



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 12, Issue 4, April 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

A Review on Conversion of Waste Plastics into Fuel

Dr. Vilas A. Pharande¹, Sarfraj Shakil Bagwan²

Principal, Arvind College of Engineering, Maharashtra, India¹

P.G Student, Department of Mechanical Engineering, Arvind College of Engineering, Maharashtra, India²

ABSTRACT: This paper discuss about the fuel preparation From low density plastic wastes. Plastics have woven their way Into our daily lives and now pose a tremendous threat to the Environment. Over a 280 million tone's of plastics are Produced annually worldwide, and the used products have Become a common feature at overflowing bins and landfills. Here, the process of converting waste plastic into value added Fuels is explained as a viable solution for recycling of plastics. Thus two universal problems such as problems of waste plastic And problems of fuel shortage are being tackled Simultaneously. In this study, plastic wastes (low density polyethylene) were used for the pyrolysis to get fuel oil that Has the same physical properties as the fuels like petrol, diesel Etc. Pyrolysis runs without oxygen and in high temperature of About 300°C. The waste plastics are subjected to pyrolysis to Obtain different value added fuels such as petrol, kerosene, and Diesel, etc. 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.

KEYWORDS: Plastics, Pyrolysis, LDPE, Oxygen, Carbon, Calorific Value, GreenhouseGases, Liquefied Petroleum Gas, Polyethylene,

I. INTRODUCTION

Majority of plastics that are used are non-biodegradable in nature, they remain in environment for long period of time which affects the environmental quality. Plastics are nonbiodegradable polymers [1]. Plastics contains mainly high density polyethylene, polyethylene, polypropylene, low density polyethylene. According to national survey approximately 10000 tons plastic wastes were produced every day in our country, but out of which only 60% waste plastics are recycled [5]. Economic growth and changing consumption and production patterns are resulting into rapid increase in generation of waste plastics in the world. Due to the increase in generation, waste plastics are becoming a major stream in solid waste. After food waste and paper waste, plastic waste is the major constitute of municipal and industrial waste in cities. Even the cities with low economic growth have started producing more plastic waste due to plastic packaging, plastic shopping bags, PET bottles and other goods/appliances which uses plastic as the major component. This increase has turned into a major challenge for local authorities, responsible for solid waste management and sanitation. Due to lack of integrated solid waste management, most of the plastic waste is neither collected properly nor disposed of in appropriate manner to avoid its negative impacts on environment and public health. On the other hand, plastic waste recycling can provide an opportunity to collect and dispose of plastic waste in the most environmental friendly way and it can be converted into a resource.

In general, the conversion of waste plastic into fuel requires feed stocks which are non-hazardous and combustible. The composition of the plastics used as feedstock may be very different and some plastic articles might contain undesirable substances like nitrogen, halogens, sulphur or any other hazardous substances which pose potential risks to humans and to the environment [7]. The broad classification of plastic includes high density polyethylene, low density polyethylene, polypropylene and polystyrene [2]. Also, plastics are classified their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and cross-linking. Low-density polyethylene (LDPE) is used for its toughness, flexibility, and relative transparency. LDPE is used to make bottles that require extra flexibility. To take advantage of its strength and toughness, it is used to produce grocery bags and garbage bags, squeezable bottles, shrink wrap, stretch films, and coating for milk cartons. It can also be found in toys, container lids, and packaging. Polypropylene (PP) is known for its high melting point, which is used to make containers for yogurt, margarine, takeout meals, and deli foods. It is also used for medicine bottles, bottle caps, and some household items.

II. REVIEW OF PYROLYSIS

Pyrolysis is the thermal degradation of plastic waste at high temperature. This process is done in the absence of oxygen. The word pyrolysis is derived from the Greek word pyro means “fire” and lysis means “separating”. The products formed at the highest temperature of the pyrolysis process include solid coal (char), liquid pyrolysis oil, and gas. Pyrolysis liquid and gas products are often used for power generation in engines and turbines. Therefore, the pyrolysis of biomass could also be used as an alternative method for energy sources. This method takes place at high temperature in the absence of oxygen where it goes through chemical and physical separation into different atoms and molecules. The critical temperature ranges for obtaining pyrolysis products are between 350 and 500°C, the process can be used for the production of raw oil or gas. This technique is usually performed by consuming less energy from the surface. There are two types of pyrolysis methods which can be done: first is by slow pyrolysis method and second is by fast pyrolysis method. But we have used the slow pyrolysis method by which we get solid char, raw petrol, diesel and gas.[8]

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 are polyolefins, so extensive research has been done on this polymer which is summarized as below.

A. Thermal Pyrolysis of Polyolefin: The non-catalytic or thermal pyrolysis of polyolefin is a high energy, endothermic process requiring temperatures of at least 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.

Characteristics of thermal degradation of heavy hydrocarbons can be described with the following points;

- High production of C1s and C2s in the gas product.
- Olefins are less branched.
- Some olefins made at high temperature.
- Gasoline selectivity is poor; i.e. oil products are a wide distribution of molecular weight.
- Gas and coke products are high.
- Reactions are slow compared with catalytic reactions.

Thermal pyrolysis of both virgin and waste plastics as well as other hydro-carbonaceous sources has been studied extensively in the past. A good number of these thermal cracking studies are on polyethylene, polypropylene and polystyrene. On the other hand, only a few have worked on the thermal decomposition of other common plastics such as polyvinylchloride, poly methyl methacrylate, polyurethane and polyethylene terephthalate. Generally, thermal cracking results in liquids with low octane value and higher residue contents at moderate temperatures, thus an inefficient process for producing gasoline range fuels. The gaseous products obtained by thermal pyrolysis are not suitable for use as fuel products, requiring further refining to be upgraded to useable fuel products. A few researchers have sought to improve thermal pyrolysis of waste polyolefin without employing the use of catalysts; however these changes either yielded insignificant improvements or added another level of complexity and costs to the system.

B. Catalytic Cracking of Polyolefin: Addition of catalyst enhances the conversion and fuel quality. As compared to 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.

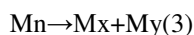
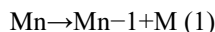
2) Narrows and provides better control over the hydrocarbon products distribution.

3) Increases the gaseous product yields. Under similar temperatures and reaction times, much higher gaseous

product yield is observed in the presence of a catalyst for polyethylene

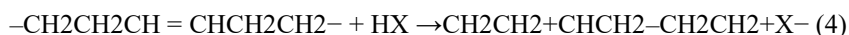
III.MECHANISM OF THERMAL DEGRADATION

The four different mechanisms proposed are: (1) end-Chain scission or unzipping,(2) random-chain Scission/fragmentation, (3) chain stripping/elimination Of side chain,(4) cross-linking. The decomposition Mode mainly depends on the type of polymer(the Molecular structure):



Equations (1) and (2) represent the thermal degradation, And(3) represents the random degradation route of the Polymers pyrolysis.

Initiation. Initiation may occur on some defected sites Of the polymer chains. For instance, an olefin linkage Could be converted into an on-chain carbonium ion by Proton addition:



The polymer chain may be broken up through beta

Emission:



Initiation may also take place through random hydride-Ion abstraction by low-molecular-weight carbonium

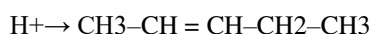
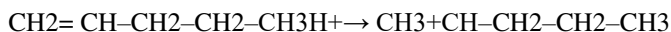
Ions (R+):



The newly formed on-chain carbonium ion then Undergoes beta-scission.

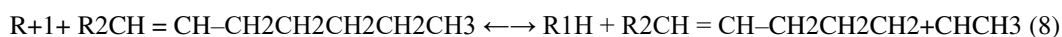
Depropagation: The molecular weight of the main Polymer chains may be reduced through successive Attacks by acidic sites or other carbonium ions and Chain cleavage, yielding in gas oligomer fraction (approximately C30–C80). Further, cleavage of the Oligomer fraction probably by direct-emission of Chain-end carbonium ions leads to gas formation on one Hand and a liquid fraction (approximately C10–C25)on The other.

Isomerisation : The carbonium ion intermediates can Undergo rearrangement by hydrogen- or carbon-atom Shifts, leading to a double-bond isomerisation of an Olefin:



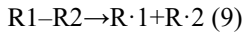
Other important isomerisation reactions are methyl-Group shift and isomerisation of saturated Hydrocarbons.

Aromatization: Some carbonium ion intermediates can Undergo cyclization reactions. An example is when Hydride ion abstraction first takes place on an olefin at a Position several carbons removed from the double Bond, the result being the formation of an olefin Carbanion ion:

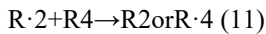
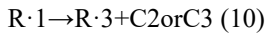




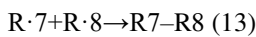
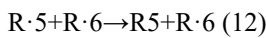
(1) Initiation. Random breakage of the C–C bond of The main chain occurs with heat to produce hydrocarbon Radicals:



(2) Propagation. The hydrocarbon radical decomposes To produce lower hydrocarbons such as propylene, Followed by scission and abstraction of H-radicals From other hydrocarbons to produce a new hydrocarbonRadical:



(3) Dis-proportionation or recombination of Two radicals:



IV. PERFORMANCE CHARACTERISTIC

The performance test of the plastic pyrolysis oil was tested In a four-stroke variable compression ratio petrol engine test Rig in our college Energy Lab. Comparing the Brake Specific Fuel consumption, Brake thermal efficiency, Air fuel ratio of The plastic pyrolysis oil with the petrol. The performance Characteristic of the engine is plotted below. [11]

4.1 Brake Specific fuel consumption

Brake specific fuel consumption is a measure of the fuel Efficiency of the fuel burnt and produces shaft power. Variations in Brake specific fuel consumption (BSFC), with Respect to engine brake power. These graphs are shown in Brake power v/s Brake Specific Fuel Consumption. Plastic Pyrolysis oil content increased further due to Plastic pyrolysis Oil has similar calorific value and also has higher viscosity Compared to the petrol.

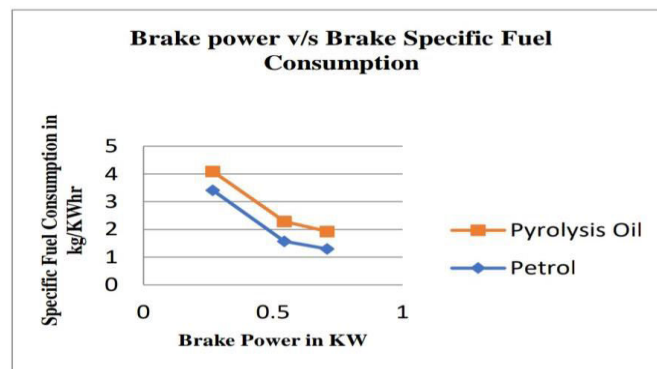


Fig.1. Brake power v/s Specific Fuel Consumption

4.2 Brake thermal efficiency

The experimental study on a Four Stroke Variable Compression Ratio Petrol Engine using plastic pyrolysis oil. At different electric load, the efficiency goes on increasing. The graph comparing Brake thermal efficiency of the plastic pyrolysis oil with the petrol is plotted below. Comparing to the petrol the plastic pyrolysis oil has less brake thermal efficiency as shown in Fig. 2.

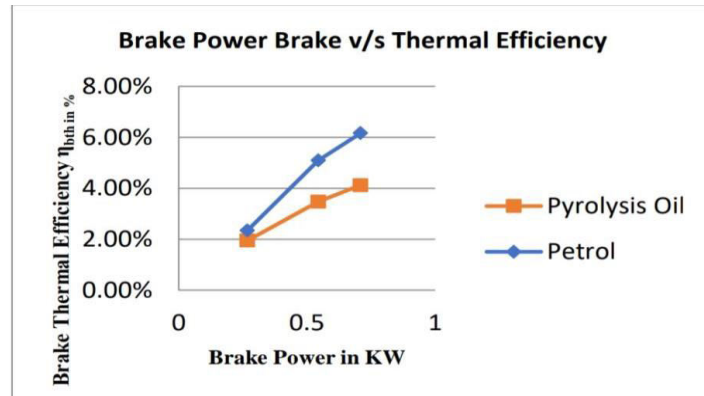


Fig. 2. Brake Power Brake v/s Thermal Efficiency

4.3 Air fuel ratio

Air fuel ratio is the mass ratio of the air to a solid, liquid, or gaseous fuel present in a combustion process. The air fuel ratio determines whether the mixture is combustible at all, how much unwanted pollutants are produced in the reaction. The graph comparing the plastic pyrolysis oil with petrol. The plastic pyrolysis oil has less air fuel ratio as shown in Fig. 3.

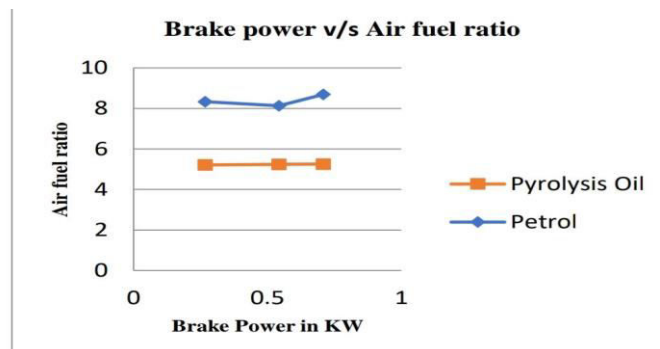


Fig.3 Air fuel ratio v/s Brake power

4.4 Emission Test

Specifications

Type of vehicle : 2-Wheeler Type of engine : 4 strokes

Model : SPLENDOR plusFuel : petrol

	Unit	Pres STD		Measured level	
		Petrol	Plastic Pyrolysis Oil	Petrol	Plastic Pyrolysis Oil
CO	% Vol	3.5	3.5	0.41	0.08
HC	PPM	4500	4500	97	75
CO2	% Vol	--	--	1.30	1.00
O2	PPM	--	--	11.8	2.7

TABLE 1 .Comparison of Emission Te

V.CONCLUSION

The use of waste plastics in the growing and developing world. Other alternatives to plastic are difficult to find because plastic has many uses and different properties. Demand for plastics is also increasing day by day and with increasing plastic rate their waste is increasing or increasing. Increasing plastic waste is causing more environmental problems worldwide. As the use of waste plastic grows, it is immediately believed that solid waste management will find more ways to collect them. Products of the plastic pyrolysis process can be used as fuels or chemicals. It also reduces the problem of waste plastic decomposition. In this work, the pyrolysis of waste plastic is done because the use of catalysts is expensive and the reproduction of catalysts is a difficult task. Plastic pyrolysis produces a mixture of gas and oil and produces a very small amount of char. The implementation of this project in the real world develops many possibilities. This is a good solution for controlling waste plastics and finding a new diesel source for the country. According to the current data, there is a continuous increase in crude oil consumption and thereby an increase in the price of crude oil, although there is a temporary decline in demand growth due to the international financial crisis and Covid-19.

REFERENCES

1. Santosh UKumar, Ketan Nalawade, Anil Jadhav & T. Vijay Kumar, "Extraction of Plastic Oil From Plastic Oil From Plastic By De-Polymerization Technique as an Alternative Fuel". International Journal of Applied Engineering & Research (2013).
2. Roopa Farshi, Chirayu Belthur, Anjan Athreya & George Jeevan, Ramesh, "Catalytic Degradation Of Municipal Waste Plastics To Produce Fuel Range Hydrocarbons Using Bentonite". Department of Chemical Engineering DSCE, Bangalore. International Journal of Current Engineering & Technology (2013).
3. Clive Maier, Teresa Calafut "Polypropylene: the definitive user's guide and Databook"
4. Andrew J. Peacock, Allison R. "Polymer chemistry: properties and applications"
5. Sathonea, "Thermo fuel Pyrolysis Of Waste Plastic To Produce Liquid Hydrocarbons", Advances in Polymer Science and Technology: An International Journal ISSN 2277 – 7164.
6. Santosh Ukumar, Ketan Nalawade, Anil Jadhav & T. Vijay Kumar, "Extraction of Plastic Oil from Plastic Oil from Plastic By De-Polymerization Technique as an Alternative Fuel". International Journal of Applied Engineering & Research (2013)
7. Roopa Farshi, Chirayu Belthur, Anjan Athreya's & George Jeevan, Ramesh, "Catalytic Degradation of Municipal Waste Plastics to Produce Fuel Range Hydrocarbons Using Bentonite". Department of Chemical Engineering DSCE, Bangalore. International Journal of Current Engineering & Technology (2013).
8. Pratikesh j. Khutle, mayuri s. Deshmukh, harshada gaikwad, nandini madane, prof. sneha Hirkane, dipika patil "pyrolysis process for conversion of plastic waste into liquid fuel" (irjet) e-issn: 2395-0056 volume: 07 issue: 09 | sep 2020
9. Pawar Harshal R. and Lawankar Shailendra M., "Waste Plastic Pyrolysis Oil Alternative Fuel for CI Engine", A Review Research Journal of Engineering Sciences ISSN 2278 – 9472 Vol. 2(2), 26-30, February (2013).
10. Asabi Abatneh, Omprakash Sahu, "Preliminary Study on The Conversion of Different Waste Plastics into Fuel Oil". ISSN (2013).
11. Abhishek C R Assistant Professor Mechanical Engineering PES Institute of Technology and Management, "Waste Plastic Pyrolysis Oil alternative Fuel for an IC Engine" (IJERT) ISSN: 2278-0181 Published by, www.ijert.org NCMPC – 2019 Conference Proceedings
12. Anup T J, Vilas Watwe, "Waste Plastic Pyrolysis Oil as Alternative for SI And CI Engines", International Journal of Innovative Research In Science, Engineering and Technology (2014).



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details