Extraction of Fuel from Plastic Waste and Its Experimental Analysis

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Abstract- *Waste plastics are indispensable material in current day scenario. Due to its fuel properties applications in industrial field increasing rapidly. The aim of this experimentation is to study fuel oil extraction from HDPE plastic waste by catalytic pyrolysis process. The process was carried in lab scale stainless steel based setup consisting of mainly pyrolysis chamber, in which HDPE is treated with natural zeolite as a catalyst and toluene as a solvent in absence of oxygen. In this study various chemical properties and performance parameters have been prepared for better understanding of operating conditions. In the present paper plastic pyrolysis oil and its blend with diesel has been experimented. Results of this process are found to be better as an alternative fuel for industrial and marine applications.*

Keywords- Catalytic pyrolysis, HDPE plastic, Performance characteristics.

I. INTRODUCTION

Nowadays, consumption of petroleum fuel are increasing continuously because of high fuel demand. As petrol and diesel are non-renewable resources, it become necessary to develop alternative fuel. On the other hand demand of plastic material are increasing because of advantages such as light weight, high specific strength, corrosion resistance etc. Continuous innovation explains that; plastic production has increased by an average of almost 10% every year on global basis since 1950. The total global production of plastic grown from 1.3 MT in 1950 to 300 MT in 2016. Developing nation like India is 3rd largest plastic consumer after U.S. and china because of rapid economic development. So rapid rate of plastic consumption throughout the world has led to creation of increasing amount of plastic waste and this imposes greater difficulties for disposal.

There are many ways of plastic management such as land filling, incineration, reducing, reusing and recycling (3R's). Landfilling and burning plastic in incinerator will cause pollution because they produce toxic gases like dioxin and furans. Hence the popular recovery method are thermal pyrolysis and catalytic pyrolysis. However thermal degradation of plastic has major drawback which can be minimize by Catalytic degradation. At the time of processing plastic material are fed into reactor with zeolite and solvent and heated up to 400 degree Celsius and Slowly condensed using condenser. The result of hydrocracking of LDPE plastic shows that over various by functional catalyst CO-MO/Z 350^0C produced 14.91% of liquid, 1.39% of solid yield and 83.72% of gas yield [1]. In the present paper waste plastic pyrolysis oil, is blended with diesel and it's operating parameters such as mechanical and volumetric efficiency, specific fuel consumption, mean effective pressure etc. has been introduce [2]. The result of this study are useful for determining the effect of catalyst types and reaction condition on both the product distribution and selectivity from hospital plastic waste [3].The paper concludes, the exhaust gas temperature for waste plastic pyrolysis oil is higher than the petrol and diesel. The NO_x emission in WPO varies from 55 to 91 ppm for petrol grade 192 to 1268 for diesel grade. The CO_2 concentration increases with Increase in load, due to incomplete combustion [5]. The process is carried out batch-wise reactor over a zeolite at a temperature from 350 to 450^0C and at atmospheric pressure. Test were carried out on polyethylene and polypropylene alone. From 90 to 98% of plastic was converted into gases at distilled hydrocarbon of this yield 20 to 55% was gas 32 to 70% was a light hydrocarbon oil [6].The purpose of study was to explore effect of various condition such as catalyst types, amount of catalyst reaction time ,P&T on product distribution. The waste plastic include LDPE, HDPE and PS & PP. A series of reaction were carried out in an autoclave reactor with 30 to 120 minute reaction time and 400 to 430^0C reaction temperature [8].

II. OBJECTIVE

The increasing demand of petroleum fuel and increasing the problem for plastic waste management poses research towards waste to energy. So the presented paper is experimental study of plastic fuel as an alternative fuel.

III. PROBLEM STATEMENT

To obtained fuel from plastic waste such as LDPE, HDPE, PP and PS. The chemical analysis of plastic fuel oil and also comparing the performance characteristics of plastic fuel oil with diesel.

IV. EXPERIMENTAL SETUP AND PROCEDURE

Experimental setup mainly consist of four unit i.e. heating unit, pyrolysis chamber, condensing unit and collection unit. A Diagrams of experimental setup is shown in the fig1. The setup consist of heating mental with capacity of 100ml and can heat up to 400 degree Celsius. A pyrolysis reactor of stainless steel with 160mm height, 120mm diameter and 3mm thickness is kept into the heating mental. Upper portion of pyrolysis reactor consist of three knobs having connection to vacuum pump, Glass syringe (10ml) with rubber septa for inserting the material into chemical reactor and last knob is used to connect shell and tube condenser at inlet and outlet using adapter.

PROCEDURE:

5 gm. plastic were mixed with 2 gm of natural zeolite in powder form using a solvent called toluene, so that whole solution will comes into one phase. By using vaccum pump maximum air will be sucked to vacuumise whole system. Using glass syringe 10ml of solution are fed into the chemical reactor through rubber septa. Then water cooling system are started for avoiding any damage to condenser. Heating system are stated with suitable energy supply at constant rate say at interval of 5 minutes. After some time temperature will rise gradually, at 1 hr. and 15 minutes temperature reaches cracking temperature of HDPE plastic

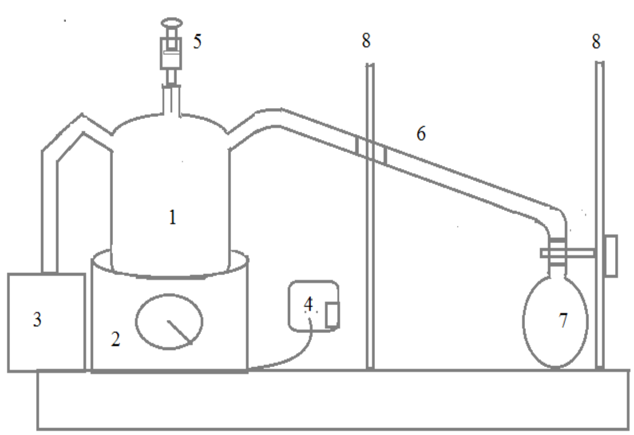

Fig.1 Experimental setup

1. Pyrolysis chamber 2. Heating mental 3. Vacuum pump 4. Electrical switch 5. Glass syringe 6. Shell tube condenser 7. Collecting flask 8. Stands some time temperature will rise gradually, at 1 hr. and 15 minutes temperature reaches cracking temperature of HDPE plastic i.e. 250- 270^{0}C . At that time the product vapours are formed and it will get condensed inside the condenser. The temperature is rise up to 400^{0}C and maintain it constant till the process is end, then liquid and solid product are collected and measured.

V. RESULTS AND DISCUSSION

A. Chemical properties

The chemical properties of waste plastic pyrolysis fuel were compared with petroleum fuel is tabulated with Table no. 1.

Table no. 1 chemical properties of diesel and plastic fuel

Sr. No.	Fuel Properties	Diesel	Plastic oil
1	Density	850	793
2	Viscosity	3.05	1.149
3	Flash Point	50	30
4	Cetane no.	55	34
5	Calorific value	44000	10200
6	Sulphur content	0.035	0.002

B. Performance Characteristics of plastic fuel:

The trail on CI engine was carried out for determining the performance characteristics of plastic fuel. The plastic fuel blended with diesel fuel in proportions of 20 % and 30 % and its power, mean effective pressure, specific fuel consumption and thermal efficiencies were stated at various loads.

Table 2. Engine Specifications

Sr. No.	Description	Specification
1	Make	Kirloaskar
2	No. of cylinders	1
3	No. of strokes	4
4	Types of cooling	Water
5	Power	5.2 KW at 1500 rpm
6	Bore	87.5 mm
7	Stroke	110 mm
8	Capacity	661cc

1. Break power

The experimental study on a single cylinder, four stroke C.I. engine with diesel fuel. From fig 2. We can conclude that break power of diesel fuel increases with the increase in load. Whereas break power for P20D80 and P30D70 coincide each other and nearer to the POD100.

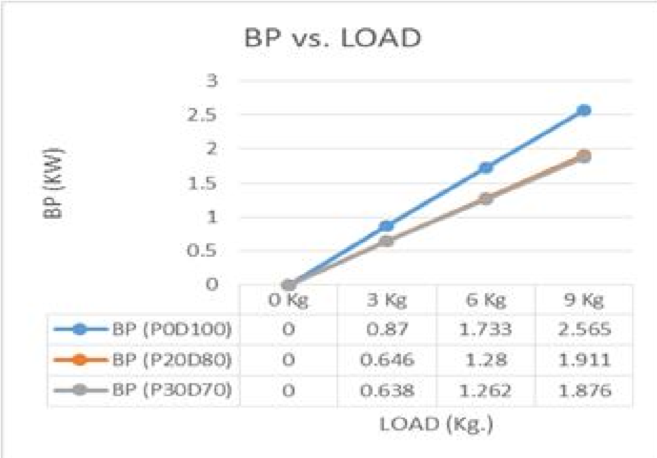

Fig. 2 Break power vs. load

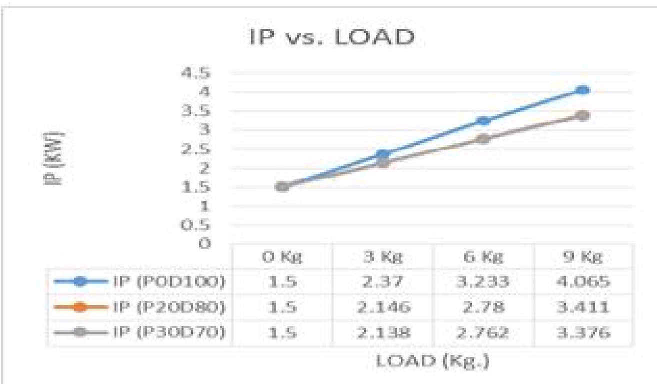

Fig.3 Indicated power vs. load

2. Indicated power:

From fig. 3 it is observe that indicative power for pure diesel is higher than P20D80 & P30D70, but at 3kg load IP are approximately same for pure diesel and its blend. Whereas IP values deflected at 6kg and 9kg. From minimum to maximum load indicative power are increases.

3. Break mean effective pressure:

Break mean effective pressure is the average pressure inside the cylinder of an internal combustion engine. Fig.3 shows the break mean effective pressure of P20D80 and P30D70 coincides with each other because of their approximately same value. Whereas BMEP (P0D100) is increases as load increases.

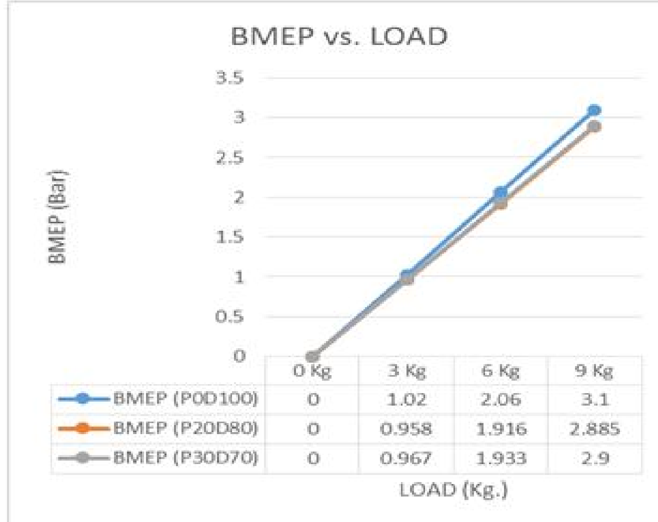

Fig. 4 Break mean effective pressure vs. load

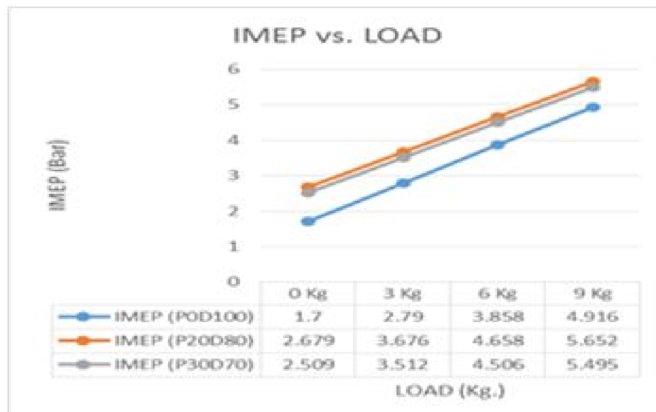

Fig.5 Indicated mean effective pressure vs. load

4. Indicated mean effective pressure:

The power stroke of an engine to do the same amount of work as is done by the varying pressures that are in fact obtained during the stroke. From fig. 4 it can be seen that indicated mean effective pressure for P20D80 and P30D70 are higher than pure diesel.

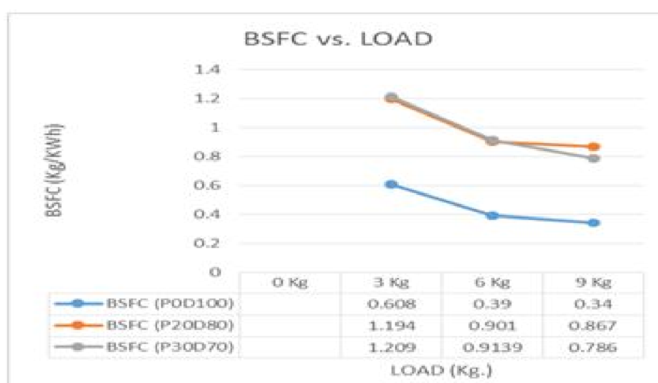

Fig.6 Break specific fuel consumption vs. load

5. Break specific fuel consumption

Fig. 6 shows break specific fuel consumption of blended fuel with various loads. BSFC decreases with increase in load. P20D80 and P30D70 fuel having lesser fuel consumption than diesel (P0D100).

6. Indicated specific fuel consumption:

Indicated specific fuel consumption is a fuel consumption per KW indicated power per hour. The fig. 7 show Indicated specific fuel consumption with various loads. ISFC decreases with increase in load and found lesser for plastic blended fuels.

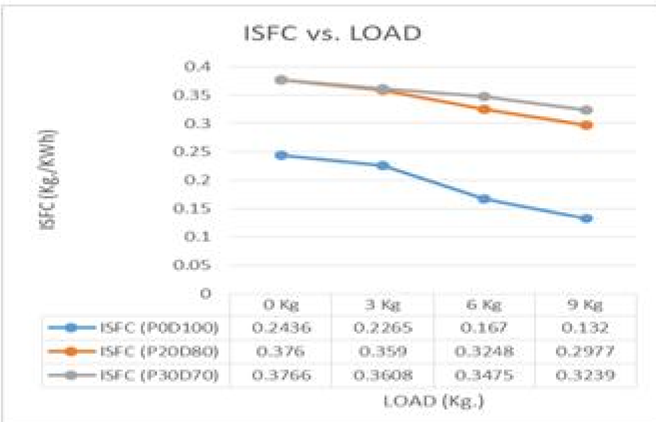

Fig.7 Indicated specific fuel consumption vs. load

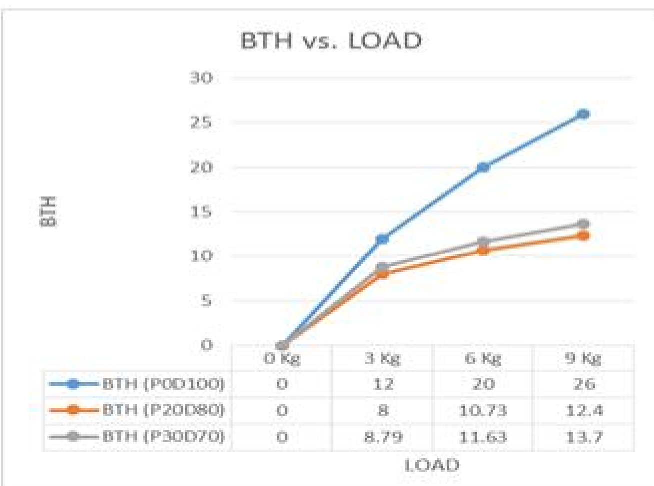

Fig.8 Break thermal efficiency vs. load

7. Indicated specific fuel consumption:

The break thermal efficiency increased with increase in the break power. The break thermal efficiency found decreased with increase in pyrolysis oil concentration compare to D100. Break thermal efficiency found better than diesel.

8. Indicated thermal efficiency:

From fig. 9 the indicated thermal for different loads for plastic fuel is varies between 20% to 35% which is lesser than diesel.

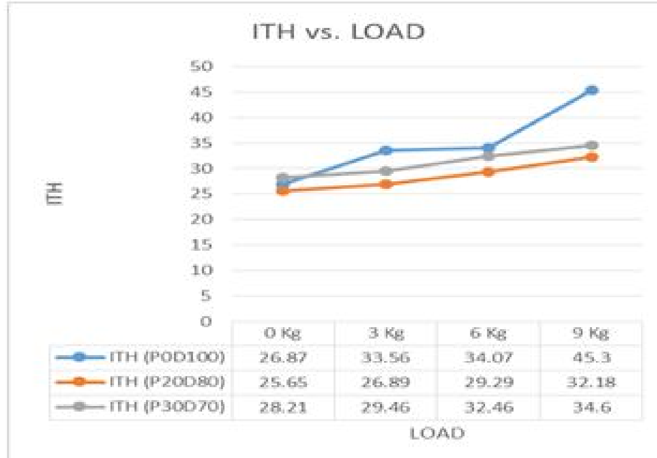

Fig.9 Indicated thermal efficiency vs. load

VI. CONCLUSION

Waste plastic pyrolysis fuel represent a good alternative fuel for diesel and therefore it must be taken into consideration in future for industrial applications. From this experimental study: Break power and indicated power increases with increase in load. Specific fuel consumption of plastic fuel is found to be greater than diesel. Indicated thermal efficiency of plastic fuel is approximately equals to diesel.

This paper advocates an efficient, clean and very effective means of removing debris that we have left behind over the last several decades by converting plastic into fuel. Thus we solved two issues, one of the largest plastic seas and the other of fuel shortage.

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