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Extraction of Fuel from Waste Plastic Using Pyrolysis

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Abstract:

There is an increase in the production and consumption of plastics as the day goes by. All the plastics need to be disposed after their usefulness, as waste from plastic become more apparent. This leads to pyrolysis, which is away of making to become very useful by recycling them to produce fuel oil. In this project plastic wastes were used for the pyrolysis to get fuel oil that has the same physical properties as the fuel used in aviation industry.

In this project a pyrolysis reactor is reactor is fabricated in order to extract pyrolysis fuel from waste plastics. It includes a rector and a condenser. Reactor to melt the waste and the condenser is to condense fuel vapour. No catalystis used since the use of catalyst produce fuel with more toxic smell. The property of fuel is checked and compared with diesel after extraction and found that the fuel produced is having property same as that of conventional.

Keywords: Waste plastic, polyethylene, pyrolysis, fuel oil, reactor

1. Introduction

Every year humans produce nearly 280 million tons of plastic, and much of that plastic ends up in the environment, harming marine life and other ecosystems. The chemical bonds that makes plastic so durable makes it equally resistant to natural processes of degradation. Since plastics are non-biodegradable in nature, it is very difficult to eliminate the waste plastics from nature. Since 1950s 1 billion tons of plastic have been discarded and may persist for hundreds or even thousands of years. [1] Management of plastic waste is a big issue in India. According to Central Pollution Control Board (CPCB), India generates 5.6 million tons of plastic waste annually and approximately only 60% of collected plastic waste is re- cycled. Tons of Plastic waste is dumped on land and huge amounts are disposed of into the water bodies. These plastic wastes could instead be used for producing fuel. Pyrolysis of waste plastic could provide a better way to dispose of the waste plastic which causes environmental pollution. [1]

2. What is Plastic

Plastic is a material consisting of a wide range of synthetic or semi synthetic organics that can be molded into solid objects of various shapes. Plastics are generally organic polymers of high molecular mass. Most plastics contain organic polymers. The vast majority of these polymers are based on chains of carbon atoms alone or with oxygen, sulphur, or nitrogen. The important thing is that part of the chain on the main "path" linking a large number of repeat units together.

Due to their relatively low cost, ease of manufacture, versatility, and imperviousness to water, plastics are used in an enormous and expanding range of products. They have already displaced many traditional materials, such as wood, stone, horn and bone, leather, paper, metal, glass and ceramic, , in most of their former uses. In developed countries, about a third of plastic is used in packaging and another third in buildings such as piping used in plumbing or vinyl siding. Other uses include automobiles, furniture, and toys. In the developing world, plastics have many uses in the medical field. [2]

3. Pyrolysis

Pyrolysis is the chemical process in which the plastic is heated in non oxygen environment where it is melted at about 400°C and the process results in formation of vapors and liquid in the heating chamber. The plastic loaded heating chamber is heated for about 45 minutes by employing heating element which is hold into ceramic coil holder made up of ceramic. Then the vapors produced in heating chamber are passed into copper coil to condenser through reducer. In condenser high temperature vapors is condensed. This condensed liquid have the properties nearly similar to standard properties of crude oil. It is collected in the fuel collector after condensation. [3]

3.1 Pyrolysis of plastic

Pyrolysis is the process of thermal degradation of plastic without oxygen. In this method we heat the plastic in a chamber. Due to absence of oxygen plastic is directly convert into the gas and gases which were produced are cooled by condensation. For this process we need temperatures about 400°C

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to 450°C and suitable catalyst is used for the quick reaction.

Pyrolysis of Plastic method has followed steps;

i) Removing oxygen from furnace.

ii) Heat the plastic evenly by increasing heating range.

iii) Pyrolising the plastic.

iv) Catalytic conversion of the gases to specific carbon chain lengths.

v) Condensation of gases (vapor) which are come from the furnace by suitable cooling method for better quality. [4]

4. Working Principle

Shredded plastics were procured before pyrolysis. Pyrolysis is the thermal degradation of solid wastes at high temperatures (350-550^{0}C) in the absence of air (and oxygen). Pyrolysis of waste plastics was carried out in an indigenously designed and fabricated reactor. Waste plastics had been procured form the commercial source and stored in a raw material storage unit. Raw material was then fed in the reactor and heated by means of electrical energy. The yield commenced at a temperature of 450^{0}C. The gaseous products resulting from the pyrolysis of the plastic wastes is supplied through the copper tube. Then the burned plastic gas condensed in a water cooled condenser to liquid fuel and collected for experiments.

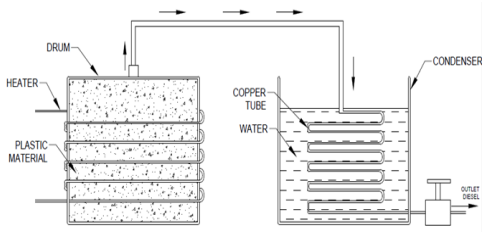

Fig.1– Line diagram of pyrolysis setup

5. Components and description

The major parts "EXTRACTION OF FUEL FROM PLASTIC WASTE MATERIAL" are described below:

5.1 LOW DENSITY POLYETHYLENE

This is prepared by high pressure of ethylene. It is made from petroleum. It has a density range of 0.910 - 0.940g cm3. It is not reactive at room temperature, except by strong oxidizing agents and some solvents causing swelling. It can withstand temperatures of 80ºC continuously and 95ºC for a short time. LDPE is used for manufacturing various containers, dispensing bottles, wash bottles, tubing, plastic bags for computer, and its common use is in plastic bags.

5.2 REACTOR

This is a stainless steel tube of length 145mm, internal diameter 37mm, outer diameter 4lmm sealed at one end and an outlet tube at the other end. The reactor is to be placed inside the furnace for external heating with the raw material inside for internal heating. The reactor is heated by electrical heating to temperature of about 500ºC and more.

5.3 FURNACE

The material used for the fabrication of major components is mild steel. Mild steel has a carbon content ranging from 0.15% to 0.30%. It has properties suitable for fabrication and is available easily. A 3 kW electric coil was selected for the purpose of attaining the required temperature in the heating chamber. The coil has been wrapped around a ceramic block of dimensions 170 mm x 170 mm x 300 mm. The coil was sealed in its place with the help of furnace cement. The figure shows the electric coil enclosed around the block and secured in its place by furnace cement. Glass wool was used for insulation around the furnace.

5.4 CONDENSER

It cools the heated vapor coming out of the reactor. It has an inlet and outlet for cold water to run through its outer area. This is used for cooling the vapor. The gaseous hydrocarbons at a temperature of about 35OºC are condensed to about 30-35ºC.

6. Fuel Properties

Density:-

Density of fuel at different temperatures was measured by a standard 25 ml marked flask. 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 measured 821 kg/m3.

Calorific value:-

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

Calorific value determined by using bomb calorimeter and measured as 41050 kJ/kg.

Flash point:-

The flash point is the lowest temperature required to generate the flammable vapors using the liquid, which is ignited in air by the flame above its surface.

The flash point is determined experimentally at 22^0c.

Fire point:-

Plastic liquid fuel is poured up to the mark indicated in the flash point Apparatus. Then the oil is heated and stirred at regular interval. The external fire is introduced at the regular period till flash is observed. Once the flash is observed the temperature is recorded. Recorded temperature at the time of the fire starts to see continuously is the fire point of the plastic liquid fuel.

The flash point is determined experimentally at 29^0c

7. Results and discussion

SL.NO	PROPERTIES	PLASTIC FUEL	DIESL FUEL
1	Density (kg/m3))	821	840
2	Calorific value (kJ/kg)	41050	42000
3	Flash point (^{0}c)	22	52
4	Fire point (^{0}C)	29	74

8. Conclusion

According to the current statistics, there is continuous rise of 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 fuel was carried out in pyrolysis process.

This method is effective in all respects, ecological as well as economical. By adopting this technology, efficiently convert weight of waste plastics into 75% of useful liquid 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 source of energy such as fossil fuels at this stage demands the improvements of this technique.

Based on the properties of the 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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