CHAPTER 3

PRODUCTION OF POLYMER OIL

3.1 GENERAL

Waste plastics are a standout amongst the most guaranteeing assets for fuel generation, as a result of its high heat of combustion and because of the expanding accessibility in the local communities. Unlike paper and wood, plastics don't retain much dampness and the water substance of plastics is far lower than the water substance of biomass, for example, crops and kitchen wastes. The conversion methods for waste plastics into fuel rely on upon the sorts of plastics to be focused on and the properties of different wastes that may be utilized as a part of the procedure. Additionally, the effective alternation needs exact methodologies to be selected in accord to the local economic, environmental, social and technical characteristics.

The change of plastic waste into fuel requires feedstocks which are harmless and combustible. In particular, each sort of plastic waste conversion method has its own suitable feedstock. The composition of the plastics used as feedstock may be extremely different and some plastic articles might contain unwanted substances (e.g. additives such as flame-retardants containing bromine and antimony compounds or plastics containing nitrogen, halogens, sulfur or any other hazardous substances) which pretend potential risks to humans and to the environment.

The sorts of plastics and their composition will condition the conversion process and will determine the pretreatment requirements, the
burning temperature for the conversion and therefore the energy consumption required, the fuel quality output, the flue gas composition (e.g. formation of hazardous flue gases such as NO\textsubscript{x} and HC), the fly ash and bottom ash composition, and the potential of chemical corrosion of the equipment.

3.2 PYROLYSIS OF WASTE PLASTIC TO POLYMER OIL


In our experiments, commercially available shredded plastics were procured (Figure 3.1) and washed before pyrolysis. One of the most favorable and effective disposing method is pyrolysis, which is environmental friendly and efficient way. Pyrolysis is the thermal degradation of solid wastes at high temperatures (275°C–375°C) in the absence of air (and oxygen), as the structure of products and their yields can be considerably modified by catalysts. Pyrolysis of waste plastics was carried out in an indigenously designed and fabricated reactor. Flow chart 3.2 shows the scheme of the process involved in the experiments.
Figure 3.1 Procured shredded plastics

Firstly, the waste plastic is encouraged into the feed system. There may be varieties in the feeding strategies utilized relying upon the characteristics of the waste plastic. The simplest path is to just bring the waste plastics into the reactor without any pretreatment. Soft plastics, for example, movies and packs are frequently treated with a shredder and a melter or hot melt extruder in order to feed them into the reactor because otherwise they would occupy a large volume of the reactor. The feed framework consisting of measuring components for sizing thin, thick and hard materials, which regularly constitute the municipal waste stream. Feed system basically comprises of crusher, cutter and shredder.

The various size and shape of the material (mixed plastic) are sorted into categories suitable for cutting, shredding and crushing. The sorted material was cut or crushed and graded into uniform size for ease of handling and melting. This process of grading and sizing the waste is semi-automatic. The sorted feedstock of known composition was stored separately for proportionate feeding for processing non-standard feed design or processing special feed design. The dust and other fine waste is collected from the cyclone filter are disposed through a vent with particle size monitoring system. The assorted waste plastic was fed into a reactor and maintained at a
temperature of 275°C to 375°C. Thermocouples are mounted on the inside wall of the reactor to monitor the temperature during the experiments.

![Flowchart](image)

**Figure 3.2 Flow chart for preparation of polymer oil**

There are also diverse sorts of reactors and heating equipment. Both kiln sort and screw-sort reactors have been proposed, while instigation heating by the electric force has been created as an option to utilizing a burner. Pyrolysis is completed in the reactor. Depending upon the pyrolysis conditions and the sort of plastic utilized, carbonous matter inclines its growth as a store on the inward surface of the reactor. After pyrolysis, this store ought to be expelled from the reactor so as to keep up heat conduction efficiency of the reactor. The evaporated oil is further cracked with catalyst (silica), in the reactor 10g of plastic is mixed with 1g of catalyst. The subsequent oil mixture of liquid hydrocarbons is ceaselessly refined, once the waste plastics inside the reactor are disintegrated to such a degree as to vanish after arriving at the
reaction temperature. The vaporous items coming about because of the pyrolysis of the plastic waste is consolidated in a water cooled condenser to the liquid oil (Figure 3.3) and gathered for tests.

![Figure 3.3 Photograph view of the polymer oil](image)

**Figure 3.3 Photographic view of the polymer oil**

3.3 OPERATING FEATURES OF CONVERSION OF WASTE PLASTIC TO POLYMER OIL

The process is safe, efficient, easy to operate and highly economical.

3.3.1 Safety

The process operates slightly above ambient pressure

3.3.2 Maintenance

Coking happens in the chamber when the pyrolysis of the waste plastics is just about to complete. However, the methodology is intended to minimize coking by settling hotness conductivity inside the pyrolysis chamber. The chamber obliges general cleaning with the burn being evacuated consequently by the inherent cleaning framework. Contingent upon defilement levels, the cleaning framework may run every day or less frequently.
3.3.3 **Pre-Treatment**

Info feedstock plastics may oblige washing or sorting to diminish the level of contaminants to underneath 10%, or to lessen the occurrence of unsuitable plastics to adequate levels. In all circumstances, the plastics must be brought into the principle chamber as a 12-15 mm flake.

3.3.4 **Pollution**

The procedure creates amazingly low level of outflows because of both fluids and gasses, inside the framework.

3.3.5 **Noise or Vibration**

The framework doesn’t possess many moving parts and as needs be there is no unreasonable clamor or vibration.

3.3.6 **Foreign Contaminants**

Foreign matters, for example, soil, sand, papers and natural materials are regularly discipled contaminants joined to the waste plastics. This framework is intended to adapt to these foreign materials.

3.3.7 **Off Gas**

Pyrolysis of plastics has a tendency to happen on sporadic premise subsequently the carbon chain lengths of the pyrolytic gasses, change between 1 and 25. A large portion of the gas is melted in the condensers yet a few gas stays uncondensed. Hydrocarbons with carbon number of 4 and lower stay as a gas under room temperature. This off-gas contains methane, ethane, propane, butane and so forth. In spite of the fact that volume of the gas separates relying on the sorts of the plastics, it is for the most part only 2-5%.
The offgas is dealt with, and then come back to the principle heater as an extra heat source with the negligible emanations to the environment.

3.4 PROPERTIES OF POLYMER OIL

The properties of the oil derived from waste plastics were analyzed and compared with the diesel fuel as shown in the table 3.1 and 3.2

Table 3.1 Properties of polymer oil

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard test methods</th>
<th>Polymer oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross calorific value (kJ/kg)</td>
<td>ASTM D240</td>
<td>45,216</td>
</tr>
<tr>
<td>Density @ 30°C in (g/cc)</td>
<td>ASTM D1298</td>
<td>0.7949</td>
</tr>
<tr>
<td>Kinematic viscosity, cst @ 40°C</td>
<td>ASTM D445</td>
<td>2.85</td>
</tr>
<tr>
<td>Cetane number</td>
<td>ASTM D613</td>
<td>51</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>ASTM D92</td>
<td>41</td>
</tr>
<tr>
<td>Fire point (°C)</td>
<td>ASTM D92</td>
<td>43</td>
</tr>
</tbody>
</table>

Table 3.2 Properties of diesel and polymer oil

<table>
<thead>
<tr>
<th>Property</th>
<th>Diesel Mani et al (2009a)</th>
<th>Polymer oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross calorific value (kJ/kg)</td>
<td>46,500</td>
<td>45,216</td>
</tr>
<tr>
<td>Density @ 30°C in (g/cc)</td>
<td>0.840</td>
<td>0.7949</td>
</tr>
<tr>
<td>Kinematic viscosity,cst @ 40°C</td>
<td>2.0</td>
<td>2.85</td>
</tr>
<tr>
<td>Cetane number</td>
<td>55</td>
<td>51</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>50</td>
<td>41</td>
</tr>
<tr>
<td>Fire point (°C)</td>
<td>56</td>
<td>43</td>
</tr>
<tr>
<td>Oxygen content (wt. %)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

From the comparison result shows the polymer oil properties are almost similar to the diesel fuel, which can easily run in diesel engine without any engine modification.