

## International Journal of Innovative Research in Science, Engineering and Technology

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# Municipal Waste Plastic Conversion into High Energy Hydrocarbon by Thermal Degradation Process

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**ABSTRACT:** The purpose of our project is to give the alternative fuel to the society by using the waste plastic. The motivation of our project is to make the alternative fuel because of the decreasing in fuel resource and now-a-days the cost of the fuel is increasing. We use various types of plastics for the thermal degradation process, we can minimize the usage of plastic in the society. We are using the waste plastic for producing WPPO by thermal degradation process. It gives alternative fuel for us and also reduces the waste plastics pollution.

**KEYWORDS:** Thermal degradation, Waste plastics pyrolysis, fuel from waste plastics, Connected component labelling.

### I. INTRODUCTION

Plastics were first invented in 1860, but have only been widely used in the last 30 years. Plastics are light, durable, modifiable and hygienic. Plastics are made up of long chain of molecules called polymers. Polymers are made when naturally occurring substances such as crude oil or petroleum are transformed into other substances with completely different properties. These polymers can then be made into granules, powders and liquids, becoming raw materials for plastic products.

Worldwide plastics production increases 80million tons every year. Global production and consumption of plastics have increased, from less than 5 million tons in the year 1950 to 260 million tons in the year 2007. Of those over one third is being used for packaging, while rest is used for other sectors. Plastic production has increased by more than 500% over the past 30 years. Per capita consumption of plastics will increase by more than 50% during the next decades. In the Western Europe total annual household waste generation is approximately 500 kg per capita and 750 kg per capita in the United States; 12% of this total waste is plastics. The global total waste plastic generation is estimated to be over 210 million tons per year. Yet for all their advantages, plastics have a considerable downside in terms of their environmental impact. It production requires large amounts of resources, primarily fossil fuels & 8% of the world's annual oil production is used in the production of plastic. Potentially harmful chemicals are added as stabilizers or colorants. Many of these have not undergone environmental risk assessment and their impact on human health and environment is currently uncertain.

Worldwide municipal sites like shops or malls had the largest proportion of plastic rubbish items. Ocean soup swirling the debris of plastics trash in the Pacific Ocean has now grown to a size that is twice as large as the continental US. In 2006, 11.5 million of tons of plastics were wasted in the landfill. These types of disposal of the waste plastics release toxic gas; which has negative impact on environment.

Most plastics are non-biodegradable and they take long time to break down in landfill, estimated to be more than a century. Plastic waste also has a detrimental impact on wild life; plastic waste in the oceans is estimated to cause

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the death of more than a million seabirds and more than 100,000 marine mammals every year (UN Environmental Program Estimate).

With this hundreds of thousands of sea turtles, whales and other marine mammals die every year eating discarded waste plastic bags mistaken for food. Setting up intermediate treatment plants for waste plastic, such as: plastic incineration, recycle, or obtaining the landfill for reclamation is difficult.

The types of the waste plastics are LDPE, HDPE, PP, PS, PVC, PET, and etc. The problems of waste plastics can't be solved by land filling or incineration, because the safety deposits are expensive and incineration stimulates the growing emission of harmful green house gases, e.g CO<sub>x</sub>, NO<sub>x</sub>, SO<sub>x</sub> and etc.

## PYROLYSIS

Pyrolysis is generally defined as the controlled heating of a material in the absence of oxygen. In plastics pyrolysis, the macromolecular structures of polymers are broken down into smaller molecules and sometimes monomer units. Further degradation of these subsequent molecules depends on a number of different conditions including (and not limited to) temperature, residence time, presence of catalysts and other process conditions. The pyrolysis reaction can be carried out with or without the presence of catalyst. Accordingly, the reaction will be thermal and catalytic pyrolysis. Plastic waste is continuously treated in a cylindrical chamber. The plastic is pyrolysed at 300<sup>0</sup>C-500<sup>0</sup>C.

## FUEL DEMAND

The present rate of economic growth is unsustainable without saving of fossil energy like crude oil, natural gas or coal. International Energy Outlook 2010 reports the world consumption of liquid and petroleum products grows from 86.1 million barrels per day in 2007 to 92.1 million barrels per day in 2020 and 110.6 million barrels per day in 2035 and natural gas consumption increases from 108 trillion cubic feet in 2007 to 156 trillion cubic feet in 2035. This way, the oil and gas reserve available can meet only 43 and 167 years further. Thus mankind has to rely on the alternate/renewable energy sources like biomass, hydropower, geothermal energy, wind energy.

## II. RELATED WORK

According to KEWEN DU (2018) in science direct publication, Research on pyrolysis process for different types of plastic in the plastic waste stream has been carried out over the years, but only focusing on the effects of individual parameters such as the pyrolysis temperature (300K to 1000K), the type of catalyst (HZSM-5, HUSY, HMOR, Z-N, Silica-Alumina, Zeolite- Beta and SZ [38]), ratio of plastic to catalyst (100:1 to 10:1), and heating rate (5, 10 and 20K/min). The effect of temperature was also studied focusing on reactions pathways and product yields and distribution from PET pyrolysis .

According to S GANESAN (2017) in research gate publication, Research on waste plastics like polyethylene used for domestic and industry purpose are not recycled for about 43% of its volume. The performance of catalytic pyrolysis waste plastic oil as fuel in diesel engines have been reviewed and compared with thermal pyrolysis fuel. Catalytic pyrolysis with subsequent Hydro treating and hydro cracking can reduce unsaturated hydrocarbon bonds and thereby improve combustion performance in diesel engine.

According to SHARUDDIN et al (2016) in science direct publication, The alternative approaches for minimization of plastic waste and to reduce the plastic disposal to the landfill is effective energy recovery. The plastics are acquired from petrochemical source and, thus, can be converted to valuable energy having high calorific value that can be reused to compensate the overall energy requirement of the pyrolysis plant.

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### III. EXPERIMENTAL SETUP

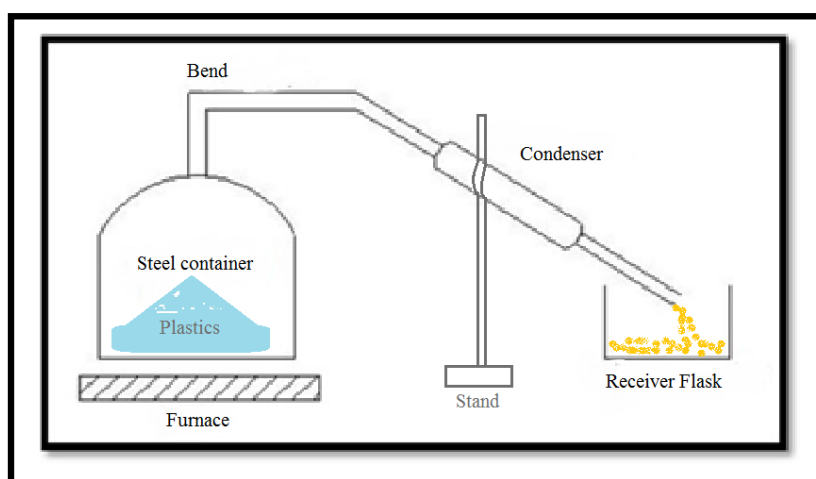


Fig -1 Schematic diagram of Experimental setup

#### Condenser

It cools the entire heated vapour coming out of the reactor. It has an inlet and an outlet for cold water to run through its outer area. This is used for cooling of the vapour. The gaseous hydrocarbons at a temperature of about 350°C are condensed to about 30 – 35°C.

#### Steel Container

It is a stainless steel cylindrical container of length 150mm, internal diameter 300mm, outer diameter 305mm sealed at one end and an outlet tube at the other end. The whole cylindrical container is placed inside the reactor. The external heating is carried out using the raw material viz., coal, wood, coke, etc., below the container and inside the reactor. The reactor is made with the following: stainless steel, mild steel and clay for lagging. The reactor is heated to a temperature of about 450°C and more.

### IV. EXPERIMENTAL PROCEDURE

The process involves heating the plastic to form liquid slurry (thermal liquefaction in the range 320°-400°C), distilling the slurry in with or without cracking catalyst, condensing the distillate to recover the liquid hydrocarbon fuel, and routing the remaining slurry residue back into fresh slurry to undergo another distillation/condensation process. No additional chemicals are used in the thermal liquefaction phase. The fuel is filtered using a commercial fuel filter that operates using coalescence and centrifugal force.

Small-scale conversion tests have been performed with the simplified process. On various waste plastic types: High density polyethylene (HDPE, code 2), Low density polyethylene (LDPE, code 4), Polypropylene (PP, code 5) and Polystyrene (PS, code 6). These plastic types were investigated singly and combination with other plastic types. In the

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laboratory scale process, the weight of a single batch of input plastic for the fuel production process ranges from 300 grams to 3 kilograms. The plastics are collected, optionally sorted, cleaned of contaminants, and cut or divided into small pieces prior to the thermal liquefaction process.

It should be noted here that WPPO process does not exclude the use of random mixtures of plastic types. Preliminary tests on the produced WPPO fuel have shown that it is a mixture of various hydrocarbons having a range of carbon chain lengths from C3 to C27. The produced WPPO fuel density has its typically 0.776 g./ml which is slightly higher than the density of commercial gasoline (0.711 – 0.770 g./ml) and lower than the density for kerosene (0.820 g./ml). The fuel is highly flammable and volatile, contains high heat capacity, and has been shown to successfully run a gas-powered generator, Diesel generator, a gas-powered lawn mower and an automobile. The filtered fuel obtained goes through another thermal distillation process. Early 40% of the distillate was collected. It was named “WPPO double condensed fuel 1<sup>st</sup> collection” or “WPPO-1”; another 50% was collected and named “WPPO Double condensed fuel 2nd collection” or “WPPO-2” and the last 10% remains in the double distillation boiling flask and it is termed “Residual Fuel” or “WPPO-3”. To obtain further refined grade, WPPO is working on using fractional distillation to separate the mixed waste plastic to individual category fuels. The fuels that will be obtained are; (a) Gasoline, (b) Naphtha, (c) Aviation or Jet fuel (Kerosene), (d) Diesel fuel, and (e) Fuel oil.

### V. RESULT AND DISCUSSION

**TABLE -1:** COMPARISON OF OBTAINED WPPO-FUEL WITH REGULAR PETROL AND DIESEL

Sl. No.	Properties	Regular Petrol	Regular Diesel	WPPO-Fuel
1.	Specific Gravity	0.67	0.79	0.75
2.	Density (Kg/m <sup>3</sup> )	742	850	775
3.	Gross Calorific Value (KJ/Kg)	46858	42000	42686
4.	Flash Point ( °C)	23	50	40
5.	Fire Point ( °C)	29	56	49

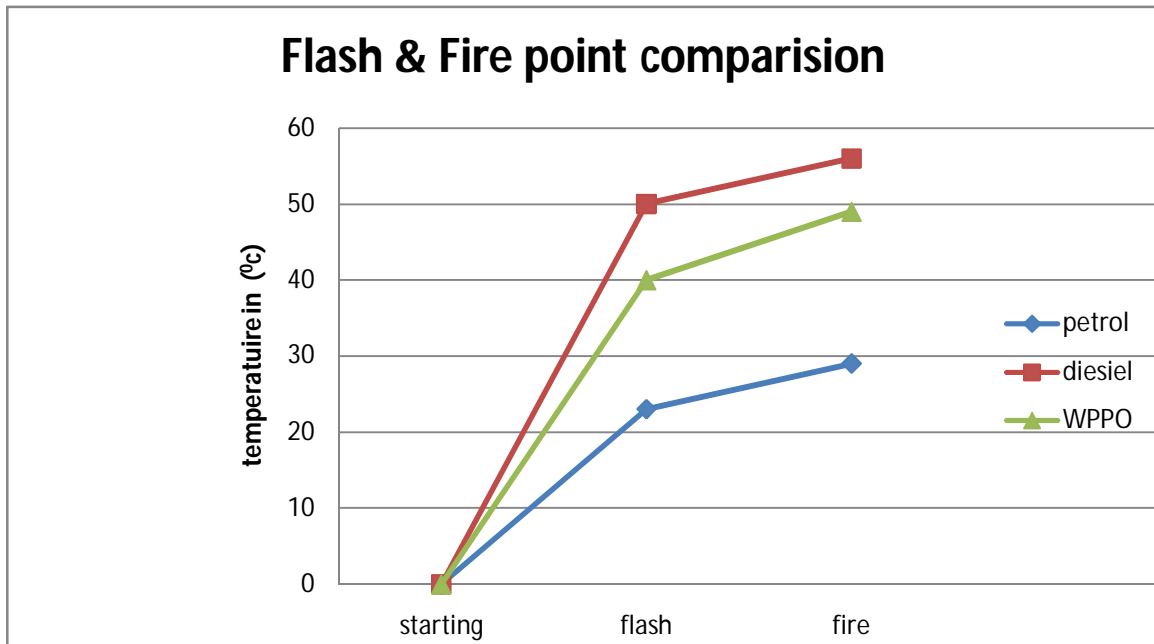
The above table-1 shows the comparison of the results obtained from the test, among the regular petrol, diesel and WPPO fuel, the diesel has the highest density, the comparison between the regular petrol, diesel and WPPO fuel, the regular petrol has highest calorific value. Thus we have found that WPPO fuel has the nearest value of regular diesel.

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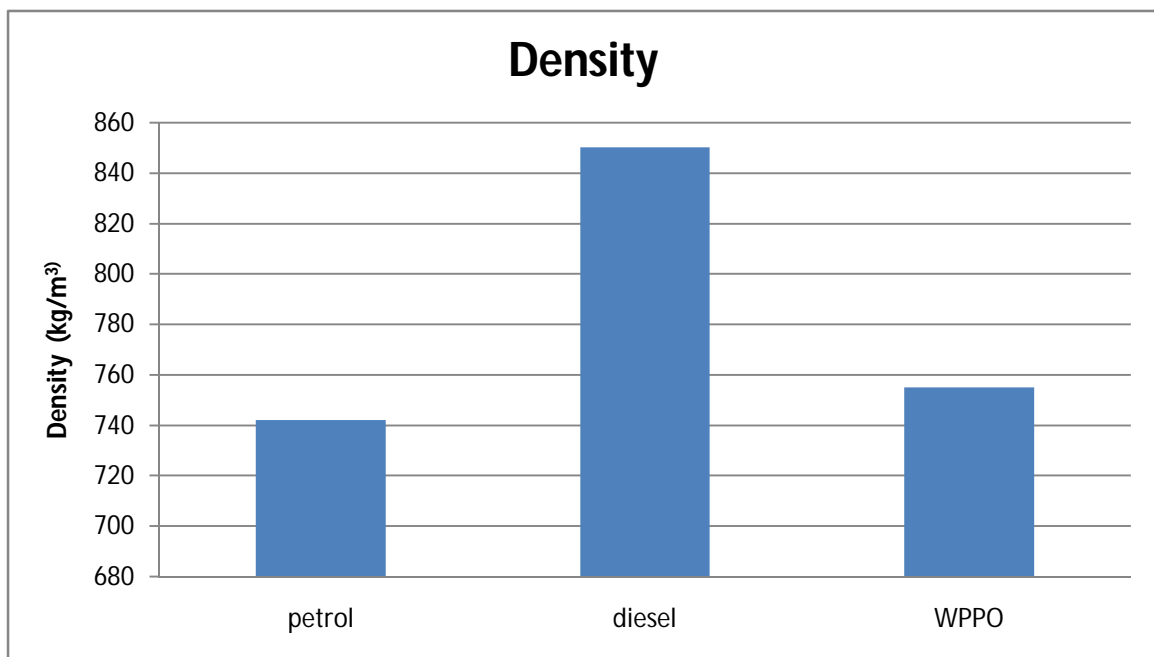
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GRAPH -1

The above graph-1 shows the flash and fire point of regular petrol, regular diesel and WPPO fuel. From this the flash and fire point of WPPO fuel has the nearest value of regular diesel. In WPPO fuel we acquired the flash point at 40°C and fire point at 49°C.



GRAPH-2

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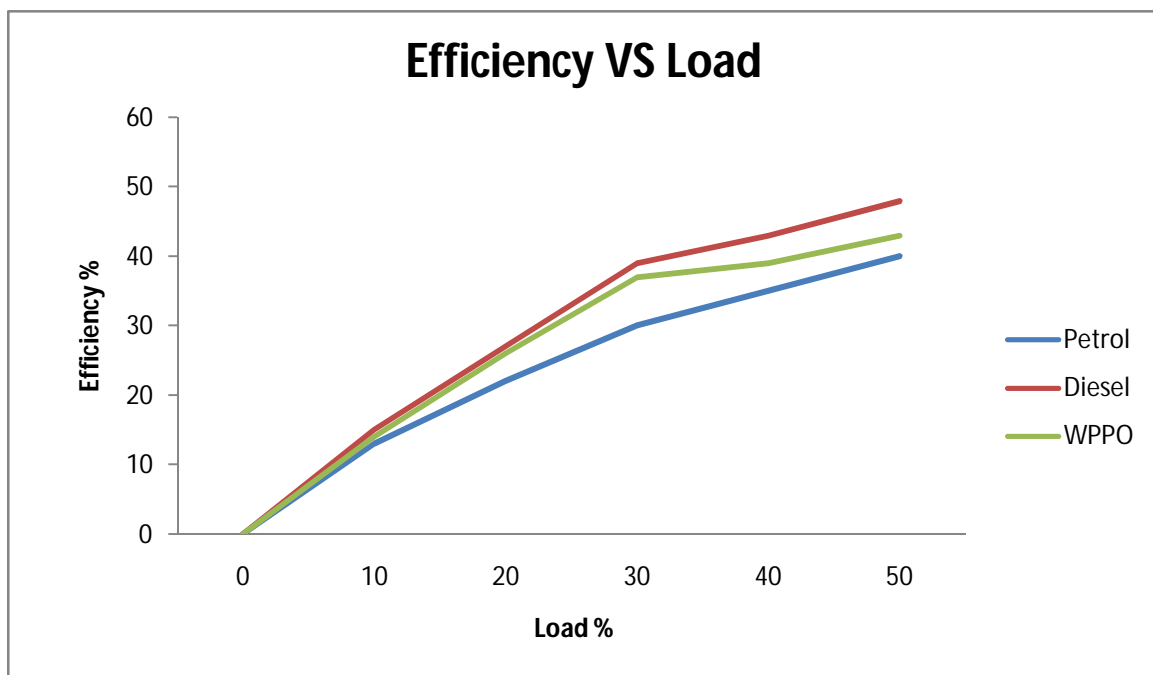
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The density is an important property of a fuel oil. If the density is high, the fuel consumption is less. It shows in the graph 2 the density of WPPO fuel were found to be  $775 \text{ kg/m}^3$  respectively which is close to be density of regular diesel and petrol. So the conventional fuels such as diesel, petrol may be replaced by WPPO oil.

**TABLE -2: EFFICIENCY COMPARISION OF WPPO-FUEL WITH REGULAR FUEL**

Load in percentage (%)	Efficiency in percentage (%)		
	Petrol	Diesel	WPPO
10	13	15	12
20	22	27	24
30	30	39	34
40	35	43	39
50	40	48	43



**GRAPH-3**

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### VI. CONCLUSION

A simple thermal process for de-polymerizing waste plastic to useful transportation fuel has been developed and further refined using a laboratory scale screw condensation process and fractional distillation process. It's right time to implement these fuel for the upcoming generation.

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