

A REVIEW PAPER ON EXTRACTION OF FUEL FROM WASTE PLASTIC BY PYROLYSIS.

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Abstract: Plastics are an integral part of our modern life and are used in almost all daily activities. Since plastics are synthesized from non-renewable sources and are generally not biodegradable, waste plastics are the cause of many of the serious environmental problems the world faces today. Due to depletion of fossil fuel reserves and increasing cost of the petroleum products are the big troubles of today's world. From past to present, tendency of oil price have increased consecutively, Especially in India has deficient amount of fossil fuel. For this reason, India has to import fossil fuel, such as petroleum for domestic demand the waste can then be converted into hydrocarbon fuel either in the collection vessel itself or in off-shore facilities, using established technology.

Keywords- Waste plastic, fuel, diesel oil, petrol oil, and pyrolysis.

I. INTRODUCTION:

The growth of the plastic consumption has been occurring rapidly in the last six decades due to their ability to be simply formed, its light weight and non-corrosive behaviour. These excellent properties have been used to replace the use of wood and metals. The world's annual plastic consumption has increased about 20 times from 5 million tons in 1950s to nearly 100 million tons [1]. This implies that more resources are being used to meet the increased demand of plastic, and on the other hand, more plastic waste is being generated. Plastics have been accepted as essential material for both in households and industrial activities due to their durability, higher load carrying capacity, less expenditure and availability. Based on their properties various types of plastic are used distinctly in specific purposes, such as packaging, material carrying, as a replacement of many mechanical components previously manufactured with metals, etc. Since plastic polymers originated from the petroleum resources, the possible technologies of converting them into fuel have been brought into attention to meet the future fuel demand to reduce the continuing fuel import demand in various countries [3].

However one has to accept that virtues and vices co-exist. Plastics are relatively cheaper and being easily available has brought about use and throwaway culture. Plastics waste management has become a problem world over because of their non-degradable property. A majority of landfills, allotted for plastic waste disposal, are approaching their full capacity. Thus recycling is becoming increasingly necessary.

Consumption of drinking water in packages increases and almost all its packaging is made from plastics. There are six plastics categories in the world: High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Polypropylene (PP), Polyvinyl Chloride (PVC), Polystyrene (PS) and Polyethylene Terephthalate (PET). Drinking water packaging is included in Polyethylene Terephthalate (PET). Plastic is made from petroleum derivatives and considered to be difficult to parse and to be a pollutant (air, land and water). This phenomenon will become a potential problem in the future. On the other hand, the amount of fuel decreases and a solution is needed to overcome this condition. Plastic is a potential ingredient to be converted into fuel by a pyrolysis process [4].

Pyrolysis process is burning of product in absence of oxygen, In this case it is waste plastic. The waste plastic is shattered into small particles and burned in a closed container without oxygen. Different fuel density is produced in different temperatures and with suitable catalyst it could give results similar to that of Diesel or Gasoline.

II. WORKING PRINCIPLE:

There are many methods to extract fuel from waste plastic but the most commonly preferred is Pyrolysis process. It is an easy process which provides more effective results compared to other methods. The process extraction of fuel from waste plastic is divided into three stages which are as follows.

- Cleaning and Shredding.
- Pyrolysis Process.
- Distillation.

The basic plastic waste preferred for Pyrolysis is Polyethylene Terephthalate (PET) bottles or Polyethylene (PE) bags which are cleaned and shredded into small pieces. This helps to easily melt the plastic and to form hydro-carbons in the form of liquid state or gaseous state depending on the output required [2].

The second and the important step among them is the Pyrolysis process. This process requires a setup with some equipment's, the equipment's required are as follows,

- A metal container.
- A condenser.
- A vessel to store the fuel.

The metal container which will be used should withstand high temperature as the pyrolysis process starts at 450°C [4]. The metal container should be provided with suitable heat source, the heat source should be good enough to attend high temperature in very short time as all the above conditions are satisfied, the cleaned and shredded plastic waste are transferred inside the container for further process.

As the Cleaned and Shredded plastic waste is transferred into the container, the container is then heated by the preferable source of heat in the absence of oxygen. When the waste plastic is burnt in the absence of oxygen it will not catch fire, instead it will burn and forms gaseous state. From the container the gaseous fuel is then sent to condenser to cool down the temperature, when the temperature cools down the gaseous state changes to liquid state which is partial fuel.

After the extraction of partial fuel from waste plastic the fuel is then sent to the container where distillation process takes place. Distillation process is done because the partial fuel which we get after pyrolysis process does not have similar properties as Diesel or Gasoline, to get the properties of the fuel approximate similar to Diesel or Gasoline this process is done. In this process the partial fuel which we get again undergoes heating at lower temperature compared to pyrolysis process [5].

At last the fuel produced from the container after distillation process is contained in a Vessel for storage. This vessel can be of any material.

III. COMPARISON OF WASTE PLASTIC FUEL WITH PETROL AND DIESEL.

- Following table is the comparison of Petrol and Waste Plastic Fuel [6].

Sl.No	Specifications	Regular Petrol	Waste Plastic Fuel
1.	Specific Gravity at 28°C	0.7423	0.7254
2.	Specific Gravity at 15°C	0.7528	0.7365
3.	Gross Calorific Value	11210	11262
4.	Net Calorific Value	10460	10498
5.	API Gravity	50.46	60.65
6.	Aniline Point in °C	48	28
7.	Aniline Point in °F	118.4	82.4
8.	Flash Point	23	22
9.	Pour Point	< -20 °C	< -20 °C
10.	Cloud Point	< -20 °C	< -20 °C
11.	Octane Rating	83	95
12.	Mileage	44.4	44.0
13.	Time for 0-60 kph	22.5 sec	18.1 sec
14.	Co % at 400 rpm/hc	2.8	3.5
15.	Comments on Engine Noise	More	Less

- Following table is the comparison of Diesel and Waste Plastic [11].

Sl. No	Property	PPO700	PPO900	Diesel
1.	Density@ 15°C (kg/l)	0.927	0.9813	0.8398
2.	Kinematic Viscosity@ 40 °C	2.9	1.918	2.62
3.	Aromatic Content (%)	53	65.5	29.5
4.	Acid Number (mg KOH/g)	47.3	41	0
5.	LHV (MJ/Kg)	38.2	38.3	42.9
6.	Ash Content (wt. %)	<0.001	0.166	<0.001
7.	Hydrogen Content (wt. %)	9.8	8.5	13.38
8.	Carbon Content (wt. %)	84.6	87.9	86.57
9.	Oxygen Content (wt. %)	5.3	3.3	0.05

PPO700 is Polypropylene Pyrolysed Oil at 700°C.

PPO900 is Polypropylene Pyrolysed Oil at 900°C

IV. APPLICATION:

- The obtained fuel could be utilized in diesel generators, vehicles such as tractors and also passenger vehicles such as cars.
- The fuel has to be refined at the industrial establishments, based on the results of which small scale industry can be established.
- As there is a high demand of crude oil and due to its sky reaching prices, we could take up this project to setup large or small scale industries and produce the fuel locally at much cheaper rates directly benefiting the National economy and also a step towards SWAACH BHARAT by recycling the waste plastic.

- The application of this project could help in reducing the dependency on the gulf countries and promote a step towards innovation.
- It could also be useful for household purposes, like LPG it could also be liquefied into gas and can be used with some catalyst or blending.

V. CONCLUSION:

Plastics present a major threat to today's society and environment. Over 14 million tons of plastics are dumped into the oceans annually, killing about 1,000,000 species of oceanic life. Though mankind has awoken to this threat and responded with developments in creating degradable bio-plastics, there is still no conclusive effort done to repair the damage already caused. In this regard, the catalytic pyrolysis studied here presents an efficient, clean and very effective means of removing the debris that we have left behind over the last several decades.

It is very difficult to find out alternative of plastic. Even plastic's demand is increasing every day as well as their waste. This project analysis has observed the use of waste plastics, a factory planning and its feasibility in Metropolitan City. It is easily assumed that, when the use of waste plastic will increase then the solid waste management will search more ways to find out to collect them. The implementation of this project can develop so many opportunities in the city. It can be a solution to control waste plastic, develop a new technique or idea, and detect the source of diesel for the country. India is such a country where this kind of project could be very promising and effective in the future.

The use of plastic pyrolysis oil in diesel engine in the aspect of technical and economical is compared and found that oil is able to replace the diesel oil. Though the plastic pyrolysis oil offers lower engine performance, the plastic waste amount is enormous and it needed to be process to reduce the environmental problems. Moreover, the engine can be modify follow the combustion condition of plastic pyrolysis oil. The waste plastic used in the process must be PE or PET in order to protect the contamination of chlorine in the oil.

By converting plastics to fuel, we solve two issues, one of the large plastic seas, and the other of the fuel shortage. This dual benefit, though will exist only as long as the waste plastics last, but will surely provide a strong platform for us to build on a sustainable, clean and green future. By taking into account the financial benefits of such a project, it would be a great boon to our economy.

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