PETROL FROM WASTE PLASTIC

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ABSTRACT

Plastics are non biodegradable polymers mostly containing carbon, hydrogen and few other elements such as chlorine, nitrogen, etc. Due to its non-biodegradable nature, the plastic waste contributes significantly to the problem of municipal waste management. Waste plastics are mostly land filled or incinerated however, these methods are facing great social resistance because of environmental problems such as air pollution and soil contamination, as well as economical resistance due to their increase of space and disposal costs. In long term neither the land filling nor the incineration solve the problem of wastes, hence recycling has become an important issue worldwide. Plastic recycling covers a wide range of different methods like material recycling, chemical recycling, energy recycling. A pyrolysis of waste plastic has been carried out in presence of hydrocarbon liquid bed without catalyst. At 300 – 400°C all waste plastic undergoes decomposition and get converted to fuel which get recovered with liquid bed. The petrol, liquid bed and diesel fractions were separated during recovery section itself. This technique able to convert 100 gm waste plastic into more than 100 ml liquid fuel (56.1 ml petrol and 45.9 ml diesel). Again in this, no use of any catalyst or acid-base system. It requires less decomposition temperature than the common pyrolysis technique and recovered liquid bed can be used again and again. Hence this liquid bed technique is efficient, economical and eco-friendly.

Key Words: Plastic waste, Environment plastic waste, Recycling of plastic waste, Fuel from plastic waste, Petrol from plastic waste

INTRODUCTION

Plastics play an important role in almost every aspect of our lives. Plastics are used to manufacture everyday products such as beverage containers, toys and furniture. The most widespread use of plastics demands proper end of life management. Plastics make up almost 13 percent of the Municipal Solid Waste (MSW) stream, a dramatic increase from 1960, when plastics were less than one percent of the waste stream. The largest category of plastics are found is containers and packaging (e.g. soft drink bottles, lids, shampoo bottles) but they also are found in durable (e.g., appliances, furniture) and non-durable goods (e.g., diapers, trash bags, cups and utensils, medical devices). 32 million tons of plastic wastes were generated in 2011, representing 12.7 percent of total MSW. Annually approximately 500 billion plastic bags are used worldwide. More than one million bags are used every minute.1,2 Types of waste

Throughout the region, the principal sources of solid waste are residential households and the agricultural, commercial, construction, industrial and institutional sectors. For the purposes of this review these sources are defined as giving rise to four major categories of waste municipal solid waste, industrial solid waste, biomedical waste and hazardous waste.1 Detailed classification of plastic waste given in Table 1.2

Effect of waste plastic on environment and human health

According to the International Plastics Task Force, plastic wastes can break down and release toxins that harm the environment, animals and the general public. Certain chemicals such as biphenyl A can cause some serious health concerns. Even low doses of biphenyl may cause developmental problems in children. Following are some common examples showing effect of waste plastic on the environment.3,5 Littering of the landfills plastic garbage becomes
Littering of plastic bags causes blocking of the cities, municipalities sewerage systems, leads to spreading of water borne diseases. Death of animals due to improper disposal of plastic food bags that are eaten by animals. Soil fertility is affected by plastic material and also decreases due to manure remaining in the soil for years without natural degradation.

Plastic particles in the oceans attract toxins. These enter the food chain, we are at the top of that food chain. Two broad classes of plastic-related chemicals are of critical concern for human health-biphenyl-A or BPA and additives used in the synthesis of plastics, which are known as phthalates. BPA is a common synthetic chemical found in plastics, foods can linings, beverage can linings and other consumer products, which interferes with human hormones.

Phthalates is a chemical used to soften plastics, to carry fragrance and scent and used in other everyday products, have been linked to birth defects and are harmful to reproductive systems.

### Table 1: Classification of plastic waste

<table>
<thead>
<tr>
<th>Plastic identification code</th>
<th>Type of plastic waste</th>
<th>Common applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PET</td>
<td>Polyethylene terephthalate, E.g. Bottles, Films</td>
</tr>
<tr>
<td>2</td>
<td>HDPE</td>
<td>High density polyethylene, E.g. Packaging, Detergent, Shopping bags</td>
</tr>
<tr>
<td>3</td>
<td>PVC</td>
<td>Polyvinyl chloride, E.g. Water pipes, Curtains, Credit card, Packaging films, Water films</td>
</tr>
<tr>
<td>4</td>
<td>LDPE</td>
<td>Low density polyethylene, E.g. Plastic bags, Wire cloth</td>
</tr>
<tr>
<td>5</td>
<td>PP</td>
<td>Polypropylene, E.g. Plastic bag and toy</td>
</tr>
<tr>
<td>6</td>
<td>PS</td>
<td>Polystyrene, E.g. Disposable cups and plates, Fast food boxes</td>
</tr>
<tr>
<td>7</td>
<td>Other</td>
<td>Acrylonitrile Butadiene Styrene, High Impact Polystyrene, General purpose Polystyrene, Polyamide, Polycarbonate etc.</td>
</tr>
</tbody>
</table>

**Recycling of waste plastics**

Recycling of waste plastics is desirable because it avoids their accumulation in landfills. While plastics constitute only about 8 percent by weight or 20 percent by volume of municipal solid waste their low density and slowness to decompose makes them a visible pollutant of public concern. It is evident that the success of recycling is limited by the development of successful strategies for collection and separation. Recycling of scrap plastics by manufacturers has been highly successful and has proven economical but recovering discarded plastics from consumers is more difficult. Following are the plastic recycling processes.

**a) Plastic process scrap recycling**

Currently most plastic recycling of the developed countries are of process scrap from industry, i.e. polymers left over from the production of plastics. This is relatively simple and economical to recycle, as there is a regular and reliable source and the material is relatively uncontaminated. This is usually described as reprocessing rather than recycling.
b) Post-use plastic recycling
Post-use plastic can be described as plastic material arising from products that have undergone a first full service life prior to being recovered. Households are the biggest source of plastic waste, but recycling household plastics presents a number of challenges. One of these relates to collection.\(^3\)

c) Mechanical recycling
Mechanical recycling of plastics refers to processes which involve the melting, shredding or granulation of waste plastics. Plastics must be sorted prior to mechanical recycling. Mostly, sorting is done manually. Recently, technology is being introduced to sort plastics automatically, using various techniques such as X-ray fluorescence, infrared and near infrared spectroscopy, electrostatics and flotation. Following sorting, the plastic is either melted down directly and moulded into a new shape or melted down after being shredded into flakes and then processed into granules called re-granulate.\(^3\)

d) Chemical or feedstock recycling
Feedstock recycling describes a range of plastic recovery techniques to make plastics, which break down polymers into their constituent monomers, which in turn can be used again in refineries or petrochemical and chemical production. A range of feedstock recycling technologies is currently being explored. These include\(^3\) are i) Pyrolysis, ii) Hydrogenation, iii) Gasification and iv) Thermal cracking. Feedstock recycling has a greater flexibility over composition and is more tolerant to impurities than mechanical recycling, although it is capital intensive and requires very large quantities of used plastic for reprocessing to be economically viable.\(^9\)-\(^11\)

AIMS AND OBJECTIVES
To convert waste plastic into useful fuel mainly petrol. But the technique adopted should be eco-friendly, economical and efficient. For this a liquid bed technique was adopted.

MATERIAL AND METHODS
In order to obtain fuel from plastic waste liquid bed technique was used. The experimental technique adopted for this are as follows:

(Fig. 1)
1. Selection of plastic waste i.e. feed
2. Selection of liquid bed
3. Selection of reactor.
4. Selection of operating conditions.
5. Decomposition of waste plastic by using liquid bed.
6. Fractionation of product and liquid.
7. Characterization of products and liquid bed.

![Fig. 1 : Experimental setup](image-url)
The actual diagram of reactor assembly adopted for research work is as shown in Fig. 1. In this research, 3 stage condenser is adopted.

To obtain liquid fuel from polystyrene waste following operating parameter are adopted:

- Room temperature = 39°C
- Type of reactor = Glass reactor
- Capacity of reactor = 250ml
- Feed used = waste polystyrene
- Weight of feed used = 100 gm
- Volume of kerosene (200-250°C) = 100 ml
- To avoid bumping, = Silica piece material used
- Heating device = Electrical heater with 2KW coil
- Temperature = Dimmerstate controlling device
- Dimmerstate reading = 160 – 240V
- Reaction temperature, for dissociation = 380 – 390°C
- Maximum temperature of feed attained = 410°C
- Reaction temperature of feed at which first drop of liquid condensate obtained = 328°C
- Time required to reach first of condensate = More than 28 minutes drop
- Total time required for feed dissociation to obtain complete product = 93 minutes

Quantity of liquid product obtained (by fraction at reaction side)

- Petrol = 56.1 ml
- Liquid bed = 102 ml
- Diesel = 45.9 ml

Quantity of residue obtained = 7.1325 ml

Total yield = Total liquid + Residue

Total losses = Gaseous products in traces

Results and Discussion

Result of various test carried for the feed liquid bed and products obtained are as shown in Table 2.

From above observation, it is clear that the waste plastic able to give the liquid product which can fractionated into petrol, recover kerosene bed and diesel. Here the fractionated was carried out by using ASTM distillation. The fraction with boiling point up to 200°C is known as petrol. The fraction with boiling range 200 – 250°C is known as liquid bed and the fraction with boiling point range above 250°C is known as diesel.

The specific gravity of petrol is 0.8571, which quite higher the specific gravity of actual petrol (which is less than 0.82). But when aniline point was check it was 1.5°C that is very low. Indicating that the petrol consist of high percentage of aromatic hydrocarbon which having high specific gravity. Hence increasing the specific gravity of petrol product. The recover bed shows slightly increase in the specific gravity than the feed bed. Similarly recover bed have low value of Aniline point indicate that the liquid bed recover associated with some aromatic hydrocarbon obtain from decomposition of plastic waste.

The specific gravity of diesel product is also higher than the actual diesel (actual diesel have specific gravity between 0.82 – 0.87). Aniline point for product diesel is low. This indicates that in diesel fraction aromatic hydrocarbon are present in high quantity. Thus above discussion indicates that decomposition product is of petrol, kerosene and diesel range. But it gives more aromatic type hydrocarbon. In order to known how much quantity and type of aromatic hydrocarbon and other hydrocarbon obtained from decomposition of waste plastic, further analysis product has to be carried out by using HPLC and IR spectroscopy.

CCR of all product is very below prescribe norm that is less than 1% by weight of feed but nature of CCR is somewhat sticky, indicating product consist of aromatic type hydrocarbon.

Flash point value is quite higher than the actual kerosene and diesel. This is due to the boiling point range. Actually flash point is related to
lower hydrocarbon (that is, IBP to 10% range hydrocarbon). Here kerosene and diesel taken as higher range (Kerosene 200 – 250°C) and diesel more than 250°C.

Table 2: Feed liquid bed and products

<table>
<thead>
<tr>
<th>S/N</th>
<th>Properties</th>
<th>Feed liquid bed</th>
<th>Petrol</th>
<th>Product liquid bed</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific gravity, at 38°C</td>
<td>0.7928</td>
<td>0.7571</td>
<td>0.8076</td>
<td>0.8711</td>
</tr>
<tr>
<td>2</td>
<td>API gravity</td>
<td>47</td>
<td>33.59</td>
<td>43.979</td>
<td>18.8479</td>
</tr>
<tr>
<td>3</td>
<td>Viscosity, CST (40°C)</td>
<td>2.3509</td>
<td>1.0658</td>
<td>2.3209</td>
<td>3.99747</td>
</tr>
<tr>
<td>4</td>
<td>Aniline point, °C</td>
<td>63°C</td>
<td>below 1.5°C</td>
<td>54°C</td>
<td>31°C</td>
</tr>
<tr>
<td>5</td>
<td>Flash point, °C</td>
<td>72°C</td>
<td>---</td>
<td>72°C</td>
<td>108°C</td>
</tr>
<tr>
<td>6</td>
<td>Conradson carbon residue, wt%</td>
<td>0.0059</td>
<td>0.01614</td>
<td>0.02288</td>
<td>0.0187</td>
</tr>
<tr>
<td>7</td>
<td>Refractive index, at 27°C</td>
<td>1.4591</td>
<td>1.4403</td>
<td>1.4582</td>
<td>1.5376</td>
</tr>
<tr>
<td>8</td>
<td>ASTM distillation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IPB °C</td>
<td>190</td>
<td>45</td>
<td>192</td>
<td>251</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>200</td>
<td>98</td>
<td>200</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>208</td>
<td>124</td>
<td>211</td>
<td>274</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>216</td>
<td>159</td>
<td>220</td>
<td>296</td>
</tr>
<tr>
<td></td>
<td>90%</td>
<td>245</td>
<td>209</td>
<td>250</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>FBP °C</td>
<td>256</td>
<td>215</td>
<td>253</td>
<td>365</td>
</tr>
<tr>
<td>9</td>
<td>Moisture content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Density %</td>
<td>0.7788</td>
<td>0.8406</td>
<td>0.79086</td>
<td>0.92306</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.019260</td>
<td>0.03028</td>
<td>0.01494</td>
<td>0.02412</td>
</tr>
<tr>
<td></td>
<td>Ppm</td>
<td>192.6040</td>
<td>302.79</td>
<td>149.43</td>
<td>241.29</td>
</tr>
<tr>
<td></td>
<td>Mg of H₂O</td>
<td>1.5000</td>
<td>2.5454</td>
<td>1.1818</td>
<td>2.227</td>
</tr>
<tr>
<td>10</td>
<td>Copper strip corrosion, at 50°C</td>
<td>Not worse than no. 1</td>
<td>Not worse than no. 1</td>
<td>Not worse than no. 1</td>
<td>Not worse than no. 1</td>
</tr>
</tbody>
</table>

Hence there is higher value of flash point. For kerosene and diesel. The ASTM rang of petrol recover kerosene and diesel are as required i.e. kerosene 200-250°C diesel 250°C and onward and petrol is well below 200°C. Water contain was determine by using Karl-Fisher auto titrated and it is quite less than 1000 ppm. Indicating that decomposition is not form water as product in traces. Refractive index is also at higher site than the prescribed norm for fuel, it is due to association of aromatic type hydrocarbon with product. As aromatic hydrocarbon having higher refractive Index.

**CONCLUSION**

From this research work, it is clear that the waste plastic able to give the high amount of liquid product by using liquid bed which can be fractionated into petrol, recover kerosene bed and diesel. Use of liquid bed carries out the decomposition of plastic waste at lower temperature (it started from 300°C). Literature survey indicates the thermal decomposition temperature for plastic waste is always more than 380°C. Use of liquid bed for decomposition gives high yield, 100 gm plastic waste give more than 100 ml liquid product and the residual product obtained is in less quantity.

**REFERENCES**

4. Sharma Suman and Manepatil Smita, Quantitative evaluation of environmental


