"PRODUCTION AND PURIFICATION OF LIQUID FUEL FROM HOUSEHOLD PLASTIC WASTE FOR CI ENGINE"

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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 at over flowing bins and landfills. Though work has been done to make futuristic biodegradable plastics, there have not been many conclusive steps towards cleaning up the existing problem. Here, the process of converting waste plastic into value added fuels is explained as a viable solution for recycling of plastics. Pyrolysis runs without oxygen and in 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 from ethane which is a constituent of natural gas. Therefore the waste plastic can be converted back into it.*

Keywords— Plastics; Pyrolysis Setup; Purification Setup

1. INTRODUCTION

Plastic were invented in 1860, but have only been widely used in the last 30 years plastic are light, durable, modifiable and hygienic. Plastic are made of long chain of molecule called Polymers. Polymers are made when naturally occurring substance such as crude oil or petroleum are transformed into other substance with completely different properties. These polymers can then be made into granules, powders and liquids, becoming raw materials for plastic products [1]

Plastics have become an indispensable part in today's world. Due to their light weight, durability, energy efficiency, coupled with faster rate of production and design flexibility, these plastics are employed in entire gamut of industrial and domestic areas. Plastics are produced from petroleum derivate 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 effective method has not been implemented. Plastics are non-biodegradable polymers mostly containing carbon, hydrogen, and few other elements like nitrogen. Due to its non-biodegradable nature, the plastic waste contributes significantly to the problem of waste management. According nationwide survey which was conducted in the year 2000, approximately 6000 tons of plastic were generated in India, and only 60% of it was recycled, the balance of 40% could not be disposed off. Today about 129 million tons of plastics are produced annually all over the world, out of which 77 million tons produced from petroleum.

In India alone, the demand for the plastics is about 8 million tons per year. More than 10,000 metric tons per day plastics are produced in India and almost the same amount is imported by India from other countries. The per capital consumption of plastics in India is about 3kg when compared to 30kg to 40kg in the developed countries. Most of these come from packaging and food industries. Most of the plastics are recycled and sometimes they are not done so due to lack of sufficient market valve. Of the waste plastics not recycled about 43% is polyethylene, with most of them in containers and packaging. [2]

2. METHODOLOGY

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 cover. Nearly 15 tons of plastic cover is wasted in single village. This waste plastic cover is also used in Belagavi, dharawad, hubli, vijayapur, karwar district's etc. for the period of 4 months that will leads to mass plastic waste. This highest portion of plastic is disposed to landfill. By survey nearly 150 tons to 200 tons of plastic cover is disposed into land in single district. By estimating 5000 tons to 6000 tons of plastic will be wasted from household sources in the state. Waste plastics have been shredded then washed before pyrolysis. [3]From above factors from municipal plastic waste have been used as raw materials. Waste plastics have been washed before pyrolysis. In this work milk plastic cover and edible oil covers are selected as feed stocks to convert waste plastic into useful liquid fuel compounds.

A) Raw materials

B) Desirable parameters for the design

1. Melting point of the substance if melting point is high, substance easily vaporizes & more oil is obtained.
2. Density if density is lower, substance easily vaporizes & more oil is obtained.
3. Quality of substance more is quality, more is the yield of oil.
4. Moisture content more is moisture, less is the oil yield.
5. Reactor Temperature more is the reactor temperature, more is the yield.
6. Heating rate more is the heating rate, more is the yield.
7. Reactor size there is an optimum for the reactor size to get maximum oil yield.
8. Feed rate Feed rate is given according to the demand for the oil.
9. Maintaining a uniform temperature for continuous production it should maintain a uniform temperature.
10. Types of condenser used Condenser design also effects the production of maximum product yield.

C) Fabrication of Pyrolysis unit

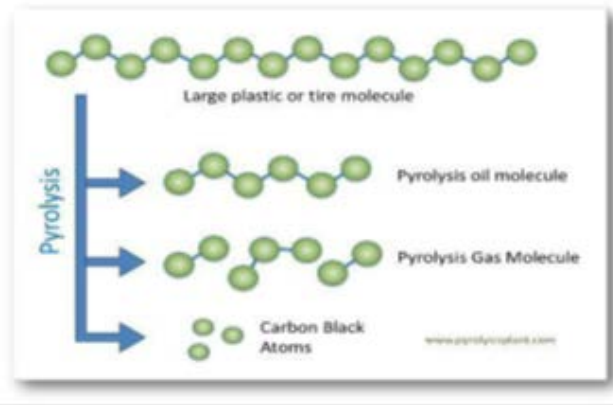
Pyrolysis unit developed from MS materials with 3mm thickness. By using arc and gas welding technology, we are fabricated the above pyrolysis unit. The experiments carry out with high temperature and atmospheric pressure so unit must be withstanding to high temperature. Thermocouples, pressure gauge and safety valves are provided to reactor. Reactor welded by using gas welding to prevent the leakage of vapors. The safe and efficient pyrolysis unit is shown in the Fig.

D) Steps involved in process

a. Feeding- Feed the feedstock‘s to reactor through feeder and closes the feeder inlet.
b. Heating- To increase the temperature of reactor, heat the product of reactor inside by using heating source.
c. Condensing- The plastic get evaporated at high temperature, this vapor is condensed to atmospheric temperature by using straight and spiral tube condensers.
d. Liquid collection-Out coming product from the condenser is collected at liquid collector. At the end of condenser provide a cyclone separator to separate the plastic liquid fuel and non-condensable gases. These non-condensable gases are reuses to heat the pyrolysis unit.
e. Water wash, Purification and pH test- This involves many purification processes. In this method we take equal proportion of plastic fuel and water in a container and shake well, allow it for 5-7 hours to settle down. Now water along with some crystals is collected at bottom and pure plastic fuel is collected at the top container.
f. Purification- Purify the plastic fuel by using filter papers and filters.
g. PH Test- After purification measure the pH value of plastic fuel by using pH meter. If the pH is less than 7, the fuel is acidic in nature. It is needed to wash with water many times to bring pH value of oil to 7.

E) Plastic Pyrolysis oil

Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements pyro "fire" and lysis "separating".



Pyrolysis differs from other high-temperature processes like combustion and hydrolysis in that it usually does not involve reactions with oxygen, water, or any other reagents. In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs. Bio-oil is produced via pyrolysis, a process in which biomass is rapidly heated to 450–500°C in an oxygen-free environment and then quenched, yielding a mix of liquid fuel (pyrolysis oil), gases, and solid char. Variations in the pyrolysis method, biomass characteristics, and reaction specifications will produce varying percentages of these three products. Several technologies and methodologies can be used for pyrolysis, including circulating fluid beds, entrained flow reactors, multiple hearth reactors, or vortex reactors. The process can be performed with or without a catalyst or reductant.

3. PURIFICATION SETUP

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

4. RESULTS AND DISCUSSION

4.1 Properties of plastic pyrolysis oil

1) 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 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. Calorific value determined by using bomb calorimeter.

Procedure:

1. Weight the empty crucible.
2. Take approximately 0.5gm of liquid fuel in a crucible & reweight.
3. Place the crucible in its support and coil a small loop of the nicrome wire between the two conductors and a piece of thread is dipped into the fuel screw the cap firmly on to the body of the bomb and charge with oxygen until a pressure of 25 bar is obtained.
4. Lower the bomb into the calorimeter and connect the firing wire. Pour about 2.25 liters of water into the calorimeter so as to completely cover the bomb, fit a thermometer and stirrer. Press fire button to start the ignition, temperature of water starts to rise, note down the temperature of water for every 10 seconds.
5. Until the transfer of heat from bomb has ceased has indicated by fall in temperature reading.
6. Take down the maximum temperature for the calculation of calorific value by using below relationship.

3) Viscosity:

Viscosity is an important property fuel and it is 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 test:

Procedure: Measured 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.

Comparison of Properties of the Waste plastic fuel And Diesel Fuel:

Sl. Nor.	Properties	Plastic Fuel	Diesel fuel
1	Density(kg/m3)	821	812
2	Calorific Value(kJ/kg)	45,050	42,000
3	Kinematic Viscosity	2.1	3.05
4	Flash Point (0c)	-	66
5	Fire Point (0c)	38	74

5. 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 liquid hydrocarbon fuel was carried out in thermal pyrolysis unit.

This method is superior in all respects (ecological and economical).By adopting this technology, efficiently convert 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 source of energy such as fossil fuels at this stage demands the improvements of this technique.

Based on the properties of the Plastic fuel and Diesel fuel the 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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