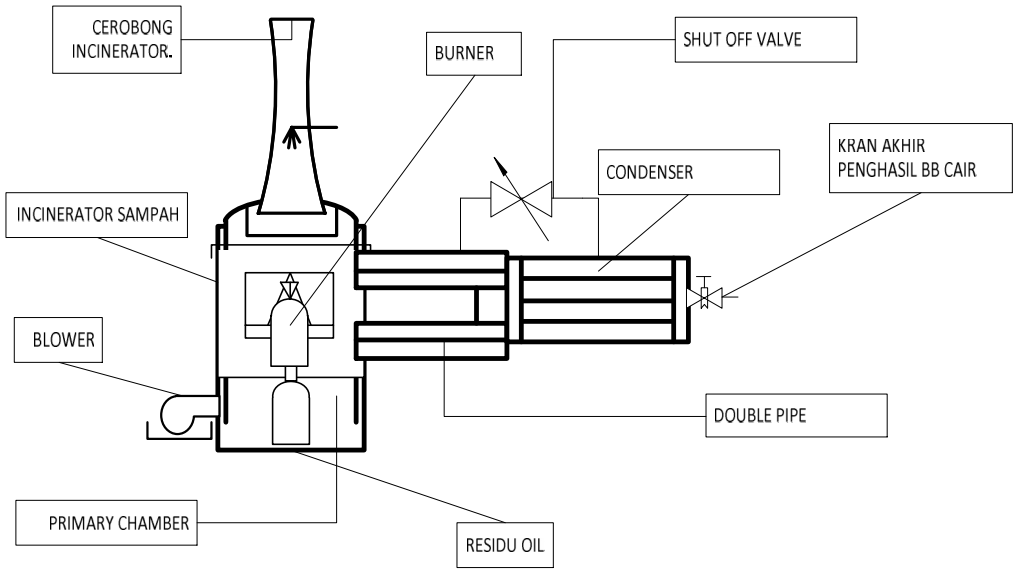

Figure 1 : Incinerator Pyrolysis Fuel Reactor

2.4. Residual Oil Heating

Lubricating oil is a petroleum product which includes a heavy distillate fraction and has a boiling point route of 300 ° C. Lubricating oil is a petroleum product. The functions of lubricating oils include: reducing friction and wear, cooling engine components, helping tighten compression and cleaning engine components. Lubricating oils used to lubricate machines have requirements, including: high temperature resistance, rust and corrosion resistance, being able to prevent foam and being able to flow at low temperatures. The selection of the lubricating oil viscosity that is not quite right can hinder engine work. Lubricating oil that is too thin will not function properly and if it is too thick it will hamper the engine because of high resistance.

It is feared that the burning of used lubricating oil directly will cause high air pollution. The process for burning used oil is very difficult, this is because the carbon bonds in used oil are long, making it

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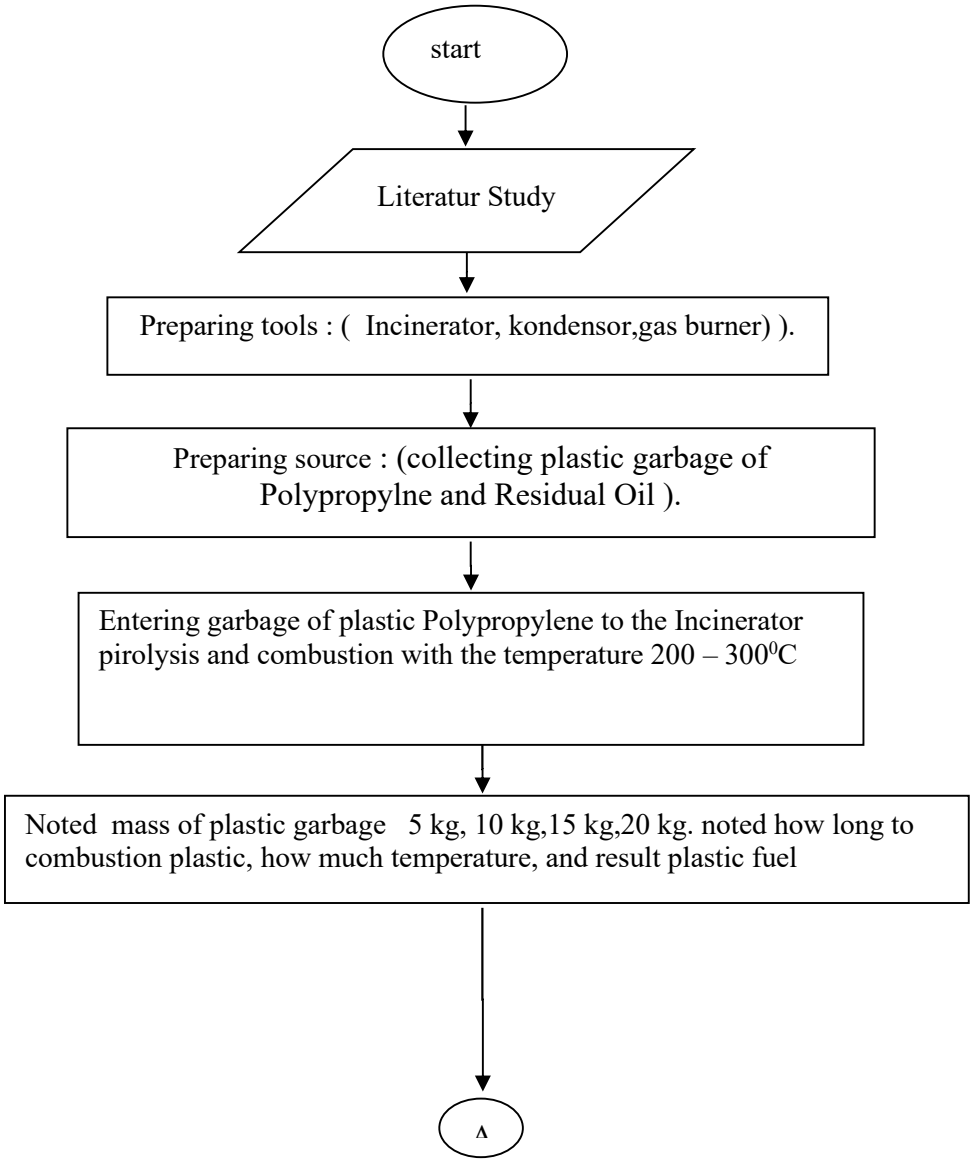
difficult to crack (cracking). In addition, used oil contains both physical contaminants (metal debris and ash) and chemically (solvents and water). One easy treatment process is to mix used oil with kerosene [15] [16].

3. Research Flowchart

In preparation for this research, the steps are formed in the flowchart as follows:



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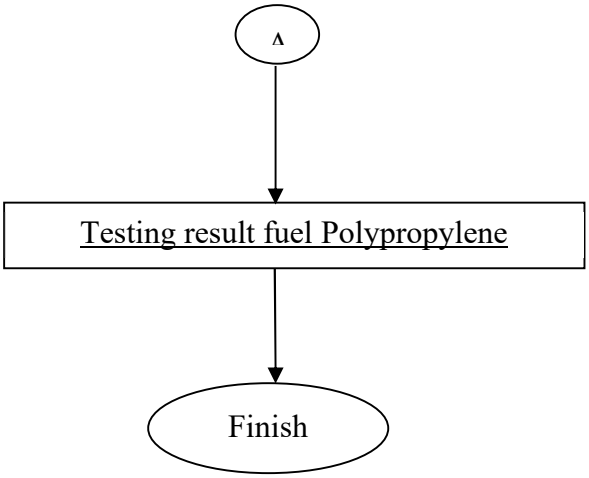

4. Parameter of measurement

4.1. Dependent variables and observed variables

4.2. Dependent Variables

- Volume of Polypropylene liquid fuel
- Fuel heating temperature
- Standar fuel like Premium, pertalite, Pertamax

4.3. Observed variables

- Mass of Plastic Garbage Polypropylene
- Temperature Heating for combustion
- Volume Liquid Fuel Polypropylene
- Calorific Value

5. Result and Discussion

The results of the Pirolysis Incinerator Design Fabrication are as follows Information:

- Pirolysis Incinerator Reactor
- Vacum Reactor
- Inlet Plastic Garbage
- Residual Oil Heating
- Pipe to Condenser tube
- Burner with combustion gas

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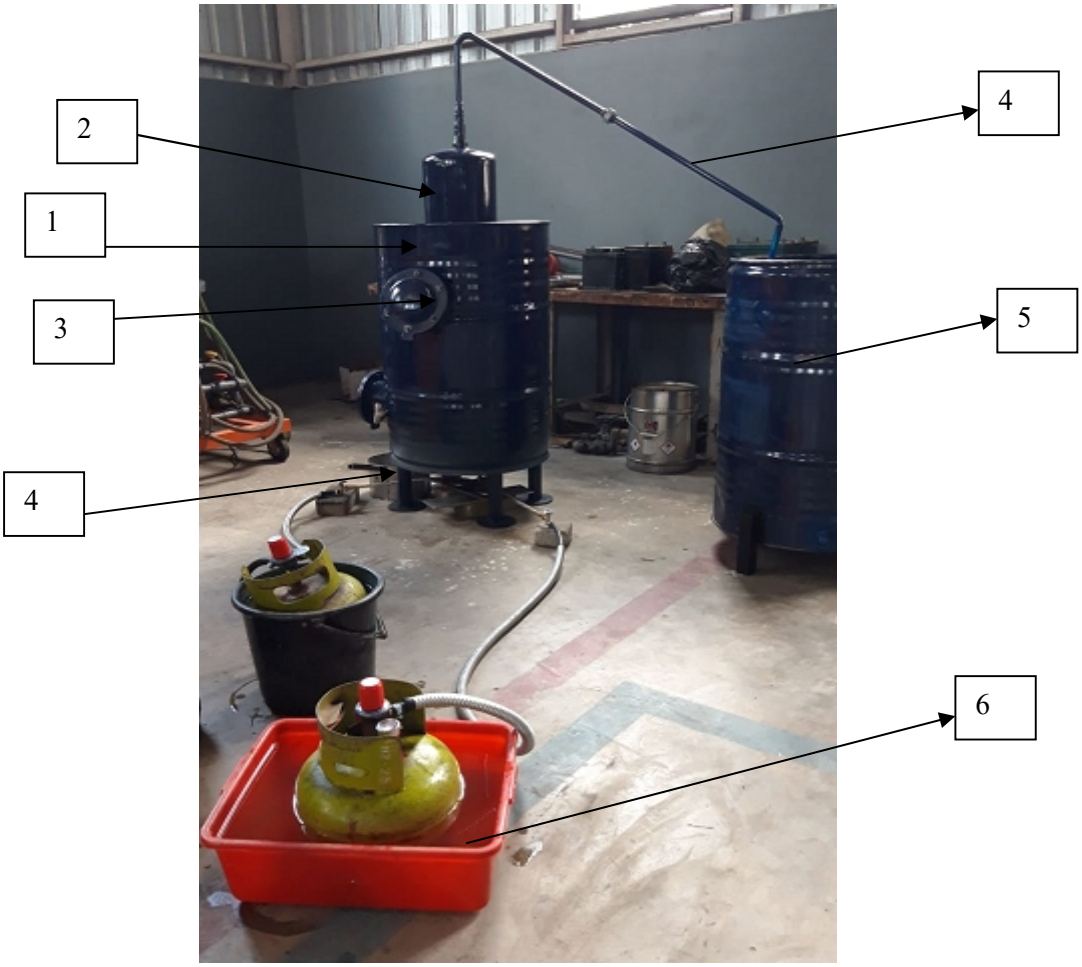

Figure 2. Incinerator Pirolysis Ready

5.1. Table

Table 1. Result Mass , Temperature, Time, Volume Of Polypropylene Fuel

NO	Mass Of Plastic Garbage	Time For Combustion	Temperature (Degree Of Celcius)	Volume Of Polypropylene Fuel
1	5 kg	100 minute	200	0,7 litre
2	10 kg	125 minute	210	1 litre
3	15 kg	200 minute	245	1,2 litre
4	20 kg	300 minute	270	1,7 litre

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5.2. Table

Table 2 . Octane and Calorific Value With Purification Tool

No.	Fuel	Octane Value/RON	Calorific value (gram/kalori)	Spesific Fuel Comsumption (second)
1	BBPP from Purifier wth temperature 80°C	93,5	16919,49	07:14
2	BBPP from Purifier wth temperature 100°C	93,3	10249,52	05:08
3	BBPP from Purifier wth temperature 120°C	92,8	10229,91	05:33

Note BBPP : Bahan Bakar Poly propylene

Figure 3.Polypropylene Fuel from Incinerator Pirolysis

5.3. Work Of Residual Oil Heating(accelerate the combustion)

When combustion uses oil residue, the oil residue is heated near the gas burner in the pyrolysis incinerator reactor, when the temperature reaches 150 ^{0}Celsius, the density of the oil residue increases as well as the viscosity, so that the gas pressure from the gas cylinder is helped by viscosity and the density of this oil residue. and will accelerate the increase in combustion temperature to 250 ^{0} Celsius and even up to 300^0 Celsius, so the function of this oil residue here is as a substance to accelerate the combustion reaction from the gas tube to the pyrolysis incinerator reactor.

From table 5.1 above it is known that to burn 5 kg of polypropylene plastic material it takes 100 minutes with a temperature of 200 degrees Celsius and produces 0.7 liters of liquid polypropylene fuel. And to burn 10 kg of plastic waste it takes 125 minutes with a temperature of 210 degrees Celsius and produces 1 liter of polypropylene liquid fuel. And to produce 1.7 liters of Polypropylene liquid fuel, it takes 20 kg of plastic waste, and it takes 300 minutes with a temperature of 270 degrees Celsius.

From table 5.2, after the fuel is produced by the Pirolysis Incinerator, the fuel is purified by a purifier apparatus as shown below:

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Figure 4. Purification Tool

After being put into the purifier and tested, it resulted that heating in the Purification Tool at a temperature of 80 degrees Celsius resulted in an octane value of 93.5, a calorific value of 16919.49 gr / calorie with a burning rate of 07.14 seconds.

6. Conclusion

Based on the results of research observations, testing the mixture of PP (Polypropylene) type liquid plastic fuel and data analysis that has been carried out in the previous chapter, it can be concluded that the following are:

- To burn 5 kg of polypropylene plastic it takes 100 minutes with a temperature of 200 degrees Celsius and produces 0.7 liters of liquid polypropylene fuel. And to burn 10 kg of plastic waste takes 125 minutes with a temperature of 210 degrees Celsius and produces liquid fuel polypropylene by 1 liter. And to produce 1.7 liters of Polypropylene liquid fuel, it takes 20 kg of plastic waste, and it takes 300 minutes with a temperature of 270 degrees Celsius.
- After being put into the purification tool and tested, it is produced that heating in the Purification Tool at a temperature of 80 degrees Celsius produces an octane value of 93.5, a calorific value of 16919.49 g / calorie with a burning rate of 07.14 seconds

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