

A Review on Waste Plastic Fuel

¹ASST.PROF. P.K.INGAWALE,¹V.V. DHONDE,¹A.D.KUMKAR, ¹T.D. CHENDGE

¹Department of Mechanical Engineering,

RDTC's Shri Ch. Shivajiraje College of Engineering Dhangawadi, Bhor, Pune.

prasadingawale@gmail.com, vaibhavdhonde88@gmail.com, kumkaraniket777@gmail.com,

tdchendge@gmail.com

ABSTRACT:

Plastic have woven their way into our daily lives and now pose a tremendous threat to the environment. Over a 100 million tons of plastic are produced annually worldwide, and use product have a become a common feature at overflowing bins and landfills, through work has been done to make futuristic biodegradable plastics, there have not been many conclusive steps towards cleaning up the existing problem. The process of converting waste plastic into value added fuels is explained as viable solution for recycling of plastics, thus two universal problem such as problem of waste plastic and problem of fuel shortage are being tackled Simultaneously in this study plastic waste were used for the pyrolysis to get fuel oil that has the same physical properties as fuel like petrol, diesel etc. The waste plastic are subjected to depolymerisation, pyrolysis, thermal cracking and distillation to obtain different value added fuels such as petrol ,kerosene, and diesel, lube oil etc. Converting waste plastics into fuel hold great promise for the environmental and economic scenarios. As a developing and one of the most populous countries in the world, India faces major challenges in supplying energy resources and solid plastic waste management. The plastic pyrolysis oil stands to be a solution for the above problem.

KEYWORDS :Plastic, Polymerisation, Fuel, Pyrolysis, Distillation

INTRODUCTION

Plastics are an integral part of our modern life and are used in almost all daily activities. Since plastics are synthesized from non-renewable sources and are generally not biodegradable, waste plastics are the cause of many of the serious environmental problems the world faces today. However, waste plastics can become a source of enormous energy with the correct treatment. In recent years, huge amounts of waste plastic are available in municipal solid waste (MSW) and many places. With an annual increase rate of approx 50%, in 1995, the production of plastic in the world had reached 150 million tons. According to information the yield of waste plastic is 100 million tons. Various type waste plastic use now a days. Established technology can convert waste plastics into a renewable source of hydrocarbon fuel. This technology plans to acquire waste plastics from City / Local Municipalities and Recycling Facilities. For plastic fuel production purposes the plastics can be collected as commingled or separated into different categories. Another source of large amounts of waste plastic is floating on our oceans and seriously damaging the ecosystem and the environment

Due to their lightweight, durability, energy efficiency, coupled with a faster rate of production and design flexibility, these plastics are employed in entire gamut of industrial and domestic areas hence plastics have become essential materials and their applications in the industrial field are continually increasing. At the same time, waste plastics have created a very serious environmental challenge because of their huge quantities and their disposal problems.

The demand for diesel fuel is greater than that of gasoline throughout the world hence seeking alternative to mineral diesel is a natural choice. Alternative fuels should be easily available at low cost, be environment friendly and fulfil energy security needs without sacrificing engine's operational performance. Waste to energy is the recent trend in the selection of alternate fuels.

1.1 Waste To Fuel

Waste-to-energy or energy-from-waste is the process of generating energy in the form of electricity, heat or fuel from waste.

WtE is a form of energy recovery.

Most WtE processes produce energy directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

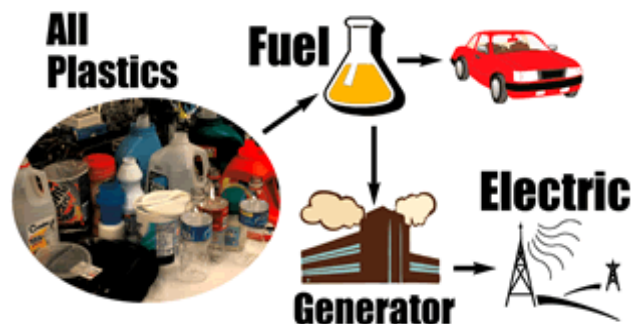


Figure 1 Waste to fuel

1.2 What is the Plastic

The term "plastics" includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine, and sulphur.

Plastics are macromolecules, formed by polymerization and having the ability to be shaped by the application of reasonable amount of heat and pressure or any other form of forces. ■

It is one of the few new chemical materials which pose environmental problem.

Polyethylene, polyvinyl chloride, polystyrene is largely used in the manufacturing of plastics.

1.3 Why Do We Need To Convert Waste Plastic Into Fuel ?

According to a recent study performed by the Environmental Protection Agency(PA) approximate billion of tons of waste plastic are generated in the world every year.

Statistics show that approximately 10% of this plastic is recycled, 25% is incinerated (destroyed by burning) and the remaining 65% is dumped in landfills.

Incineration is an alternative to landfill disposal of plastic wastes, but this practice could result in the formation of unacceptable emissions of gases such as nitrous oxide, sulfur oxides, dusts, dioxins and other toxins.

The option of secondary recycling or mechanical recycling, which is the reprocessing of plastic waste into new plastic products with a lower quality level ,is not showing any signs of growth in the recycling industry

The method of converting the polymers present in the waste plastics into fuel.



Figure2 Recycling of waste

PYROLYSIS OF PLASTIC

- Pyrolysis is process of thermal degradation of plastics in the absence of oxygen.

2.1 Principle Of Pyrolysis

- All plastics are polymers mostly containing carbon and hydrogen and few other elements like chlorine, nitrogen, etc.
- When this long chain of polymers breaks at certain points, or when lower molecular weight fractions are formed, this is termed as degradation of polymers. This is reverse of polymerization.
- If such breaking of long polymeric chain occurs randomly, it is called Random depolymerization.

In the process of conversion of waste plastics into fuels, random depolymerization is carried out in a specially designed

reactor in the absence of oxygen and in the presence of coal and certain catalytic additives. The maximum reaction temperature is 350°C.

There is total conversion of waste plastics into value-added fuel products.

2.2Process

The process consists of two steps:

i) Random de-polymerization
under controlled reaction conditions, plastics materials undergo random depolymerization and are converted into three products:

- a) Solid Fuel i.e., Coke
- b) Liquid Fuel i.e., Combination of Gasoline, Petrol, Diesel and Lube Oil
- c) Gaseous Fuel i.e., LPG range gas

ii) Fractional Distillation
Separation of various liquid fuels by virtue of the difference in their boiling points.

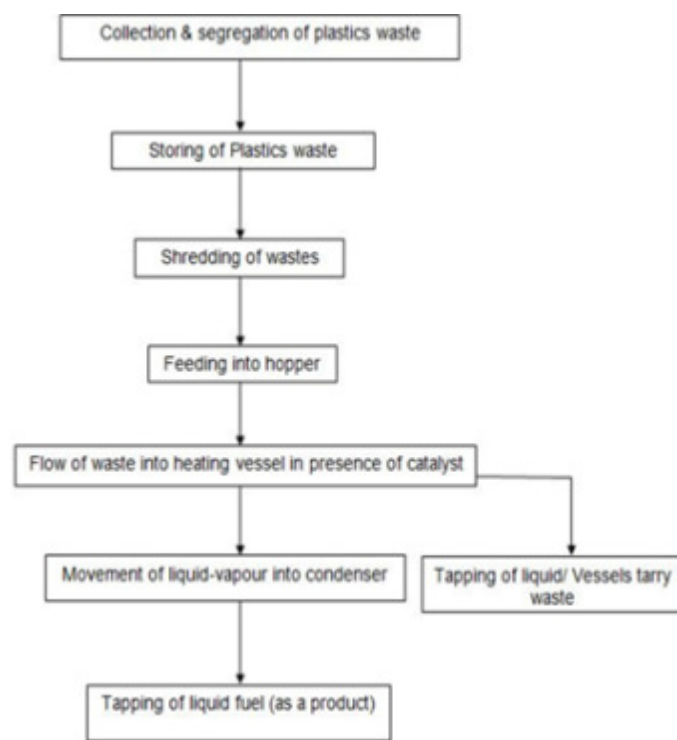


Figure3 process layout

Methodology

Pyrolysis process for conversion of waste plastic into fuel Pyrolysis is the chemical decomposition of organic substances by heating the word is originally coined from the Greek-derived elements pyro "fire" and lysis "decomposition". Pyrolysis is usually the first chemical reaction that occurs in the burning of many solid organic fuels, cloth, like wood, and paper, and also of some kinds of plastic. Anhydrous Pyrolysis process can also be used to produce liquid fuel similar to diesel from plastic waste. Pyrolysis technology is thermal degradation process in the absence of oxygen. Plastic

waste is treated in a cylindrical reactor at temperature of 300°C – 350°C. Now a days plastics waste is very harmful to our nature also to human beings .plastic is not easily decomposable its affect in fertilization ,atmosphere ,mainly affect on ozone layer so it is necessary to recycle these waste plastic into useful things .so we recycle this waste plastic into a useful fuel.

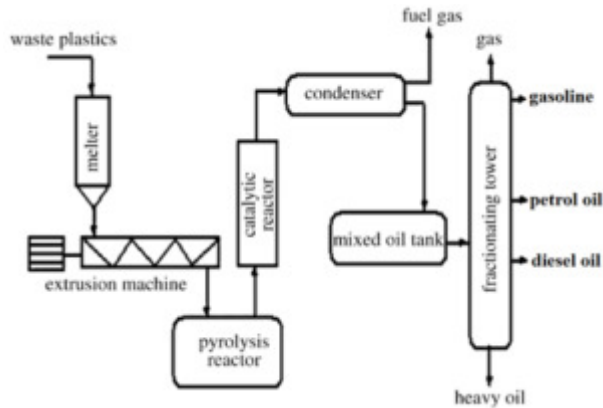


Figure 4 Pyrolysis technique of plastic waste



Figure 5 Plastic Pyrolysis Process Plant.



Figure 6Converted purified fuel from plastic.

3.1 Waste Plastic Pyrolysis

Pyrolysis is the chemical decomposition of organic substances by heating the word is originally coined from the Greekderived elements pyro "fire" and lysis "decomposition". Pyrolysis is usually the first chemical reaction that occurs in the burning of many solid organic fuels, cloth, like wood, and paper, and also of some kinds of plastic. Anhydrous Pyrolysis process can also be used to produce liquid fuel similar to diesel from plastic waste. Pyrolysis technology is thermal degradation process in the absence of oxygen. Plastic waste is treated in a cylindrical reactor at temperature of 300°C – 350°C. The plastic waste is gently cracked by adding catalyst and the gases are condensed in a series of condensers to give a low sulphur content distillate. All this happens continuously to convert the waste plastics into fuel that can be used for generators. The catalyst used in this system will prevent formation of all the dioxins and Furans (Benzene ring). All the gases from this process are treated before it is let out in atmosphere. The flue gas is treated through scrubbers and water/ chemical treatment for neutralization. The non-condensable gas goes through water before it is used for burning. Since the Plastics waste is processed about 300°C - 350°C and there is no oxygen in the processing reactor, most of the toxics are burnt. However, the gas can be used in dual fuel diesel-generator set for generation of electricity.



Figure 7 Obtained Fuel From Pyrolysis.

3.2Distillation

This process applied for petrol and diesel grade fuel production process. Waste plastic to fuel was use for further distillation process and making petrol and diesel grade fuel. Distillation column was use for distillation process. Distillation process set up different columns with different temperature profile like low boiling point fuel to high boiling point fuel. Petrol grade fuel collected from 1st fractional column and temperature range was 90°C to 130°C. Diesel grade fuel collected from 2nd fractional column and temperature range was

250°C to 285°C. In distillation process, 2nd grade fuel was diesel fuel and diesel fuel density 0.80 g/ml. This fuel hydrocarbon compound also heavier and this fuel are not igniting. Collected diesel grade fuel percentage was 30%, petrol grade fuel percentage was 60% and rest of all light gas percentage was 10% including light gas also. Fractional distillation process was also generating some light gases. Light gas cleaning procedure also same above procedure. Plastic pyrolysis fuel to different fuel by using fractional distillation column used for heat applied with different column temperature wise and fuel break down into shorter into longer chain wise and come out into different fraction column then collected into different separate container for grade wise.

3.3 After Distillation-

The main raw materials of distillation machine are waste plastic oil, pump the raw oil to heat reactor, and the liquid oil will become oil gas, oil gas from reactor has already been purified by distillation tower before it gets into condensers and liquefied in to light fuel oil, this kind of oil will be piped into deep purifying system with acidity and alkaline cleaning device as well as pressure filtering system. Then we will get qualified diesel oil & petrol oil that can be used in engine and generators.

4PARTS OF MACHINE:-

4.1Reactor:-

Vessel in which reaction takes place.



Figure 8 Reactor

4.2 Catalytic Cracker :-

- Catalytic cracking is the breaking of large hydrocarbon molecules into smaller and more useful bits.
- The cracker must be designed in such a way that the vapour from the reactor must have maximum surface contact with the catalyst.
- The catalyst will act as a molecular sieve which permits the passage of small molecules.
- The hydrocarbon molecules are broken up in a fairly random way to produce mixtures of smaller

hydrocarbons, some of which have carbon-carbon double bonds.



Figure 9 Catalytic Cracker

4.3Condenser:-

- It is the part of machine which condenses the vapors coming out from Catalytic Cracker.
- The condenser must condense the very hot vapors in an efficient manner to give the condensate.
- Clogging in the condenser must be prevented.
- This can be achieved by increasing the diameter of pipe.
- In this machine we are using a spiral condenser to increase the efficiency of condenser.



Figure 10 Condenser.

4.4 Nitrogen Cylinder:-

Cylinder is attached to the reactor, used to provide inert atmosphere in the reactor by pumping nitrogen from nitrogen cylinder.

- Purpose:- plastic feed should not burn instead it should melt at high temperature inside the reactor.



Figure 11 Nitrogen Cylinder

5. OTHER PARAMETERS

5.1 Selection Of Plastic

Table.1- selection of plastics

Resin	Thermo Fuel System Suitability
Polyethylene (PE)	Very Good
Polypropylene (PP)	Very Good
Polystyrene (PS)	Very Good (gives excellent fuel properties)
ABS Resin (ABS)	Good
Polyvinylchloride (PVC)	Not suitable, should be avoided
Polyurethane (PUR)	Not suitable, should be avoided
Fibre reinforced plastic (FRP)	Fair. Pre-treatment is required to remove fibre

5.2 Feasibility

- The production of the fuels from the waste plastic of various sorts has been carried out the No. of times to arrive at the unit cost of production. The break-

up of the cost for per kg input of plastic and the related output for the same is represented in the table.

Process for 1kg input and yield of output

Input	Qty (Kg)	Rate Per Kg	Amount (Rs)	Output	Qty (L)	Rate Per Liter	Amount (Rs)
Plastic	1:00	14:00	14:00	Petrol	0.6	65:00	39:00
Labour			7:00	Diesel	0.3	54:00	16:20
Service Charge			2:50	Lube Oil	0.1	25:00	2:50
Total	1:00		23:50		1:00		57:70

Table.2- Feasibility

5.3 Physical Properties of Fuel Derived From Waste Plastic

Table.3- Physical properties of derived fuel

Sr. No.	Characteristic	Petrol Grade Fuel	Diesel Grade Fuel
1.	Flash point (°C)	29	87
2.	Fire point (°C)	33	92
3.	Viscosity at 40°C	0.8	3.8
4.	Density (Kg/m ³)	735	800
5.	Calorific Value (KJ/Kg)	48000	47000

5.4 Advantages

- Problem of disposal of waste plastic is solved.
- Waste plastic is converted into high value fuels.
- Environmental pollution is controlled.
- Industrial and automobile fuel requirement shall be fulfilled to some extent at lower price.
- No pollutants are created during cracking of plastics.

- The crude oil and the gas can be used for generation of electricity.

5.5 Applications in Real Life

The city-based Sustainable Technologies & Environmental Projects (STEPS) plans to set up a plant to convert plastic waste into light diesel, petrol, calorific value combustible gas and carbon pellets.

Pune Municipal Corporation, India is planning on running a pilot project that will convert plastic into fuel for generators.

6.RESULT

- Petrol Engine was able to run with 100% waste plastic oil.
- Engine fuelled with waste plastic pyrolysis oil exhibit higher thermal efficiency up to 50% of the rated power for petrol engine.
- Engine fuelled with waste plastic pyrolysis oil exhibit higher thermal efficiency up to 75% of the rated power for diesel engine.

Based on the above inspection it is found that there is no significant power reduction in the engine operation on plastic pyrolysis oil – diesel blends with 20% level of significance. A. The volumetric efficiency is found to be decreased when compared to diesel, at all three levels of blends. B. The brake thermal efficiency is increased up to 20% with an increased blend of plastic pyrolysis oil as compared to diesel. C. Similarly, the mechanical efficiency is also increased up to 20% with an increased blend of plastic pyrolysis oil blend when compared to diesel. Hence, it can be concluded that the oil derived from waste plastic can be used as a promising alternate fuel for transportation.

Based on the reviewed paper for the performance and emissions of waste plastic Pyrolysis oil , it is concluded that the waste plastic Pyrolysis oil represents a good alternative fuel for diesel and therefore must be taken into consideration in the future for transport purpose. Further it is concluded that, i. Engine was able to run with 100% waste plastic oil. ii. Engine fuelled with waste plastic oil exhibits higher thermal efficiency up to 75% of the rated power. iii. Brake thermal efficiency of the engine fuelled with waste plastic oil with retarded injection timing is found to be higher.

7. CONCLUSION

In this regard, the catalytic pyrolysis studied here presents an efficient, clean and very effective means removing the debris at we have left behind over the last several decades.

By converting plastics to fuel, we solve two issues one of the large plastic seas, and the other of the fuel shortage. This dual benefit, though will exist only as long as the waste plastics last but will surely provide a strong platform for us to build on a sustainable, clean and green future. By taking into account the financial

benefits to such a project, it would be a great boon to our economy.

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