Plastic Waste Processing to Alternative Energy

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Abstract. The purpose of this research to know characteristics of pyrolysis oil of plastic waste. The observed factors include physical properties: viscosity and density, whereas chemical property was calorific values. The study was conducted on Polypropylene (PP) plastic type which was dipyloidized at batch reactor, by outside heating. The reactor wall temperature was done by 300 °C, 350 °C and 400 °C. The result of polypropylene (PP) pyrolysis obtained oil at the temperature 300 °C was at least at all, clearer color and residual solids much more than 350 °C. While, oil at the temperature reactor 400 °C is the most widely and residual solids at least at all.

Keywords: pyrolysis, plastic, polypropylene, temperature.

1 Introduction

On these days plastics still a material that widely used by industry and household. Using plastics often could be caused of plastic waste stacking. Plastic waste is a garbage thats not easily broken down by microorganisms. Behind all its advantages, plastic waste creates problems for the environment. It caused of plastic properties could not be deciphered in soil. To overcome this problem, environmentalists and scientists from various disciplines have done researches and actions. One of them by recycling plastic waste. However, this method is not very effective. Only about 4% can be recycled, the rest are mounted in garbage shelters.

Increased energy consumption and increased waste are two major problems that arise growth of economic and population. Energy consumption comes from fossils for transportation, industrial and electrical sources of households. It continues to population growth. Whereas fossil energy reserves are running to low, its creating a critical energy concern in the future if no found new energy sources. Some efforts continue to be done, the development alternative energy derived from renewable resources among others. The direction of research evolves into waste processing. Waste in which inorganic waste, for example: plastic waste. Plastic waste belongs to the polymer group. Which is a process of incorporation (polymerization process) of the monomer, while the monomer is an organic chemical compound. It has ability to polymerize and this depends on the type of monomer [1] Plastics is one type of macromolecule formed by polymerization process. Plastic waste is a problem that has been taken seriously for environmental pollution, especially against soil pollution. Increasing plastic waste will become serious problems if it has not solved by actions. Handling of popular plastic waste during this reuse to use plastic repeatedly. Another alternative to

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handling plastic waste is currently widely studied and developed converting plastic waste into fuel oil.

In this way two important issues can be overcome namely the dangers of plastic waste accumulation and recovery of fuel oil, which is one of plastic raw materials. The technology to convert plastic waste into fuel oil calls pyrolysis process.

The strategy developed in this study is how to produce environmentally friendly renewable energy sourced from waste that has not been maximized processing, that is plastic waste processed into oil.

2 Theory

Pyrolysis is the process of material decomposition at high temperatures in the absence of air or limited air. The decomposition process in pyrolysis is also often called devolatilization. The main products of pyrolysis that can be produced are char, oil and gas. The charcoal formed can be used for fuel or used as activated carbon. While the resulting oil can be used as an additive or a mixture in the fuel. Whereas the formed gas can be burned directly[2]. Based on the analysis ever conducted by the Institute of Oil and Gas (Lemigas), oil from plastic used has unsaturated properties. It means that the ratio between carbon and hydrogen is not balanced, so there is an unfilled link. The main component of pyrolysis oils by polyethylene plastic is styrene monomer, which is nearly 64%. While more than 80% of this pyrolysis oil consists of styrene.

The results of research showed that interaction between temperature and time against the char is the higher temperature after passing the peak temperature found that the reactivity of the char will decrease. While the time component does not significantly affect the reactivity of char [3]. Previous studies have shown that examined PP plastic pyrolysis found at low temperature of PP plastics having a regular crystal bond structure. It is more difficult to decompose when compared to PE plastics that have long and branched chain structures[4].

3 Experiment Procedure

This research uses Polypropylene (PP) plastic as raw material, it could be cut cheap shaped. This specimen washed clean and then dried off. The results of pyrolysis are oil, gas and charcoal. To know the quality of pyrolysis oil, it is required various kinds of testing such as calorific value test, viscosity test and density. Testing oil was using to turned on the generator to generate electricity.

The tube reactor (Figure 1) has a diameter 40 cm and height 60 cm, gas cooling using water passed in the pipe. Heat energy comes from an oil-fired burner. Temperature reactor 300^{o}C, 350^{o}C and 400^{o}C. Heat gauge uses thermo reader and thermocouple. This pyrolysis oil hose serves to drain the pyrolysis gases to the cooling machine for condensing and to connecting the connection between the cooling unit and the pyrolysis oil site.

Fig. 1. Tube reactor.

Cooling system uses a pipe that made of a stainless pipe. It formed spiral and inserted into a plastic barrel containing water. It modified in such a way with the input and output holes as the gas path to be condensed. Once condensed the gas will turn into a liquid, that is accommodated in the container bottle. The water pump serves to circulate water from the water reservoir to the cooling unit. So, the water contained within the cooling unit is constant. Measuring instrument using thermo reader and thermocouple. To turned on and charging generator use ATAGUA SB 2000DC brand generators, with 100 watts, 150 watt, 200 watt, 250 watt power loads. The mixed variation of pertalite and oil. This variations contained 0%, 5%, 10%, 15%, 20%, 25%, 50%, 100%.

4 Result and Discussions

The results of oil pyrolysis got data as follows:

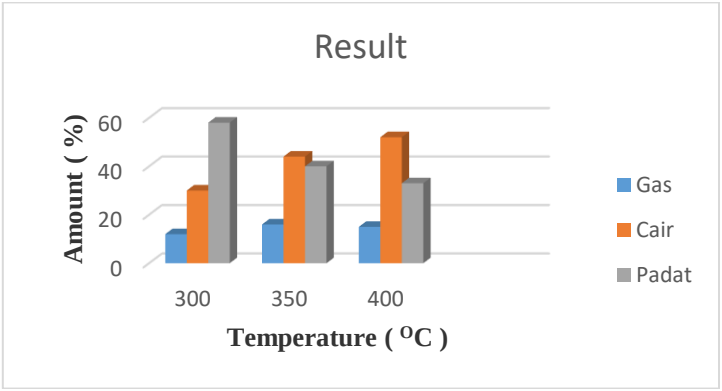

Fig. 2. Results of PP plastic oil pyrolysis.

Production of PP plastic pyrolysis oil by reactor temperature 300 °C, 350 °C, 400 °C. The result obtained as follows: PP pyrolysis result at temperature reactor 300 °C obtained amount of oil least, clearer color and solids residual is the most widely at all. At temperature reactor 400 °C amount of oil was cloudy, solids residual is less than others.

Pyrolysis at low temperature PP plastic will produce a little oil. PP plastics have a regular crystal bond structure. It is more difficult to decompose when compared to PE plastics that have long and branched chain structures. Test results showed that at 400 °C the amount of oil, gas and solids produced respectively 52%, 15% and 33%. This oil produced is higher than 300 °C reactor temperature. The yield at the temperature of 300 °C amount of oil, gas and solids produced respectively by 30%, 10%, and 60%.

Table 1. Properties of plastic pyrolysis oil

Properties	Value
Density	74 Kg/ l
Viscosity	1,117 mm^2/S
Flash Point	22 ^oC
Calorie	46,47 mJ/ kg

Those table shows that the higher of reactor temperature produced thicker and cloudy pyrolysis oil with strong odor. Viscosity of 400 °C reactor pyrolysis oil is 1,117 mm^2/s. The color of oil pyrolysis at temperature 400 °C is cloudier than temperature 300 °C and 350 °C. The calorific value of pyrolysis oil is almost equal to the kerosene heating value: 43 MJ / kg. While the highest heating from pyrolysis oil is 46.47 MJ / kg, it almost close to the calorific value of gasoline that has a calorific value of 47.3 MJ / kg (Warrington, 1994). Testing of oil from pyrolysis plastic for generator fuel is obtained as follows:

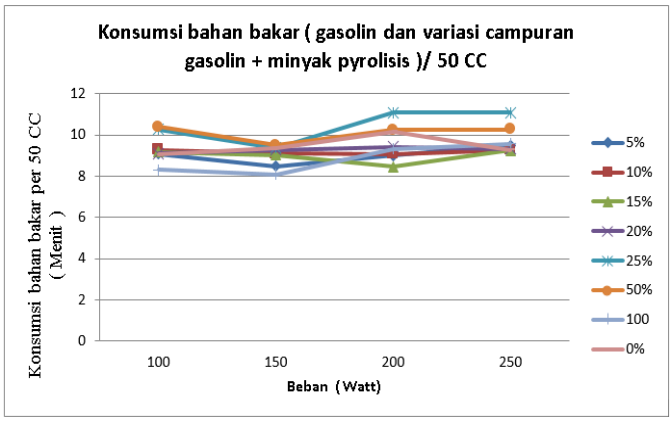

Fig. 3. Test results load generator, oil pyrolysis temperature 300 °C.

Figure 3 shows the lowest fuel consumption load result at 100 watt. It is mixture of gasoline and pyrolytic at 300 °C reactor temperature, it produced 25% volume and blend time 8.09 minutes. At the same blend variation, it got the longest time with 11.09 minutes.

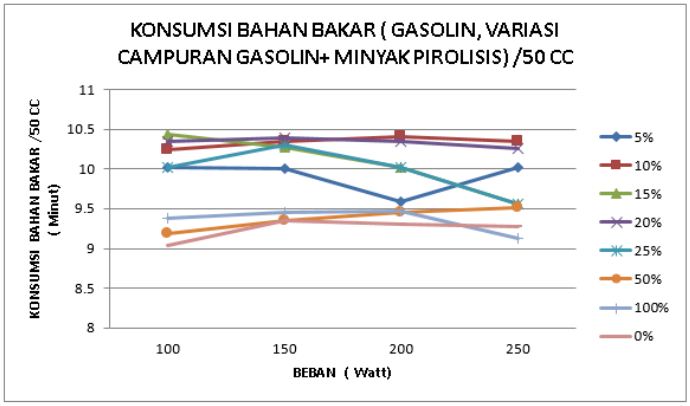

Fig. 4. Test results load generator, oil pyrolysis temperature 350 °C.

Figure 4 illustrates the graph of loading time, the shortest time at the lowest fuel consumption in gasoline mixture and the oil of reactor temperature 350 °C, it produced 20% volume of the flame mixture in 9.39 minutes. On the same mixture variations take 10:39 minutes.

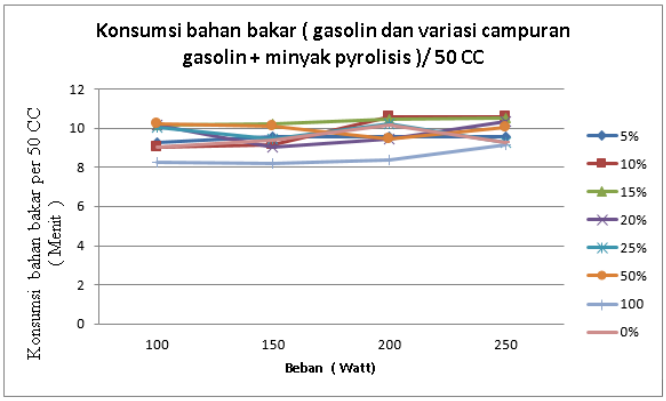

Fig. 5. Test results load generator, oil pyrolysis temperature 400 °C.

Figure 5 illustrates the graph of loading time, the shortest time on the lowest fuel consumption in gasoline mixture and the oil pyrolysis 400 °C reactor temperature, it produced 100% by volume of the flash mixture in 8.02 minutes. On the same mixture, it has done in 10.49 minutes. The average time of ignition of gasoline-fueled generator is 9.35 minutes with various variations of loading.

5 Conclusion

Pyrolysis at low temperature PP plastic produced by a little oil. PP plastics have a regular crystal bond structure. Test results showed that at 400 °C amount of oil, gas and solids, it produced respectively 52%, 15% and 33%. This oil is higher than the 300 °C reactor temperature. The yield at the temperature of 300 °C amount of oil, gas and solids produced respectively by 30%, 10% and 60%. The average ignition time of a gasoline-fueled generator is 9.25 minutes with various loading variations. The lowest fuel consumption at 100 watt load is mixture of gasoline and pyrolytic at 300 °C reactor temperature. It produced 25% volume of blend time 8.09 minutes. At the same blend variation, the longest time is 11.09 minutes. The shortest time on the lowest fuel consumption in gasoline mixture and oil pyrolysis 350 °C reactor temperature, it produced 20% volume and mixture time 9.39 minutes. In the same mixture, the longest time is 10.39 minutes. The shortest time at the lowest fuel consumption in gasoline mixture and oil pyrolysis 400 °C reactor temperature, it produced 100% volume of blend time 8.02 minutes. On the same mixture variations take the longest time of 10.49 minutes.

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