A design of pyrolysis test-bed for plastic waste

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Abstract. The problem of plastic waste is a serious environmental problem because plastic waste takes hundreds of years to be decomposed into elements that can be naturally accepted by the environment. On the other hand, there has been an increase in the accumulation of the spread of plastic waste to the environment. The utilization of plastic waste as its conversion into oil is one alternative to reduce the exposition of plastic waste to the environment while also offering benefits in the form of new energy sources. The pyrolysis process without a firm understanding of the science of its process may lead to a utilization is far from optimum. Optimization of this process requires research on the properties of the spectrum and the behavior of the pysrolisis process such as the relation of temperature of pyrolysis to the spectrum of oil products. Due to this reason, a pyrolisis test device was designed in this study that can regulate the temperature of the prolysis furnace so that the results of pyrolysis associated with the temperature can be analyzed chemically. This test equipment was designed with the aim to determine the effect of pyrolysis temperature on the composition of the resulting pyrolysis products.

1. Introduction

The use of petroleum as an energy source continues to increase which results in the decline of world oil reserves. This decline will be a global crisis for the next few decades. The search for new energy alternatives is an urgent topic for world current research trends. One alternative energy that is considered as an energy source is plastic waste.

The problem of plastic waste is a serious environmental problem because plastic waste takes a long time, up to hundreds of years, to be decomposed into elements that can be naturally accepted by the environment. On the other hand there has been an increase in the accumulation of the spread of plastic waste to the environment. The use of plastic waste to be compiled into oil is one alternative to reduce the exposition of plastic waste to the environment while also offering benefits in the form of new energy sources.

The environmental crisis in the form of the accumulation of plastic waste disrupts the healthy balance of the environment for humans and threatens the sustainability of vegetable diversity both on land and sea. The obstacle in overcoming this problem is that there is a lack of favorable incentives in handling plastic waste. With the utilization of plastic waste into fuel which has economic value, it will trigger many parties to enter this field.

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properties of the spectrum and the behavior of the pysrolisis process as in the relation of temperature of pyrolysis to the spectrum of oil products. For this reason, a pyrolisis test device was designed in this study that can regulate the temperature of the prolysis furnace so that the results of pyrolysis associated with the temperature can be analyzed chemically. This test equipment was designed with the aim to determine the effect of pyrolysis temperature on the composition of the resulting pyrolysis products.

Plastic decomposition products through pysolysis are strongly influenced by temperature. Different temperatures will produce different compositions on the product. Departing from this background, the researchers intend to design a pyrolysis test device that will be used as a research tool to know the chemical behavior of the process of pysrolysis from plastic waste. The tool designed will be able to map the effects of temperature variables in the pyrolysis process on the composition of the oil produced. Thus the results of this study will be useful in designing the pyrolysis tool in the future in determining the parameters of the temperature setting of the design of the plastic garbage pyrolysis device.

In this research, the configuration of the pyrolysis test tool including its components and its working principle was designed. The optimal size of each component of the tool so that it can function as a research tool capable of mapping the effect of pyrolysis process temperature on product composition was also determined.

The purpose of this study is to design a pyrolysis test device that functions as a research tool capable of mapping the effect of process temperature on product composition. The specific objectives of this study are to determine the configuration, components and how the pyrolysis test equipment works. Calculations to determine the optimal size of each component so that it can function as a pyrolysis test tool was also performed.

2. Method

Pyrolysis is the thermochemical decomposition of organic matter through a process of heating without or little oxygen or other chemical reagents, where the raw material will break down the chemical structure into a gas phase [1]. Pyrolysis is a special case of thermolysis. Extreme pyrolysis, which only leaves carbon as a residue, is called carbonization.

Carbonized coal briquettes are briquettes that have previously undergone a carbonization process. Carbonization is the process of heating coal to a certain temperature and time (200–1000 ° C (390–1800 ° F) [2] in oxygen-poor conditions to remove the coal fly substance so that it produces solid coal or coal coke or semi coke with tar and gas byproducts.

This process is used in general in the chemical industry, for example, to produce charcoal, activated carbon, and other chemicals from wood, to convert ethylene dichloride to vinyl chloride to make PVC, to produce coke from coal, to convert biomass into synthesis gas and biochar, to convert plastic waste back into usable oil, or waste to be a disposable safe substance, and to convert hydrocarbons of medium molecular weight such as oil to lighter ones like gasoline. Pyrolysis is also used in the manufacture of nanoparticles, zirconia and oxides utilizing ultrasonic nozzles in a process called ultrasonic spray pyrolysis (USP) [3].

Several studies have been conducted in rcent years regarding pyrolysis of plastic waste. The characteristic of the char produced in the fast pyrolysis of the high density polyethylene was investigated by Jamradloedluk and Lertsatitthanakorn [4]. Plasma pyrolysis is an innovative technology for transforming high calorific plastic waste into a valuable synthesis gas (syngas) by means of thermal plasma. The process developed is a drastic non-incineration thermal process, which uses extremely high temperature in an oxygen-starved environment to completely decompose input plastic waste into syngas, composed of very simple molecules: CO, H2 and small amount of higher hydrocarbons [5]. The use catalist in the pyrolysis of biomass and plastic mixtures has been investigated by Sebestyén et al. [6]. Areepraserta et al. have conducted composition study of plastic waste in Bangkok and its feasibility for energy recovery [7]. Pyrolysis of plastic waste in microwave oven was studied by Aishwarya and Nangarthody [8]. Ghenai et al. have investigated the plastic waste

pyrolysis using solar energy [9]. Hossain et al. conducted the combined pyrolysis of plastic waste and rice straw [10].

3. Results and discussions

The first phase of the 2019 research is the beginning of the future applied research plan to develop pyrolysis machines for pastic waste to become oil fuels that have economic value such as gasoline and diesel fuel.

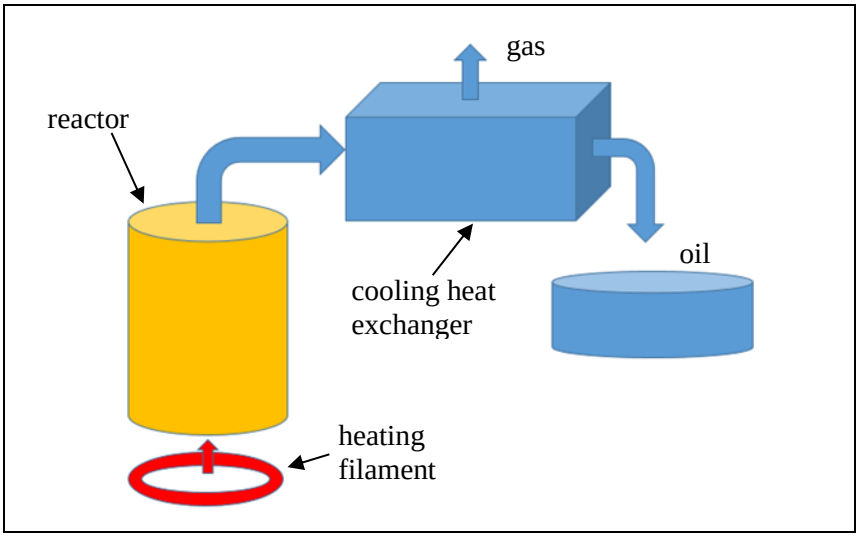

Figure 1. The design of pyrolysis test-bed.

This plastic waste is usually in the form of a polymer compound. This polymer has the same basic structure as oil which is in the form of hydrocarbons or C-H, but because it has experienced hydrocarbon polymerization it has a very long chain. In other words, the chemical structure of plastic and oil is similar. This pyrolysis process returns the plastic back to oil by cutting the long chain of hydrocarbons.

As a preliminary study this study focused on the design of pysrolysis test bed. Plastic waste is placed on a reactor tube that is heated with heating elements controlled by a thermostat. Heated plastic will melt and decompose into shorter hydrocarbon compounds and then evaporate. The gas flow from the hot pysrolysis will flow into the cooling tube. The oil that has been cooled will be collected with a storage vessel.

The oil product from the decomposition of plastic waste will be in the form of short chain hydrocarbons where the composition will depend on the temperature of the reactor. The test equipment made in this study will be able to control the temperature of the reactor so that it can set the temperature of the process related to the specific product, which in the next study will be a research tool to map the effect of process temperature on the composition of pyrolysis products.

Tests carried out in this study were to try tools in pyrolysis of one type of plastic waste. The testing criteria are the ability of the tool to produce pyrolysis products and also the stability of the process temperature.

4. Conclusions

A test bed has been designed as research tool to investigate the effect of temperature to the pysrolysis products of plastic waste. The continuation of this research will be to utilized this tool to investigate the pyrolysis products for various plastic waste compositions.

5. References

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