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# EXPERIMENTAL INVESTIGATION OF THERMOFUEL FROM WASTE PLASTIC

CHINTAN R PATEL[1], KEYUR JOSHI[2], MARGESH AMIN[3] KEVAL SHAHT[4]

[1,2,3,4]*Mechanical engineering, Parul Institute of Technology*

**Abstract** — *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. 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 using plastic as the major component. This project is an effort for the conversion of plastics into fuel which are in commercial use, under pilot implementation and under laboratory testing, aimed to raise awareness on available options.*

*The production method for the conversion of plastics to liquid fuel is based on the pyrolysis of the plastics and the condensation of the resulting hydrocarbons 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 most of the situations, plastic waste recycling could also be economically viable, as it generates resources, which are in high demand. Plastic waste recycling also has a great potential for resource conservation and harmful emissions reduction, such as producing fuel from plastic waste.*

***Keywords***- *Fuel, Waste Plastic, Pyrolysis*

## I. INTRODUCTION

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, 0020plastic shopping bags, PET bottles and other goods/appliances using plastic as the major component. 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 most of the situations, plastic waste recycling could also be economically viable, as it generates resources, which are in high demand. Plastic waste recycling also has a great potential for resource conservation and harmful emissions reduction, such as producing Diesel fuel from plastic waste.

This paper is a compilation for the conversion of plastics into fuel which are in commercial use, under pilot implementation and under laboratory testing, aimed to raise awareness on available options.

The production method for the conversion of plastics to liquid fuel is based on the pyrolysis of the plastics and the condensation of the resulting hydrocarbons. Pyrolysis refers to the thermal decomposition of the matter under an inert gas like nitrogen, followed by cracking using suitable catalyst. Polyethylene, Polypropylene and Polystyrene plastic will be preferably used in this project as feedstock in the production of liquid Hydrocarbons. When the waste is broken down, it produces gaseous products including methane, propane and ethane, which are then converted into ethanol for use as biofuel.

## II. DIFFERENT RECYCLING CATEGORIES:

**Primary Recycling:**

It is also known as mechanical reprocessing. During the process, the plastic waste is fed into the original production process of basic material. So, we can obtain the product with same specification as that of the original one. This process is feasible only with semi clean scrap, so it is an unpopular choice with the recyclers. Degraded plastic waste partly substitutes the virgin material. So, on increasing the recycled plastic fraction in feed mixture, the quality of the product decreases. This type of recycling requires clean and not contaminated waste which is of the same type as virgin resin.

For this reason, steps in the primary recycling process are:(1)separate the waste by specific type of resin and by different colors and then wash it,(2)the waste has better melting properties so it should be extruded into pellets which can be added to the original resin. This type of recycling is very expensive compared to other types of recycling due to the requirements of plastic properties mentioned above. If the waste can be easily sorted by resin but cannot be pelletized due to mixed coloring contamination, then waste can be fed into molding application, and regarding reactants properties, it is less demanding.

**Secondary Recycling:**

Secondary recycling uses PSW in the manufacturing of plastic products by mechanical means, which uses recyclates, fillers, and/or virgin polymers. The objective of the process is to retain some energy which is used for plastic production to attain financial advantages. Unlike primary recycling, the secondary recycling process can use contaminated or less separated waste. However, this waste has to be cleaned. The recycling process involves different products and is different compared to original production process.

**Tertiary Recycling:**

This process is also known as cracking process. The process includes breaking down the plastics at high temperatures (thermal degradation) or at lower temperatures in the presence of catalyst (catalytic degradation), which contain smaller carbon chains. For any chemical production, this feedstock can be used as basic material of lower quality (e.g., polymerization or fuel fabrication). The original value of the raw material is lost. The tertiary recycling process is more important due to high levels of waste contamination. We are able to recover the monomers of condensation polymers. Mechanisms like hydrolysis, methanolysis, or glycolysis can be used, for example, PET (polyethylene terephthalate), polyesters, and polyamide while addition of polymers like polyolefin, polystyrene, and PVC requires stronger thermal treatment, gasification, or catalytic degradation to be cracked.

**Quaternary Recycling:**

This process includes the recovery of energy content only. As most plastic waste has high heat content so it is incinerated. Generation of the heat energy is the only advantage of this process. The residual of this incineration has 20wt%, respectively, 10 vol% of the original waste and are placed in landfills. Solid waste problem is not solved by this process; in fact it leads to the problem of air pollution

## III. EXPERIMENTAL PROCEDURE

The pyrolysis process is an advanced conversion technology that has the ability to produce a clean, high calorific value hydrocarbon from waste (polyethylene). The detailed procedure is given below:

- Take1 kg of waste plastics of some kind [LDPE, HDPE] cut it into piece and dry it .
- The waste plastic is put inside the reactor after drying it.
- The reactor must design to withstand high temperature of about $350^{0}$c-$400^{o}$c.
- It has an inlet at the top for collecting the vapor.
- Start the burner for heating the reactor and measure the temperature.
- When the temperature reaches $150^{o}$c the vapour start to come down to the Condenser.
- The heating is continued for about $1^{1/2}$ hours till the vapour stop collecting.
- After 1 or $1^{1/2}$ hrs the plastics are decomposed.
- At the time larger carbon molecules are break into smaller molecules.
- There is no need of using catalyst for the process.
- The top of the reactor inlet is connected with the spiral condenser where the vapours are condensed.
- Finally the fuel from condensed vapours are collected .
- Approximately 700ml of thermo fuel will be collected from per kg of waste plastics.
- Thermocouple is used to measure high temperature .

**Apparatus and Material**.

**1)Reactor**

**Figure Initial Reactor**

**Figure Final reactor**

The Reactor which we used in initial phase had some leakages in it and it was not enough strong to withstand against the pressure and temperature that will be created during the process, to avoid the above mentioned problems we used Mild Steel pipe of approx. 5mm thick and machined it from upper side we had used pressure and temperature gauges measure the temperature we had also used handles on the lid and outer surface of the reactor so to avoid the accident and for safety. In reactor the plastic waste is heated and the temp goes up to 500C.

**2) Condenser**

It cools all the heated vapour coming out of the reactor. It has an inlet and an outlet for Vapour to run through its outer area. This is used for cooling of the vapour. The gaseous hydrocarbons at a temperature of about 350c are condensed to about 30 – 35c. The initial condenser was made was not really a success case it has lots of leakages in it after deep thinking of another type of condenser which is like heat exchanger is made and it worked successfully.

**Figure Successful working condenser**

The successful working codensor we made is of aluminum of outer shell and the flow of vapour will be given through the spiral copper tube which is inside of the shell. The refrigerant used in condenser is cold water and ice cubes. We also managed to fit tap for removing hot water

we were success in eliminating the errors in the 1st phase. There were no leakages found, the reactor was air tight, safety aspects things like temp and pressure gauge as be fitted. The condenser was also made which was successful in condensing the vapour into the liquid form.

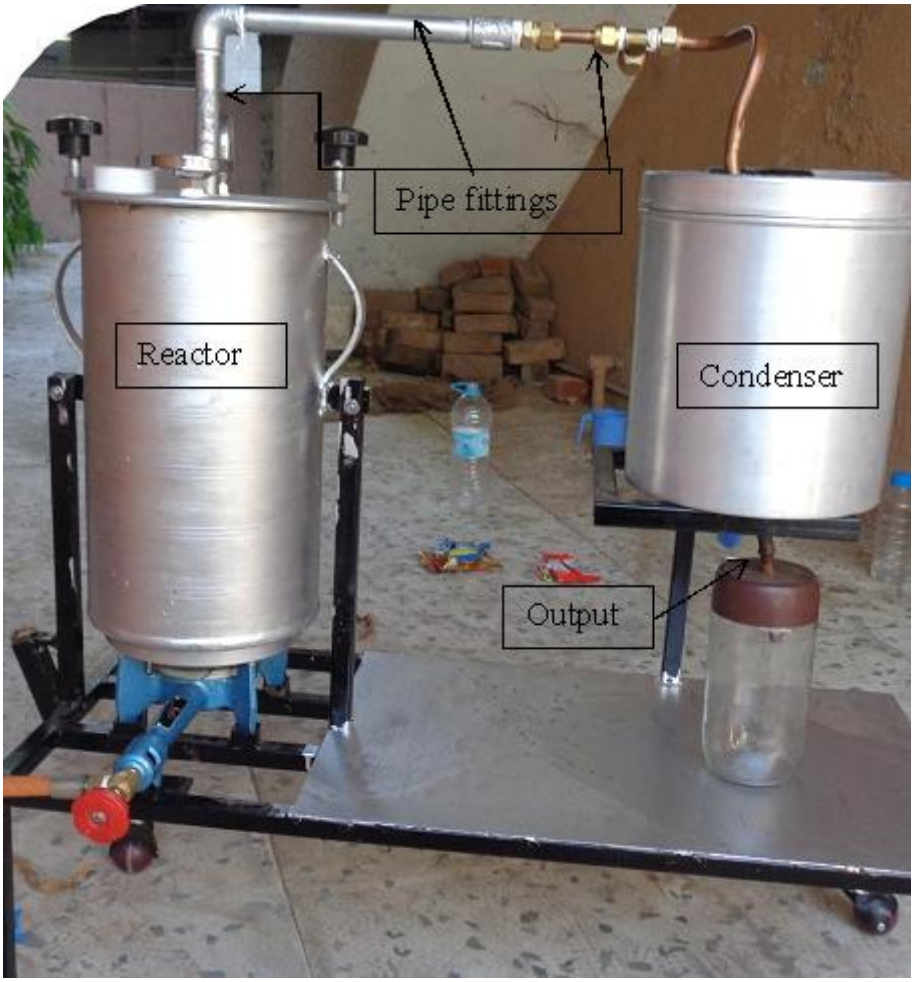
## IV. PROCEDURE

a) The setup was being made ready for the experiment.
b) We Fed the plastic into the reactor then the external heat source was given.
c) The process started and after approx. 45min of heating and reach temp of 350c the vapour started to evolve and it can be seen.
d) The Vapour goes to the condenser where it gets condensed to liquid.
e) Finally we got the output.
f) The sample (output) was collected in air tight container so its properties don‘t change.

- **INPUT FEED**
    1. Plastic bottles
    2. Plastic bottle caps

3. Polyethylene
4. Plastic food packets
5. Other plastic waste




## V. TESTING

The flash point of a volatile material is the lowest temperature at which it can vaporize to form an ignitable mixture in air. Measuring a flash point requires an ignition source. At the flash point, the vapor may cease to burn when the ignition source is removed. The flash point is not to be confused with the auto ignition temperature (which does not require an ignition source) or with the fire point (the temperature at which the vapor continues to burn after being ignited).Neither the flash point nor the fire point is dependent on the temperature of the ignition source, which is much higher Specific Gravity- Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance. Ash- Absence of ashes

## VI. CONCLUSION

The production of thermofuel from waste plastics is one of the better methods to save the environment profitably. The collected fuel had been tested in MET-CHEM LABORATORIES and the sample test results have been enclosed with this report which shows its stability in this world as a fuel. We here by conclude that our project will be a pillar to save the environment and source for fuel.

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