

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

## Waste Plastic Fuel used in Petrol Engine

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**ABSTRACT:** By subjecting plastic trash to pyrolysis in the presence of a catalyst, it is possible to produce a fuel with similar properties to petroleum. In the absence of oxygen and with the aid of a suitable catalyst, polymeric chains can be broken down to their component monomers. Most of the discarded plastics that are LDPE (Low Density Polyethylene). Using various catalysts, the experiment involves creating oil samples from plastic. The catalyst speeds up the reaction and boosts oil production. Alumina silica and barium carbonate are employed as a catalyst. When subjected to high temperatures, plastic degrades into a vapour that, upon condensation, yields a liquid hydrocarbon byproduct. Carbon black, found in the residuals, has multiple applications, including in the construction industry (bricks) and the transportation industry (tar). A synthetic oil sample was subjected to a parametric investigation. Study results were used to determine which catalyst would be most effective for the process. In pyrolysis, the ratio of polymer to catalyst is 10:1. The temperature was stable at around 300–450C.

**KEYWORDS:** Plastic wastes, plastic fuel, Pyrolysis, waste management, and oil production

### I. INTRODUCTION

Plastics are ubiquitous in today's society and can be found in nearly every aspect of our lives. Waste plastics are the root cause of many of the world's most pressing environmental concerns since plastics are synthesised from non-renewable sources and are not biodegradable. However, with the right kind of processing, trash plastics can become a massive energy source. Huge quantities of plastic trash have accumulated in MSW and other sites in recent years. By 1995, global plastic output had reached 150 million tonnes, an increase of almost 50% annually. According to data, annual production of plastic trash amounts to 100 million tonnes. Nowadays people utilise all sorts of different kinds of plastic trash. [1] Recycling plastics into usable hydrocarbon fuel is a proven process. Recycling centres and city administrations will be the primary sources of waste plastics for this technique. The plastics collected for plastic fuel manufacture can be mixed together or sorted according to kind. The oceans are home to enormous amounts of waste plastic, which are hurting marine life and the environment.

Because there is no sulphur in the waste plastic, the resulting fuels contain zero sulphur. Since the sulphur concentration of the fuels, if burned, might generate SO<sub>2</sub>, this is a benefit in comparison to the main fossil fuels like diesel. Severe air pollutions from SO<sub>2</sub> can be bad for people's health and ruin the integrity of concrete buildings. As a result, this technology has a substantial positive effect on the local government and community, and it is also friendly to the environment. [2]

To construct these polymers, monomers are used over and over again. As a result, polymers can be manipulated to take on a variety of forms through the processes of moulding and extrusion. Thermoplastics and thermosetting polymers are the two most common categories of plastics.

- Thermoplastics can repeatedly soften and melt if enough heat is applied and hardened on cooling, so that they can be made into new plastics products.  
Examples are polyethylene, polystyrene and PVC
- Thermosets or thermosetting plastics can melt and take shape only once. They are not suitable for repeated heat treatments; therefore after they have solidified, they stay solid.  
Examples are phenol formaldehyde and urea formaldehyde.

### Pyrolysis process for conversion of waste plastic into fuel

By applying high temperatures to organic compounds, a chemical degradation process known as pyrolysis takes place. The Greek roots of the term mean "fire" and "decomposition" respectively. Many solid organic fuels, textiles like wood

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and paper, and even some types of plastic undergo pyrolysis as their first chemical process when burned. As an alternative to diesel, plastic waste can be pyrolyzed in an anhydrous environment to create a liquid fuel with diesel-like properties. [3] Pyrolysis is a heat-degradation method that takes place in an oxygen-free environment. For the purpose of recycling plastic, a cylindrical reactor heated to between 300°- 350° is used. Modern society's reliance on single-use plastics has led to an accumulation of trash that is bad for the environment and, by extension, people. Since plastic is not naturally biodegradable and can have negative effects on the environment (particularly the ozone layer), it is important that we find ways to turn our waste plastic into new products. As a result, we convert this plastic trash into a functional energy source. [4]



Fig. 1 Experimental setup and Plastic Fuel

Plastic oil waste contains a wide range of organic molecules, from C10 to C30. The calorific value and sulphur content of waste plastic oil are lower than those of diesel. Table 1 lists the most important process parameters and the resulting product yields. On a weight basis, plastic waste oil contains 75% liquid hydrocarbons like gasoline, diesel, and kerosene, along with 5- 10% residual coke and LPG. [5]

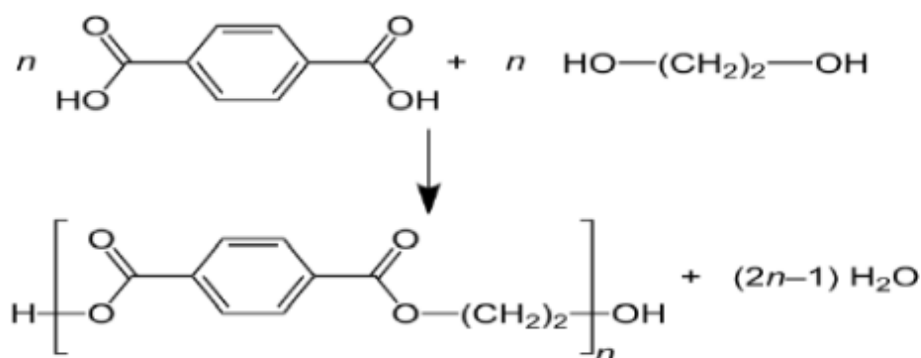
### Chemical Properties of Plastic

In addition to being a regular molecule, plastic is a polymer with a highly variable composition and, by extension, structure. Since many different substances, such as ethylene, styrene, butadiene, acrylene, vynil, propylene, etc., can be used to create polymers, the composition of polymers is highly changeable.

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### TYPES OF PLASTICS

The plastics are divided into the following seven groups based on the chemical structure and applications by the Society of Plastic Industry (SPI).

- PET (Polyethylene Terephthalate)
- HDPE (High Density Polyethylene)
- PVC (Polyvinyl Chloride)
- LDPE (Low Density Polyethylene)
- PP (Polypropylene)
- PS (Polystyrene)
- Other

### Types of Plastics

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Table 1. Different Types of Plastics

| Types  | Name                       | Examples   | Can be pyrolyzed |
|--------|----------------------------|--|------------------|
| Type 1 | Polyethylene Terephthalate | Water bottles, Plastic bags                          | Yes              |
| Type 2 | High Density Polyethylene  | Oil bottles, Plastic detergent bottles, Plastic toys | Yes              |
| Type 3 | Vinyl/Polyvinyl            | Plastic curtains Shampoo bottles                     | No               |
| Type 4 | Low Density Polyethylene   | Garment bags   | Yes              |
| Type 5 | Polypropylene              | Microwaveable meal trays                             | Yes              |
| Type 6 | Polystyrene                | Egg cartons, Cutlery                                 | Yes              |
| Type 7 | Others                     | Toothpaste tubes, Plates<br>Cups                     | No               |

## II. REVIEW OF LITERATURE

Fuel from waste plastic has been studied by Chana Shetty and Patil [6], who utilised a condenser and reactor in their pyrolysis process. They discovered that this approach is useful for storing fuel products like diesel, kerosene, and lubricating oil, and for dealing with the widespread plastic pollution of the world's oceans. This study made use of the plastic debris in the form of stiff film, plastic sheeting, and expanded foam.

Arun kumar and Nataraj [7] investigated the pyrolysis of waste plastic using a materials condenser and a reactor approach based on the use of bentonite to produce fuel oil. It takes in PET bottles, shopping bags, and plastic packaging as inputs and produces gasoline, diesel, and fuel oil as outputs. Based on their findings, they determined that it guarantees a perfect and environmentally friendly future while also improving fuel economy and reducing human health risks associated with nitrogen, halogen, and sulphur.

Physical, biological, and chemical processes are the three main types of plastic breakdown seen in nature. Stress, moisture, and solar radiation are the three main agents in the natural deterioration processes. Chemically speaking, the bonds between the hydrocarbon monomers in plastics made from hydrocarbon chain polymers generated from petroleum refining are so strong that breakdown is impossible at room temperature (about 32°C). Therefore, it is exceedingly challenging to be biologically decomposed by enzymes and bacteria, and the degradation process takes a very lengthy period (Yuliansyah et al., 2015). [8]

Using HY, rare earth metal-exchanged Y-type (REY), and HZSM-5 zeolites, along with silica-alumina, Songip et al. [9] investigated the conversion of polyethylene to transportation fuel (SA). REY zeolite was identified as the catalyst most capable of generating high-octane plastic oil and a high yield of gasoline. The best option was REY since it had the largest pores and the right amount of acidic intensity. Oils generated by Y zeolite and ZSM-5 zeolite had a high research octane number, similar to oil produced by REY, however the output of gasoline produced by the formers was much lower than that of REY.

Akpanudoh et al. [10] looked into the impact of the polymer-to-catalyst ratio. It has been determined that the efficiency of the catalyst does not grow in direct proportion to the amount of catalyst used. Up to a certain threshold, adding more catalyst boosts conversion significantly; beyond that point, adding more catalyst has no discernible effect. Studies have found that a ratio of 4:1 between polymer and catalyst works best. In contrast, it has been discovered in the literature that a lower catalyst ratio will likewise give similar degradation, but at greater reaction temperatures [8]. In order to keep the operation cost-effective, the catalyst ratio and temperature will need to be optimised.

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## Objectives

1. Study on Global consumption of individual plastics.
2. Analysis of Global per capita consumption of plastics.
3. To define Product types of some plastics pyrolysis.
4. Schematic model of the experimental setup.

## III. RESEARCH METHODOLOGY

A research technique is an established procedure for investigating a topic by gathering relevant information, analysing it, and drawing conclusions from the findings. A research methodology is a preconceived scheme for doing an investigation. Research, in its broadest sense, can be thought of as the systematic gathering and analysis of facts and information for the progress of knowledge in any field. The purpose of this research is to apply methodical methods to the problem-solving process in order to identify and implement effective solutions to intellectual and practical issues. The data used in this descriptive study came from a wide range of secondary resources, such as books, journals, scholarly papers, government documents, and printed and online reference materials.

## IV. RESULT AND DISCUSSION

Table 2. Global consumption of individual plastics

| Types of plastic  | Consumption % |
|---|---------------|
| Polythene (PE)  | 33.5          |
| Polypropylene (PP)  | 19.5          |
| Polyvinylchloride (PVC)   | 16.5          |
| Polystyrene (PS)  | 8.5           |
| Polyethylene terephthalate (PET) and polyurethane (PU)  | 5.5           |
| Styrene copolymers (ABS, SAN, etc.)   | 3.5           |
| Blends, alloys, high performance and specially plastics, thermosetting plastics, and so forth | 13            |

There was a growth in plastics manufacturing around the world, from about 1.3 million tonnes in 1950 to 245 MT in 2006. There has been a stealthy plastic revolution taking place across all industries, as evidenced by the meteoric rise in demand for plastic and its projected future growth[11, 12].

For a long time now, Asia has been the greatest consumer of plastics worldwide, making up 36.5% of total consumption. Packaging remains the largest market, accounting for about 35% of worldwide demand in recent years [13]. Figure 2 displays the average annual plastics use per person in the world.

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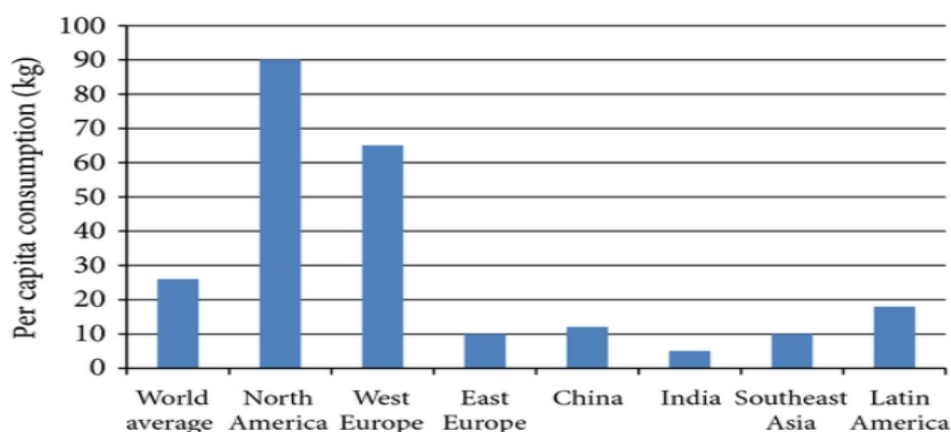


Fig. 2 Global per capita consumption of plastics

Table 3 shows that polyethylene (PE), polypropylene (PP), and polystyrene (PS) thermoplastics are the best feedstock for making liquid hydrocarbons. Carbonous substances are formed when thermosetting polymers, wood, and paper are added to the feedstock, which reduces the pace and yield of liquid products. [14]

Table3. Product types of some plastics pyrolysis

| Main products                     | Type of plastics                | Feedstock of liquid fuel  |
|-----------------------------------|---------------------------------|---|
| Liquid hydrocarbons               | Polyethylene (PE)               | Allowed.  |
|                                   | Polypropylene (PP)              | Allowed.  |
|                                   | Polystyrene (PS)                | Allowed.  |
|                                   | Polymethyl metacrylate (PMMA)   | Allowed.  |
| Liquid hydrocarbons               | Acrylonitrile-Butadiene-Styrene | Allowed. But not suitable.  |
|                                   | copolymer (ABS)                 | Nitrogen-containing fuel is obtained. Special attention required to cyanide in oil- |
| No hydrocarbons suitable for fuel | Polyvinyl alcohol (PVA)         | Not suitable, formation of water and alcohol.                                       |
|                                   | Polyoxymethylene (POM)          | Not suitable. Formation of formaldehyde.  |

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|   |   |   |
|---|---|---|
| <b>Solid products</b>                           | <b>Polyethylene terephthalate (PET)</b> | <b>Not suitable. Formation of terephthalic acid and benzoic acid.</b> |
| <b>Carbonous products</b>                       | <b>Polyurethane (PUR)</b>               | <b>Not suitable.</b>  |
|   | <b>Phenol resin (PF)</b>                | <b>Not suitable.</b>  |
| <b>Hydrogen chloride and carbonous products</b> | <b>Polyvinyl chloride (PVC)</b>         | <b>Not allowed.</b>   |
|   | <b>Polyvinylidene chloride (PVDC)</b>   | <b>Not allowed.</b>   |

Since polythene accounts for a sizable fraction of overall plastic waste, it has been designated as the material from which recycling efforts will commence. Silica alumina, zeolites, barium carbonate, titanium chloride, and their mixtures are some of the catalysts identified for the research. When performing the pyrolysis reaction, a polymer to catalyst ratio of 4:1 is used. The temperature of the reaction might be anything from 350°C to 450°C. A constant flow rate of 10 mL/min of nitrogen is used to create a chemically inert environment for the pyrolysis. [15] A literature review was conducted to inform these choices. Figure 3 depicts a high-level outline of the experimental setup.

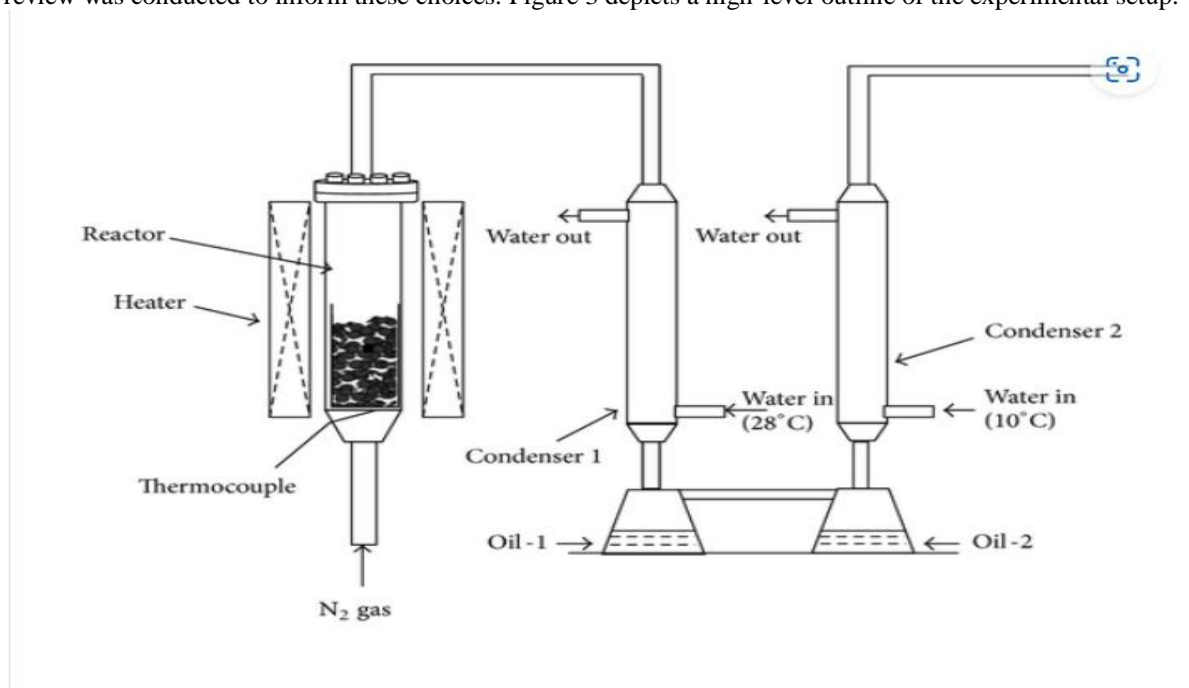


Fig. 3 Schematic model of the experimental setup.

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Table 4 optimum properties of plastic oil with different catalyst

| PROPERTY  | BARIUM CAR-<br>BONATE<br>CATALYST | ALUMINA<br>SILICA<br>CATALYST |
|---|-----------------------------------|-------------------------------|
| TEMPERATURE ( C )                               | 403                               | 418                           |
| LIQUID-COLLECTED(mL)                            | 32                                | 150                           |
| AFTER FILTRATION (mL)                           | 26                                | 130                           |
| CALORIFIC VALUE(MJ/Kg)                          | 35.87                             | 42.23                         |
| VISCOSITY(X10 <sup>-3</sup> Ns/m <sup>2</sup> ) | 1.6123                            | 1.2756                        |
| DENSITY (g/cc)                                  | 0.9723                            | 0.9491                        |
| FLASH-POINT ( C )                               | 43                                | 30.3                          |
| FIRE POINT( C )                                 | 49                                | 35.8                          |

Table 4 displays the differences in oil quality between samples made using the two catalysts. Their characteristics in various contexts are also discussed. For both catalysts, the liquid yield was seen only at temperatures higher than 350°C.

### V. CONCLUSION

Nowadays, plastics pose a serious danger to both people and the environment. Annually, about 14 million tonnes of plastic are poured into the oceans, killing an estimated one million marine species. Humanity has recognised this danger and responded by making progress toward the invention of biodegradable plastics, but nothing has been done to fix the damage that has already been done. In this respect, the catalytic Pyrolysis investigated here offers a quick, clean, and very effective way to get rid of the trash we've left behind over the years. It is a win-win situation since we get rid of the massive plastic oceans and the worldwide gasoline crisis by using plastics as fuel. Even though this double advantage will only continue as long as the waste plastics do, it will undoubtedly give us a solid foundation upon which to construct a sustainable, clean, and green future.

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