Conversion of plastic waste to fuel oil using pyrolysis process

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ABSTRACT – The development of this project is based on the purpose of converting plastic waste into fuel oil. The study is focusing on the design and fabrication of a plastic waste oil converter as an effort in finding environment-friendly means of waste recycling. It is an alternative solution to increasing problem of waste disposal by converting waste plastics into a resource. Pyrolysis process was the basis in the design and fabrication of the equipment. The conversions of Polypropylene (PP), Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) into Plastic Waste Oil (PWO) are the key element of this design and development project. The converter consists of a filler tube, stove, working table, condensing rod, beaker, stop valve, condensing chamber, cooling outlet and intake. The filler tube attached to a mechanism of condensing unit, which collect the amount of PWO in a beaker. The stop valves functioned to allow the cooling medium entering the condensing system. Hence, plastic waste which evaporated travel through a condensing chamber, which made to turn the vapour into PWO. The filler tube is made of stainless steel with holding capacity of 500g/batch of plastic waste. The equipment tested for five trials using 500g of Polypropylene (PP), Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) plastics per trial. With the aid of this equipment, it can optimize the amount of PWO produced due to its arrangement. Recommendations also discussed in order to increase the performance of plastic waste converter.

1. INTRODUCTION

The development of this project is based on the purpose of converting plastic waste into fuel oil. Plastic is the general common term for a wide range of synthetic or semi synthetic organic amorphous solid materials used in the manufacture of industrial products. Plastics are typically polymers of high molecular mass, and may contain other substances to improve performance and reduce costs. Plastics are dominantly contributed 70% of domestic waste. The effect of plastics waste was seen in water and land pollutions. The study focused on the design and fabrication of a plastic waste oil converter as an effort in finding environment-friendly means of waste recycling. It is an alternative solution to increasing problem of waste disposal by converting waste plastics into a resource.

Pyrolysis process was the basis in the design and fabrication of the equipment. It is a prototype model that will serve as baseline in developing technology for energy recovery from plastics waste [1]. The conversions of Polypropylene (PP), Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) into Plastic Waste Oil (PWO) are the key element of this design and development project.

2. RESEARCH METHODOLOGY

The equipment used for converting plastic waste into fuel oil. 500g of plastic waste of Polypropylene (PP), Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) were collected into filler tube. The stove is then heated the plastic waste to become liquid. Plastic waste was later evaporated travel through a condensing chamber, which is made to turn the vapour into PWO. The stop valves functioned to allow the cooling medium entering the condensing system. The duration of heating is set for 1 hour. The amount of PWO produced is then measured. The basic steps of plastic waste pyrolysis processes explained in Figure 2.1.

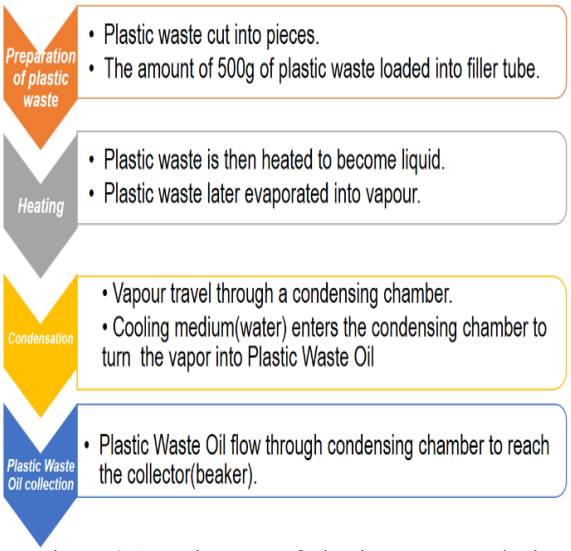

Figure 2.1 Basic steps of plastic waste pyrolysis processes.

3. RESULTS AND DISCUSSION

For the performance evaluation of the equipment, only Polypropylene (PP), Low Density Polyethylene

(LDPE) and High Density Polyethylene (HDPE) were used as feedstock. Two thousand and five hundred grams of each plastic waste were prepared, cut into small pieces and divided into five sample weighing 500g each. Five trials conducted for each type of plastic. The performance of the equipment measured in terms of volume of oil recovery [2]. The observations of PWO colours and time for melting were also taken into consideration. The data gathered during plastic waste pyrolysis processes shown in Table 3.1.

Table 3.1 Data gathered during plastic waste pyrolysis processes.

Parameters	TRIAL						Average	Observation
	1	2	3	4	5	Total		
Weight of PP/ LDPE/ HDPE plastic (g)	500	500	500	500	500	2,500	**500 g**	
Duration of Operation (1 hr)	1	1	1	1	1	5	**1 hr**	Duration for plastic to melt: 1.PP-20 minutes 2.LDPE-20 minutes 3.HDPE-50 minutes
Volume of oil recovered PP (ml)	381	385	383	384	383	1,916	**382.2 ml**	Colour of oil observed-yellow
Volume of oil recovered LDPE (ml)	379	378	376	371	373	1,877	**375.4 ml**	Colour of oil observed-light brown
Volume of oil recovered HDPE (ml)	489	492	493	488	495	2,457	**491.4 ml**	Colour of oil observed-dark brown

3.1 Average Volume per Mass Produced

(i) Polypropylene (PP) produced 382.2 ml for 500 g, therefore the average volume capacity of PP is 0.765 ml /g

(ii) Low Density Polyethylene (LDPE) produced 375.4 ml for 500 g, therefore the average volume capacity of LDPE is 0.751 ml /g

(iii) High Density Polyethylene (HDPE) produced 491.4 ml for 500 g, therefore the average volume capacity of HDPE is 0.983 ml /g

3.2 Physical Observations

(i) Polypropylene (PP) produced a Yellow PWO

(ii) Low Density Polyethylene (LDPE) produced a Light Brown PWO

(iii) High Density Polyethylene (HDPE) produced a Dark Brown PWO

4. SUMMARY

The process was successful in converting Polypropylene (PP), Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) plastics into oil without using catalyst. It is able to convert PWO at an average volume capacity of 0.765 ml /g, 0.751 ml /g and 0.983 ml /g respectively. Although it is a laboratory scale model, it can be used to address the demanding problem of waste disposal in the country. Further study on other factors that affects the performance of the plastic waste oil converter could be also conducted. Factors such as temperature, pressure and duration can be taken into consideration. Further study should also consider using other types of plastic waste. Oil recovered must be analyzed to determine its physical and chemical properties. Studies should be conducted on the applications and benefits that can be drawn from Plastic Waste Oil.

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