International Journal of Engineering Research and General Science Volume 3, Issue 1, January-February, 2015
ISSN 2091-2730

Production and Analysis of Pyrolysis oil from waste plastic in Kolhapur city

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Abstract: The aim of this research was to study the pyrolysis oil production from municipal plastic waste of Kolhapur city. A pyrolysis experiment is done on the municipal LDPE plastic waste of 150 grams. A series of tests were carried out at a temperature range of 300- 350 ^{0}C with all other parameters being same. Under pyrolysis conditions plastic waste was decomposed into three types: producer gas, oil and solid residue. The obtained result shows that the properties of the pyrolysis oil are closely similar to that of diesel. hence it can be used as alternative fuel for compression ignition engines.

Keywords: alternative fuel, Compression ignition, LDPE, Plastic waste, Producer gas, Pyrolysis oil, solid residue.

Introduction:

Conversion of waste to energy is one of the recent trends in minimizing not only the waste disposal but also could be used as an alternate fuel for internal combustion engines. Waste plastics are non-biodegradable materials and its application in the domestic as well as industrial field is continually increasing. As the disposal of plastic will take more than 500 years in natural way. Hence, the plastic waste disposal is the biggest concern of the city. In Kolhapur city, around 165 tonnes of solid waste is generated every day, out of which nearly 11% i.e. 18 tonnes is contributed by only plastic waste. The aim of this experiment is to convert this non biodegradable plastic into useful components.

A plastic material is a wide range of synthetic or semi-synthetic organic solids that are malleable. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are partially natural. Plastics can be converted into hydrocarbon fuels since it contains hydrogen and carbon. LDPE (Low Density Polyethylene) is defined by a density range of 0.910–0.940 g/cm^3. It is widely used for domestic as well as industrial applications.

Pyrolysis is the thermo chemical decomposition of organic substances at elevated temperatures in absence of oxygen. Plastic waste is treated in a cylindrical reactor at temperature of 300 ^{o}C – 350 ^{o}C. The gases are condensed to give a low density oil. A solid carbon residue gets generated at the bottom of the reactor.

Method:

The process flow chart:

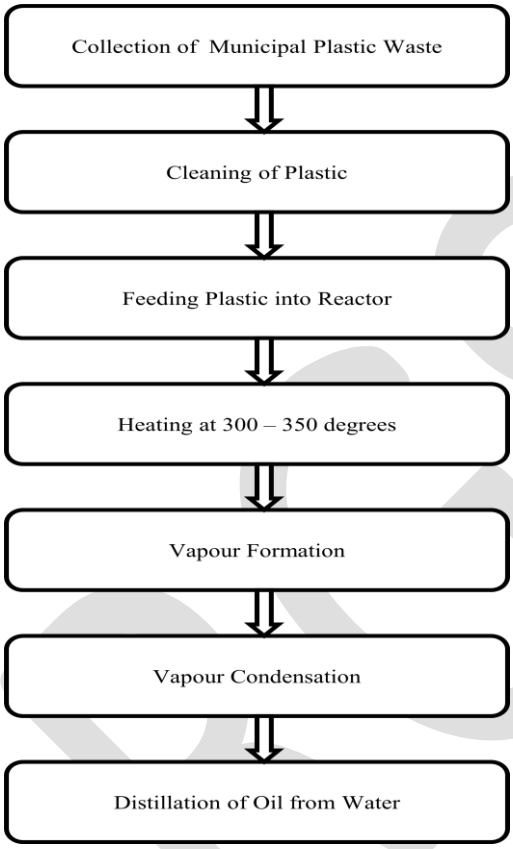


Figure 10: Flow chart

Experimental Set up:

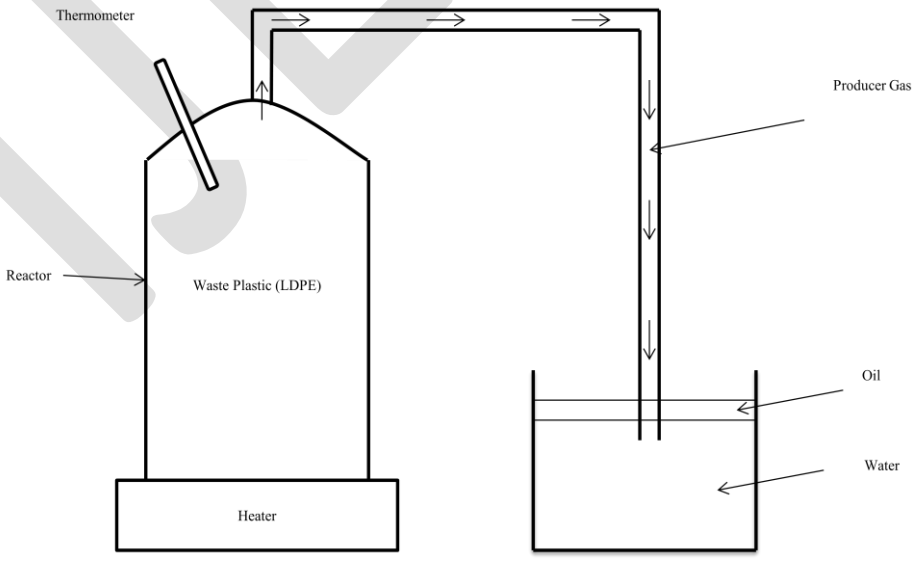


Figure 11: Experimental Set Up

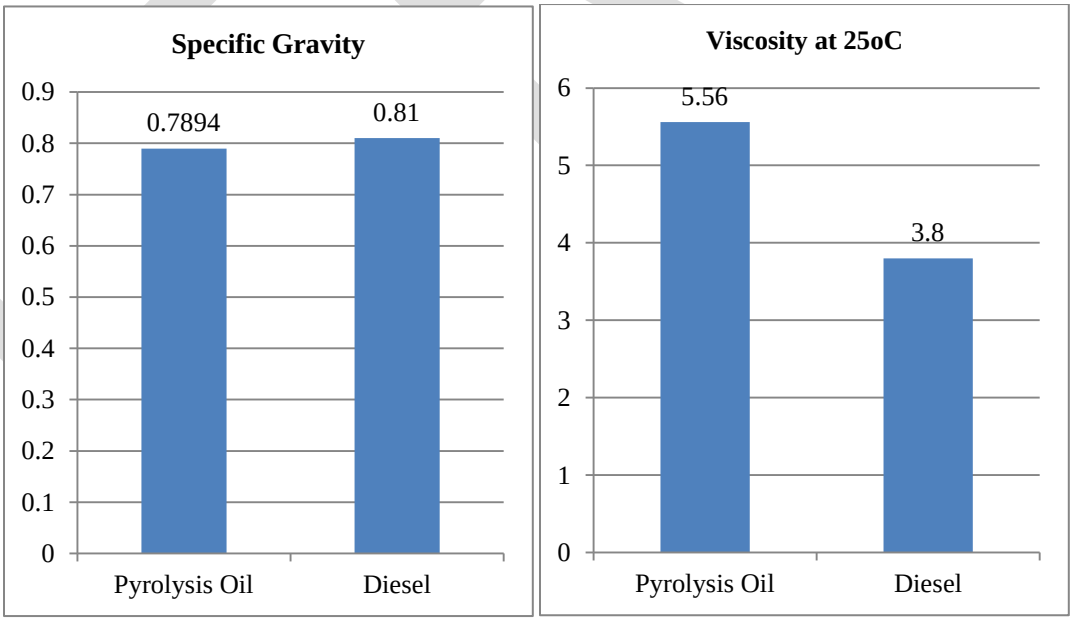
Waste plastic is collected from municipal solid waste. A sample of 150 grams of waste plastic (LDPE) is taken and cleaned. The sample is fed into the reactor and heated at a temperature of 300-350 ^{o}C for about 35 minutes using induction heater. The plastic is evaporated at this temperature and the vapours are condensed by direct mixing it with water at atmospheric temperature. The layer of oil is formed at the surface of water due the difference in their densities. This oil is separated by using distillation process. 100ml oil was formed with 150 grams of plastic waste.

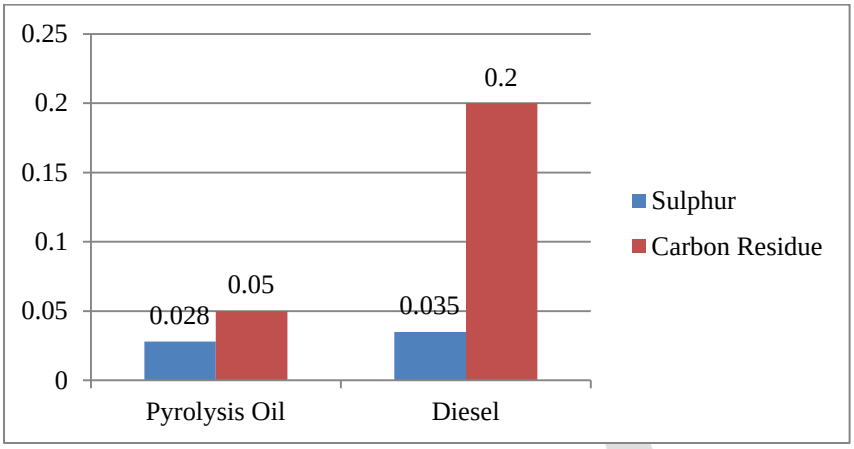
Results and Discussion:

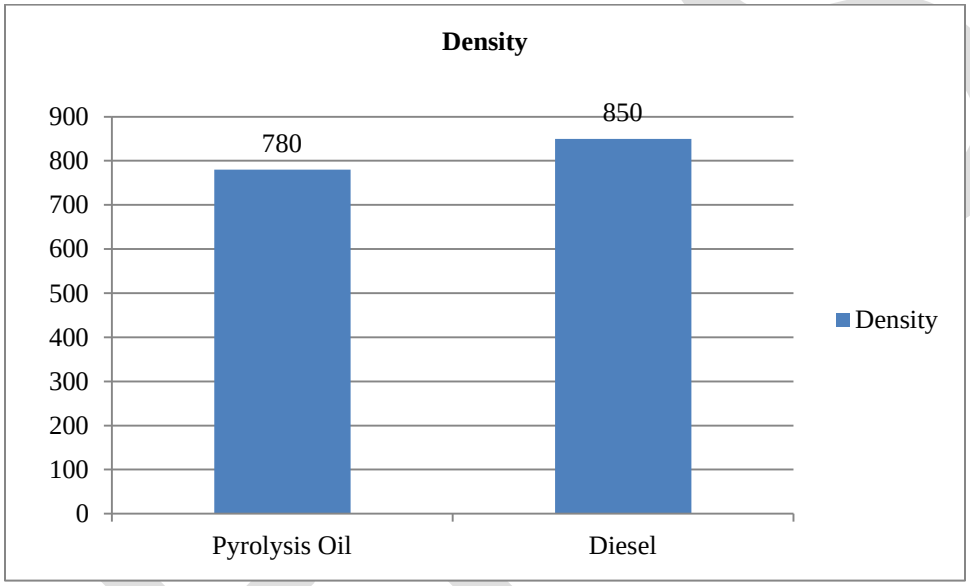
Sr. No.	Parameter	Unit	Pyrolysis Oil	Diesel
1	Specific Gravity	-	0.7894	0.81
2	Viscosity at 25^{o}C	cSt	5.56	3.80
3	Flash Point	^{o}C	41	50
4	Fire Point	^{o}C	46	56
5	Sulphur	%	0.028	<0.035
6	Carbon Residue	%	0.05	0.20
7	Calorific value	KCal/Kg	9434	10031.52
8	Cetane Number	-	49	55
9	Density	Kg/m^3	780	850

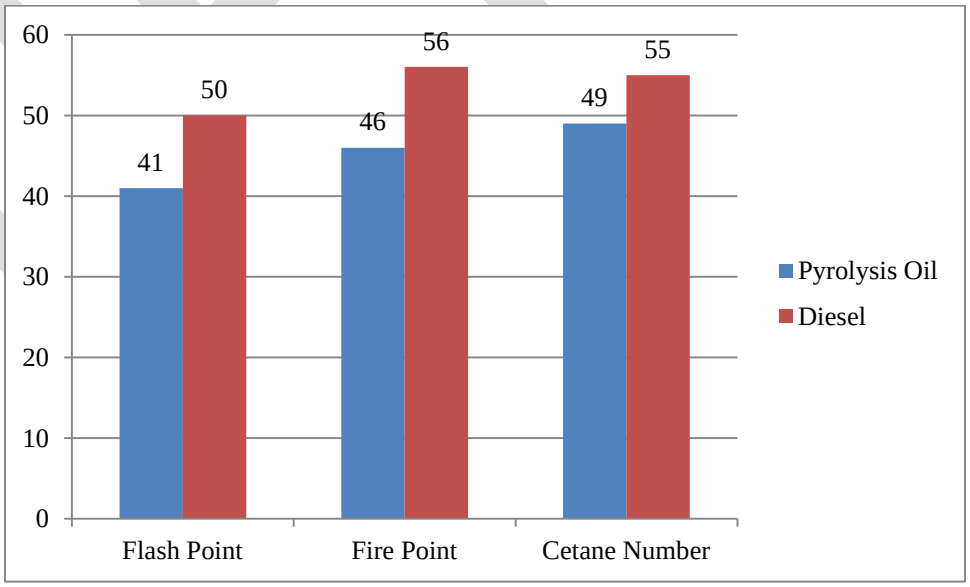
Table 3: Comparison of properties

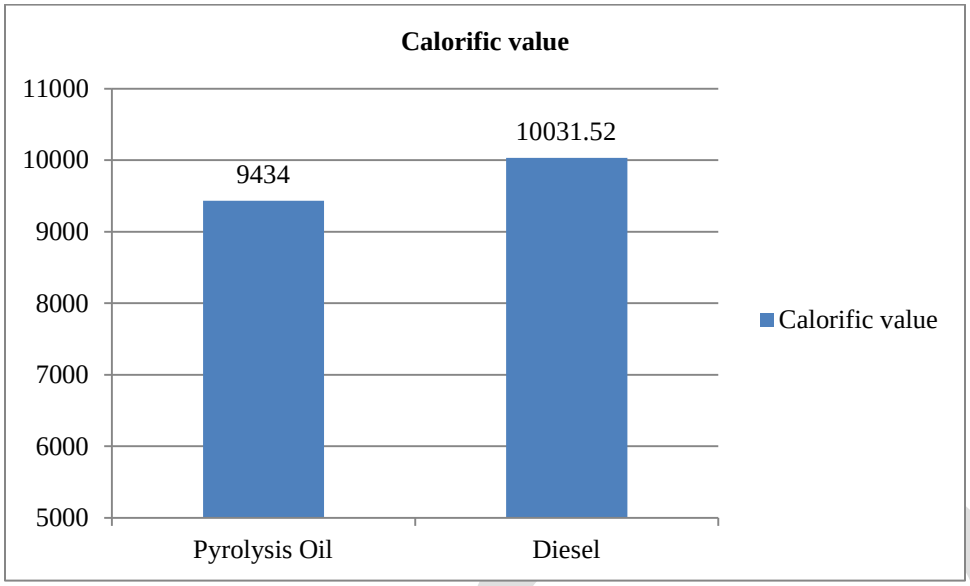
Graphical Representation:




0.25
0.2
0.15
0.1
0.05
0
0.028
0.05
0.035
0.2
Pyrolysis Oil
Diesel
Sulphur
Carbon Residue


Density
900
800
700
600
500
400
300
200
100
0
780
850
Pyrolysis Oil
Diesel
Density


60
50
40
30
20
10
0
41
50
46
56
49
55
Flash Point
Fire Point
Cetane Number
Pyrolysis Oil
Diesel



The breakdown of the output from pyrolysis process is given below:

Output	% of output
Fuel Oil	80% - 90%
Producer Gas	8% - 10%
Char as Residue	2% - 13%

Table 4: Breakdown of output

From above comparative analysis, it is clear that the properties of pyrolysis oil are similar o that of diesel. Also, it is found that the carbon residue, sulphur content of plastic pyrolysis oil is much lesser than the diesel, hence its use will result in lesser air pollution. Hence plastic pyrolysis oil can be used as an alternative fuel for diesel engines and oil fired furnaces. Char is the material that is left once the pyrolysis process is complete and the fuel recovered.

The total amount of plastic waste collected from Kolhapur city is 18 tonnes/day. This can be converted into 12000 litres of pyrolysis oil per day. The running cost of pyrolysis plant ranges from Rs. 14 to Rs. 18 per litre while the market price of oil is Rs. 40 per litre.

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