



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 6, June 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



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Extraction and Analysis of Plastic Fuel

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ABSTRACT: Plastics have woven their way into our daily lives and now pose a tremendous threat to the environment. Over 100 million tons of plastics are produced annually worldwide, and the used products have become a common feature in overflowing bins and landfills. Though work has been done to make futuristic biodegradable plastics, there have not been many conclusive steps toward cleaning up the existing problem. Here, the process of converting waste plastic into value-added fuels is explained as a viable solution for recycling plastics. Pyrolysis runs without oxygen and at a high temperature of about 300°C which is why a reactor was fabricated to provide the required temperature for the reaction. Converting waste plastics into fuel hold great promise for both the environmental and economic scenarios. Thus, the process of converting plastics to fuel has now turned the problems into an opportunity to make wealth from waste. The conversion of oil from plastic has dual benefits. First of all the oil produced can be used as a fuel for domestic purposes and also in vehicles and industries when further refined. Secondly, the various types of pollution caused due to waste plastics can be minimized. Plastic in the first place is manufactured from natural gas specifically ethane which is a constituent of natural gas. Therefore the waste plastic can be converted back into it.

An increase in energy demand, stringent emission norms, and depletion of oil resources have led researchers to find alternative fuels for internal combustion engines. On the other hand waste plastic pose a very serious environmental challenge because of its disposal problems all over the world. Plastics have now become indispensable materials in the modern world and their application in the industrial field is continually increasing. In this context, waste plastic solid is currently receiving renewed interest. The properties of the oil derived from waste plastics were analyzed and compared with the petroleum products and found that it has properties similar to that of diesel.

In this project work, an attempt has been made to investigate the conversion of household waste plastic into liquid fuel by using the pyrolysis process, a pyrolysis unit is designed, fabricated, and evaluated for various kinds of plastic wastes, properties of liquid fuels obtained is determined.

I. INTRODUCTION

Plastic was invented in 1860, but has only been widely used in the last 30 years plastic is light, durable, modifiable, and hygienic. Plastic is made of a 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.

Plastics have become an indispensable part of today's world. Due to their lightweight, durability, energy efficiency, coupled with a faster rate of production and design flexibility, these plastics are employed in the entire gamut of industrial and domestic areas. Plastics are produced from petroleum derivatives and are composed primarily of hydrocarbons but also contain additives such as antioxidants, colorants, and other stabilizers. Disposal of the waste plastics poses a great hazard to the environment and an effective method has not been implemented. Plastics are non-biodegradable polymers mostly containing carbon, hydrogen, and a few other elements like nitrogen. Due to its non-biodegradable nature, plastic waste contributes significantly to the problem of waste management. According to the nationwide survey which was conducted in the year 2000, approximately 6000 tones of plastic were generated in India, and only 60% of it was recycled, the balance of 40% could not be disposed of. Today about 129 million tones of plastics are produced annually all over the world, out of which 77 million tones are produced from petroleum.

In India alone, the demand for plastics is about 8 million tonnes per year. More than 10,000 metric tonnes per day of plastics are produced in India and almost the same amount is imported by India from other countries. The per capita consumption of plastics in India is about 3kg when compared to 30kg to 40kg in developed countries. Most of these come from the packaging and food industries. Most of the plastics are recycled and sometimes they are not done so due to a lack of sufficient market value. Of the waste plastics not recycled about 43% is polyethylene, with most of them in containers and packaging.

II. RELATED WORK

In order to have a proper background study on technologies available for conversion of waste plastics to fuel, a literature survey is carried out to know its various applied method throughout the globe, which are summarized below. From this crude oil various products petrol, diesel, and kerosene, etc. can be obtained by distillation. This process can convert all HDPE waste plastic to different grade fuels and especially jet grade fuel. After reviewing these various kinds of literature, we can see that different forms of Pyrolysis processes have been employed for the conversion of plastic wastes to efficient fuels and also successfully tested as well.

III. MATERIALS AND METHODS

Municipal plastic wastes (MPW) normally remain a part of municipal solid wastes as they are discarded and collected as household plastic wastes. The various sources of MPW plastics include domestic items like food containers, milk covers, water bottles, packaging foam, disposable cups, plates, cutlery, and CD and cassette boxes. Fridge liners, vending cups, electronic equipment cases, drainage pipes, carbonated drinks bottles, plumbing pipes and guttering, and flooring.

In this project work pyrolysis method is used to convert household plastic wastes like food containers, milk covers, water bottles, packaging foam, and waste cooking oil covers. Nearly 15 tonnes of plastic cover is wasted in a single village. This waste plastic cover is also used in Belagavi, Dharwad, Hubli, vijayapur, Karwar district, etc. for 4 months which will lead to mass plastic waste. This highest portion of plastic is disposed to landfill. By a survey, nearly 150 tonnes to 200 tonnes of the plastic cover are disposed of on land in a single district. By estimating 5000 tonnes to 6000 tonnes of plastic will be wasted from household sources in the state. Waste plastics have been shredded and then washed before pyrolysis. From the above municipal plastic waste has been used as raw materials. Waste plastics have been washed before pyrolysis. In this work, milk plastic covers and edible oil covers are selected as feedstocks to convert waste plastic into useful liquid fuel compounds.

1) The raw material used to produce liquid fuel:



Fig.3.1 Plastic bottles



Fig. 3.2 Grinded plastic waste

The above Figure.3.1 and Fig 3.2 shows the plastic bottle wastes and grinding of plastic bottle waste respectively, these are used as feedstocks to produce liquid fuel compounds. Plastic covers and edible oil covers are selectively collected from local hotels and hostels.

2) Methodology:**A. 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 or oligomers and sometimes monomer units. Further degradation of these subsequent molecules depends on many 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 a catalyst. Accordingly, the reaction will be thermal and catalytic Pyrolysis. Since the majority of plastic used is a polyolefin, extensive research has been done on this polymer which is summarized below.

B. Thermal Pyrolysis of Polyolefin :

The non-catalytic or thermal Pyrolysis of polyolefin is a high-energy, endothermic process requiring temperatures of at least 350–500 °C.

In some studies, high temperature as 700–900 °C is essential in achieving decent product yields. The extent and the nature of these reactions depend both on the reaction temperature and also on the residence of the products in the reaction zone, an aspect that is primarily affected by the reactor design. In addition, reactor design also plays a fundamental role, as it has to overcome problems related to the low thermal conductivity and high viscosity of the molten polymers. Several types of reactors have been reported in the literature, the most frequent being fluidized bed reactors, batch reactors, and screw kiln reactors.

C. Catalytic Cracking of Polyolefins:

The addition of catalyst enhances the conversion and fuel quality. As compared the purely thermal Pyrolysis, the addition of catalyst in polyolefin Pyrolysis

- 1) Significantly lowers Pyrolysis temperatures and time. A significant reduction in the degradation temperature and reaction time under catalytic conditions results in an increase in the conversion rates for a wide range of polymers at much lower temperatures than with thermal Pyrolysis.
- 2) Narrows and provides better control over the hydrocarbon products distribution.
- 3) Increases the gaseous product yields. Under similar temperatures and reaction times, a much higher gaseous product yield is observed in the presence of a catalyst for polyethylene.

3) Fabrication of Pyrolysis unit:

Fig. 3.3 Pyrolysis unit

Pyrolysis unit developed by using Reactor which can hold high temperature. By using arc and gas welding technology, we fabricated the above pyrolysis unit. The experiments were carried out with high temperature and atmospheric

pressure so the unit must be withstanding high temperature. Reactor welded by using gas welding to prevent the leakage of vapors. The safe and efficient pyrolysis unit is shown above in Fig.

4) Pyrolysis Unit:



Fig. 3.4 Reactor



Fig.3.5 Condenser

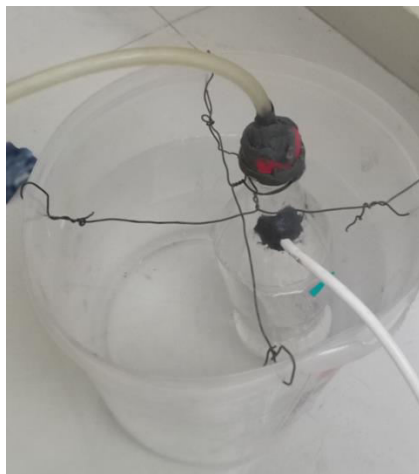


Fig. 3.6 Collection of fuel



Fig. 3.7 Collection of plastic



Fig. 3.8 Grinding of plastic



Fig. 3.9 Feeding into the reactor

Fig.3.4 shows, the experimental setup of the pyrolysis process. The apparatus was designed to operate at high temperatures and atmospheric pressure. The heart of the experimental apparatus was a vertical tubular reactor. A feeder was attached to the reactor's upper end; this enabled controlled amounts of plastic pellets to be added before operation. At the bottom of the reactor attached a furnace for the purpose of heating the reactor. LPG cylinder with a blower is used as a heating source to heat the reactor. Due to increasing reactor temperature, the plastic starts to evaporate, these vapors leave the reactor and passed into a condenser, a condenser maintained at atmospheric temperature. The cyclone separator is provided at the end of the condenser to separate the gaseous and plastic liquid fuel compounds. The gas is reused to heat the pyrolysis unit and another end of the cyclone separator is connected to a flask in which the liquid hydrocarbon product was collected.

5) Purification Setup:

In this method, we take an equal proportion of plastic fuel and water in a container and shake it well, allowing it for 5-7 hours to settle down. Now water along with some crystals is collected at the bottom and pure plastic fuel is collected at the top container. In meantime check the pH value of plastic oil by using a pH meter if it is acidic in nature it is needed to many times wash with water to bring the pH of oil to 7.



Fig. 3.10 Purification Setup

IV. RESULTS AND DISCUSSION

Properties of plastic pyrolysis oil

1) Density:-

The density of fuel at different temperatures was measured by a standard 25 ml marked flask. The weight of the fixed volume of fuel (25 ml) was measured at different temperatures by an electronic balance which measures up to 0.0001 gm. The density values are reported in kg/m³.

2) Calorific value:-

Determination of calorific value:

The calorific value of a fuel is the quantity of heat produced by its combustion at constant pressure and under normal conditions. The calorific value is determined by using a bomb calorimeter.

3) Viscosity:-

Viscosity is an important property of fuel and it is a fluid's resistance to the flow (shear stress) at a given temperature. Fuel viscosity is specified in the standard for diesel fuel within a fairly narrow range. Hydrocarbon fuels in the diesel boiling range easily meet this viscosity requirement. The viscosity range for typical fuels overlaps the diesel fuel range with some fuels having viscosities above the limit. If fuel viscosity is extremely excessive, there will be a degradation of the spray in the cylinder causing poor atomization, contamination of the lubricating oil, and the production of black smoke. Kinematic viscosity takes into account the fluid density and centistokes is the engineering unit used to express the kinematic viscosity.

4) Fire point and Fire point test:-

The flashpoint of a volatile material is the lowest temperature at which its vapors ignite if given an ignition source. The fire point of a fuel is the lowest temperature at which the vapor of that fuel will continue to burn for at least 5 seconds after ignition by an open flame of standard dimension.



V. CONCLUSION AND FUTURE WORK

According to the current statistics, there is a continuous rise in consumption and thus cost of petroleum oil, International Energy Outlook 2008 reports the world consumption of petroleum oil as 84 million barrels per day. The conversion of waste plastics to liquid hydrocarbon fuel was carried out in a thermal pyrolysis unit.

This method is superior in all respects (ecological and economical). By adopting this technology, efficiently convert the weight of waste plastics into 75% of useful liquid hydrocarbon fuels without emitting any pollutants. It would also take care of hazardous plastic waste and reduce the import of crude oil. Depletion of non-renewable sources of energy such as fossil fuels at this stage demands improvements in this technique.

Based on the properties of the Plastic fuel and Diesel fuel all properties are nearer hence concluded that Waste plastic fuel represents a good alternative fuel for diesel engine and therefore it can be used for diesel engine vehicles for the transportation purpose.

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SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN  INTERNATIONAL
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