JMM: Journal of Mechanical and Manufactur
Vol. 1 No 2, April 2022 , pp. 90-96
DOI:
e-ISSN: 2829-4424

PYROLYSIS REACTOR ANALYSIS OF MATERIAL PRODUCTION RESULTS BURN WITH 3KG CAPACITY

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Abstract
Garbage is one of the factors that damage the environment, basically garbage increases along with the increase in population and the level of consumption of the processing community Waste is two sides of a coin, waste recapitulation in 2020 in Majalengka Regency is data from the DLH (Environmental Service) Majalengka states that the population is 1,250,180 people produce 14,857 tons/day or 178,285 tons/year waste and transported or processed waste only 34,675 tons/year, this pyrolysis process is a thermochemical decomposition of organic material or inorganic processes that take place without air or oxygen where the raw material will undergo breakdown chemical structure into the gas phase, the plastic pyrolysis process requires several tools, namely a reactor as a combustion without air or oxygen from plastic so that it becomes gas, parameters including temperature which affects the change of plastic into gas, the pressure on the reactor tube caused by the thermal decomposition of plastic into pyrolysis gas, these parameters in the pyrolysis process are mutually tangent because the temperature of the combustion of the reactor will determine the resulting pressure, This is because the hotter the combustion in the reactor, the faster the pyrolysis process occurs, 180 minutes of the oil process produced by PP type plastic is 800 ml while LDPE type plastic is 500 ml, the results on the two plastics are different due to the difference in melting point temperature between types of plastic PP and LDPE, these parameters can be seen in the heat transfer in the pyrolysis reactor of 3.798 x 10^9 with turbulent flow type
Keywords: *Oil yield, Waste treatment, Pyrolysis process, Parameters, Waste.*

Submitted: 2022-04-01	Revised: 2022-04-01	Accepted: 2022-04-10

Introduction

Garbage is one of the factors that damage the environment, the problem of waste has not become the main priority for most people to be resolved, basically garbage increases along with the increase in population and garbage, waste that is piled up for too long causes bad odors and is a source of germs.

In processing waste, consumption levels are two sides of a coin, this is because it can be detrimental if it is not managed properly and vice versa if it is managed properly, the recapitulation of waste in SS2020 in Majalengka Regency which comes from DLH (Environmental Service) Majalengka data states a population of 1,250,180 people produces 14,857 tons of waste/day or 178,285 tons/year and only 34,675 tons/year of transported or processed waste.

One of the processing of plastic waste is by the pyrolysis process, the workings of this pyrolysis process is the thermochemical decomposition of organic or inorganic materials that takes place without air or oxygen where the raw material will undergo chemical structure breakdown into a gas phase, the advantages of the pyrolysis process compared to combustion. iceneration), which can reduce flue gas 20 times, on the other hand the results of the pyrolysis products can be utilized more flexibly and the handling is easier, the pyrolysis process generally takes place at temperatures of 300℃ to 600℃ (Basu, 2010), the advantages of the pyrolysis process can work at atmospheric pressure and at a temperature of around 500℃ (Rahayu et al, 2012), the plastic pyrolysis process requires several tools, namely a reactor as a combustion engine without air or oxygen from plastic so that it becomes gas which is then cooled by a condenser and produces fuel oil.

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The reactor is an important component in the plastic pyrolysis process which functions as plastic decomposition or as a plastic converter into gas, in the process the reactor has parameters, namely temperature and pressure that affect the results and processing time of plastic waste into fuel.

Research Method

Pyrolysis device design

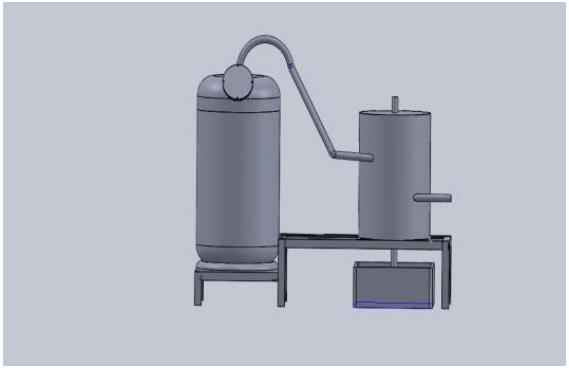

Figure 1 Pyrolysis device design

The plan includes:

1. Reactor

This pyrolysis reactor uses a fixed bed reactor, namely a reactor in which the catalyst resides in the reactor. This reactor has a diameter of 28 cm with a height of 74 cm with a capacity of 26 kg of solid plastic in the reactor.

2. Condenser

The condenser is designed with water cooling in which there is a spiral pipe, the size of this condenser is 31 cm in diameter and 28 cm in height, has a spiral length of 125 cm with a diameter of 25 cm so that 5 times the revolution and density are obtained.

spiral 0.5 cm, there is a circulation flow with the pipe at the bottom of the condenser

3. Connecting pipe

The connecting pipe between the reactors has a length of 150 cm with a slope radius of 45°

4. Support legs

On the legs using L iron which is adjusted as a support or seat for the reactor and condenser.

Materials needed for the manufacture of tools

1. LPG gas cylinder 12 kg

This 12 kg LPG gas cylinder functions as a plastic combustion reactor

2. Iron pipe

Pipe as a connection between the reactor and the condenser

3. Iron L

Serves as a holder or base for the pyrolysis tool

4. Paint can 25 kg

Serves as a reservoir for condenser water

5. Spiral Iron Pipe

Serves as a place for cooling the steam duct, as a component of the condenser

6. Aquarium Pomba Functions as a circulating water pump

Assembly

At this stage the connection between the components uses an electric welding system with 1G and 2G welding types, namely the reason for the pipe to rotate about the horizontal axis and the vertical pipe axis, is used to connect the steam line pipe from the reactor to the condenser.

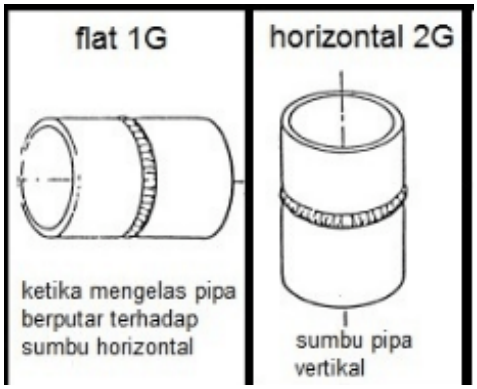

Figure 2 welding 1G and 2G

Tool testing

In testing the pyrolysis apparatus, perform the following stages:

1. Prepare the plastic that is input into the reactor, in this test using PP and LDPE plastic, on LDPE plastic in the form of bottles that are chopped making it easier to enter into the reactor
2. Put plastic into the reactor with a plastic capacity of 3kg
3. Burning plastic in the reactor using a rose stove fueled by 3kg LPG gas
4. Observing the temperature increase in the reactor using a heatgun and observing the reactor walls if there is a leak
5. Observing the oil output that occurs due to the increase in reactor temperature

Data analysis and processing

In the analysis process there are several things that are needed as follows:

1. Tools needed:

a. Heat gun, Heat gun is used to determine the increase in heat that occurs in the reactor

b. Stopwatch, Stopwatch is used to determine the processing time of the pyrolysis process and the time of temperature rise in the reactor

2. The analysis process, at the analysis stage is carried out as follows:

a. Temperature, Observing the increase in temperature from the reactor with PP and LDPE plastic waste materials at different times during combustion in the reactor with fuel of 3 kg

b. Time, the time specified at the time of analysis for 180 minutes and seeing the temperature rise in the reactor, the temperature data is taken every 30 minutes from the start of burning plastic waste

c. Oil yield, Difference in oil yield between PP and LDPE plastic types

3. Data processing. Data processing is carried out to calculate the work evaluation of the reactor on PP and LDPE plastics, find out the parameters that have been known and calculate the convection heat transfer in the reactor.

Results and Discussion

Parameters of the pyrolysis process reactor

Parameters are characteristics that can help and define a particular system, in the pyrolysis reactor process there are several influential parameters including:

1. Temperature

Temperature is a determinant of the melting point of the plastic in the reactor so that it can decompose into steam which is then condensed into a condenser with a cooler temperature than the reactor so that the gas mass changes into liquid.

2. Pressure

Pressure is a driving force for plastic waste steam in the reactor which is burned so that it can be channeled through the pipeline to the condenser, the pressure in the reactor is influenced by heat. from the reactor, the hotter the reactor the greater the pressure generated.

3. Time

The time needed to heat the reactor is calculated for 180 minutes, the time in the pyrolysis process is influenced by the temperature and pressure of the steam in the reactor. From these parameters, the pyrolysis process is in contact with each other because the temperature of the combustion of the reactor will be

determine the resulting pressure, this is because the hotter the combustion in the reactor, the faster the pyrolysis process occurs.

Oil Yield Pyrolysis Process

On the results of the pyrolysis process oil with a combustion capacity of 3 kg on PP and LDPE plastics which were processed for 180 minutes, the temperature data collection based on the reactor temperature was as follows:

Table 1 The results of the pyrolysis process on PP . plastics

Temperatur (℃)	Waktu (menit)	Hasil (mL)
120	30	24
255	60	120
270	90	250
290	120	300
305	160	540
310	180	800

The table shows that in 180 minutes the oil process produced by PP plastic is 800 ml.

Table 2 The results of the pyrolysis process on LDPE plastic

Temperatur (℃)	Waktu (menit)	Hasil (mL)
120	30	0
255	60	0
270	90	26
290	120	125
305	160	328
310	180	500

Calculation of work evaluation on reactor

In the evaluation of the work of the reactor using the amount of plastic as much as 3 kg, and the experimental results obtained oil for the type of PP plastic with specific heat yield of 800 ml of oil, while for LDPE plastic it was obtained 500 ml and char or waste of 500 g,

a. Conversion efficiency of PP type plastic in reactor Conversion efficiency to determine feed weight plastic then you can count

$$CE = \frac{800\ gram}{3000\ gram} \text{ x } 100\% = 26\ \%$$

b. Efficiency

reduction of waste type pp plastic (%wt) In the pyrolysis process on pp plastic, there is residue or char buried in the reactor, in pp plastic char or residue buried is 500 g.

$$WRE = \frac{3000g - 500\ g}{3000\ g} \text{ x } 100\% = 83{,}3\ \%$$

c. Plastic oil recovery(ml/kg)

in the recovery of oil on pp plastic, it can be seen that the volume of oil produced is 800 ml with a total of 3 kg of plastic, so it can be calculated:

$$QR = \frac{800ml}{3000\ g} = 0.26\ \text{ml/g}$$

While the LDPE plastic can be calculated as follows:

a. LDPE type plastic conversion efficiency in reactor

$$CE = \frac{500\ gram}{3000\ gram} \text{ x } 100\% = 16\ \%$$

b. Efficiency of reducing pp type plastic waste (%wt) In the pyrolysis process on pp plastic, there is residual or char buried in the reactor, in pp plastic char or residue buried is 200 g.

$$WRE = \frac{3000g - 200\ g}{3000\ g} \text{ x } 100\% = 93{,}3\ \%$$

char buried in the reactor, on plastic pp char or buried residue of 200 g.

$$QR = \frac{500ml}{3000\ g} = 0.16\ \text{ml/g}$$

3.4 Convective heat transfer in the reactor

The type of heat transfer flow in the reactor is turbulent flow, this is because the Reynolds number is above 5000

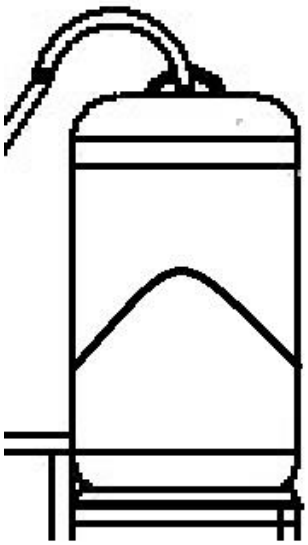

Figure 3 Turbulent flow in the reactor

In a pyrolysis reactor, turbulent flow is found in the middle core of the reactor with the main characteristic of the flow being a vortex

Convective heat transfer with turbulent flow rate can be calculated

$$q = h.A\ (tw\text{-}wb)$$

Then it can be calculated

$$q = 1692{,}437 \text{ x } 7.736{,}9\ (600 - 300)$$

So that by calculating the heat transfer in the reactor above, it results in a convection heat transfer of $3.798 \text{ x } 10^9$

Conclusion

From the discussion of this report, it can be concluded as follows

1. Parameters that affect the pyrolysis process are interconnected because the higher the combustion temperature in the reactor, the higher the vapor pressure which affects the processing time in the pyrolysis process, with these parameters it can be seen that the heat transfer in the pyrolysis reactor is 3.798 x 109 with turbulent flow type.
2. The reactor itself is a component that is very influential on the output of oil because the results of burning solid plastic in the reactor can produce pressure that affects the decomposition process

time in the reactor and the steam that will be condensed in the condenser, this can be evaluation with a comparison of oil yields between PP plastics of 800 ml while LDPE of 500 ml differs in results due to differences in melting point temperatures between types of plastics.

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