ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Special Issue
National Conference on Advances in Civil and Mechanical Engineering (NCACME 17)

Production of Biofuel Compounds from Different Plastic Wastes

[1]Prof Naveen Kumar P, [2], Prof Manjunath G P [3] Prof Mahesh Halli
[1][2][3] Assistant Professor, Girijabai Sail Institute of Technology, karwar,

Abstract:- **Plastics have been one of the materials with the fastest growth because of their wide range of applications due to versatility and relatively low cost. The duration of life of plastic products is relatively small, there is a vast plastics waste stream that reaches each year to the final recipients creating a serious environmental problem. In this paper attempt has been made to investigate the conversion of waste plastic into liquid fuel by using pyrolysis process, a pyrolysis unit is designed, fabricated and evaluated for various kinds of plastic wastes, properties of liquid fuels obtained are determined. Blending with diesel fuel is done.**

Keywords:-- **Biodiesel, Low Density Polyethylene, High Density Polyethylene, Plastic fuel.**

I. INTRODUCTION

Plastic were invented several years 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.

Plastics have become an indispensable part in today‘s world. 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. Plastics are produced from petroleum derivates 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 yet 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 to a nationwide survey which was conducted in the year 2000, approximately 6000 tons of plastic wastes were generated every day 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 tones are produced from petroleum.

In India alone, the demand for plastics is about 8 million tons per year. More than 10,000 metric tons per day of plastics are produced in India and almost the same amount is imported by India from other countries. The per capita consumption of plastics in India is about 3 kg when compared to 30 kg to 40 kg 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 value. Of the waste plastics not recycled about 43% is polyethylene, with most of them in containers and packaging.

II. GENERATION OF DIFFERENT PLASTIC WASTE

Continuous innovation explains that, plastics production has increased by an average of almost 10% every year on a global basis since 1950. The total global production of plastics has grown from around 1.3 million tons (MT) in 1950 to 245 MT in 2006. Plastics continue to be a global success story with Europe (EU25 + Norway (NO) and Switzerland (CH) remaining a major manufacturing region, producing about 25% of the total estimated worldwide plastics production of 245 million tons during 2006. An analysis of plastics consumption on a per capita basis shows that this has now grown to over 100 kg/year in North America and Western Europe, with the potential to grow to up to 130 kg/year per capita by 2010 [1]. The highest consumption of plastics among different countries is found in USA which is equal to 27.3 MT against 170 MT world consumption in 2000 and is expected to reach to 39 MT by 2010[1]. The highest potential for growth can be found in the rapidly developing parts of Asia (excluding Japan), where currently the per capita consumption is only around 20 kg/year. In the European context, it is the new member states such as Poland, Czech

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Special Issue
National Conference on Advances in Civil and Mechanical Engineering (NCACME 17)

Republic and Hungary which are expected to see the biggest increase as their economies development. Their current average per capita consumption of 55 kg is a little more than half of that of the old Member State. Significant growth rate in Asia and Eastern Europe expected, however in 2010 demand per capita in Asia and Eastern Europe is still much below the rate of the traditional markets‘‘ like America and Western Europe. The average Indian consumption of virgin plastics per capita reached 3.2 kg in 2000/ 2001 (5 kg if recycled material is included) from a mere 0.8 kg in 1990/1991 and 1.8 kg in 1998/1999. However, this is only one fourth of the consumption in China (12 kg/capita, 1998) and one sixth of the world average (18 kg/ capita) [1].

India has a plastic consumption of 3.2 MT during 2000 and is expected to reach nearly 12.5 million ton by 2010 [1]. Hindu Business line, January 21, 2006 reveals India will be the third largest plastics consumer by 2010 after USA and China. The reason of highest growth rate in last few year in India is due to the fact that, one third of the population is destitute and may not have the disposable income to consume much in the way of plastics or other goods. The virgin industry does not target this population to expand its markets. However, one third of the population is the middle class whose aspirations could be moulded to increase consumption. Plastic manufacturers create needs for this segment of population. The rising needs of the middle class, and abilities of plastics to satisfy them at a cheaper price as compared to other materials like glass and metal, has contributed to an increase in the consumption of plastics in the last few years . The rapid rate of plastic consumption throughout the world has led to the creation of increasing amounts of waste and this in turn poses greater difficulties for disposal. This is due to the fact that duration of life of plastic wastes is very small (roughly 40% have duration of life smaller than 1 month) and depending on the area of application, the service life of plastic products ranges from 1 to 35 years. The weighted average service life of all plastics products is different in different countries and in India it is 8 years; this is much less than the weighted average service life for Germany which is estimated at 14 years. This difference in service life reflects the fact that a particularly high share of plastics is used for short life products in India (e.g. share of plastics packaging: 42% in India versus 27% in Germany [1].

Figure 1: Agriculture generated plastic waste

Figure2: Household plastic wastes

III. METHODS AND METHODOLOGY

In this paper cracking (Pyrolysis) is used to convert waste plastic into liquid fuel compounds. Pyrolysis is generally defined as the controlled burning or over heating of a material in the absence of oxygen. In plastics pyrolysis, the macromolecular structures of polymers are broken down into smaller molecules or oligomers and sometimes monomeric units. Further degradation of these subsequent molecules depends on a number of different conditions including temperature, residence time, and the presence of catalysts and other process conditions [1]. The pyrolysis reaction can be carried out with or without the presence of catalyst. Mainly two methods are used to produce bio fuel from plastic waste

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Special Issue
National Conference on Advances in Civil and Mechanical Engineering (NCACME 17)

(a).Thermal Pyrolysis
(b)Catalytic Pyrolysis

A. Biofuel production
Following steps are involved in the production of biofuel.

1) Collection of waste plastic
In this step different plastic waste are collected

2) Feeding- Feed the feedstock's to reactor through feeder and closes the feeder inlet.

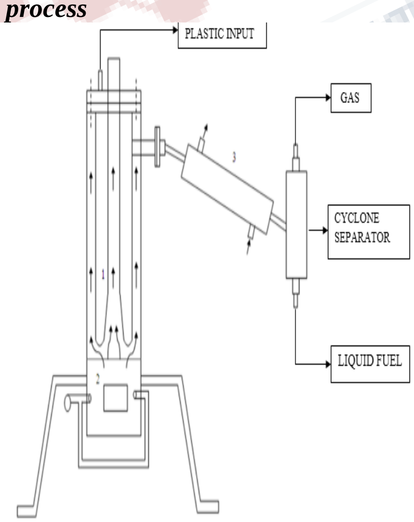
3) Heating- To increase the temperature of reactor, heat the product of reactor inside by using heating source

4) Condensing- The plastic get evaporated at high temperature, this vapor is condensed to atmospheric temperature by using straight and spiral tube condensers.

5) 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.

6) 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.

7) Pyrolysis process



1. Reactor, 2. Combustion chamber, 3. Condenser
Fig3: Experimental setup of pyrolysis process

The heart of the experimental apparatus was a vertical tubular reactor. A feeder was attached to the reactor's upper end; this enabled controlled amounts of plastic pellets to be added before or during operation. At the bottom of the reactor attached a furnace for the purpose of heating the reactor. Biomass and charcoal with blower is used as a heating source to heat the reactor. Due to increasing reactor temperature the plastic starts to evaporate, these Vapors leaving the reactor and passed into a condenser, condenser maintained at atmospheric temperature. The cyclone separator is provided at the end of condenser to separate the gaseous and plastic liquid fuel compounds. The gas is reused to heat the pyrolysis unit and another end of cyclone separator is connected to a flask in which the liquid hydrocarbon product was collected. Temperatures and pressure were monitored continuously by using thermocouples and pressure gauge [1].

Following figure 4 and figure5 shows the working details. In figure4 shows working setup with assembly of blower, condenser (cooling system) and furnace. In fig 5 shows a gaseous product produced after pyrolysis process started. The properties of produced gaseous product is almost similar to the LPG.

Figure 4:Working setup

Figure 5: Gaseous product

B. Purification of raw biodiesel

In the purification process taking equal proportion of plastic fuel and water in a container and shacked well and 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.

Figure 6: Purification setup
Fig 6: purification setup

IV. RESULTS AND DISCUSSION

A) Table 1: Analysis of liquid fuel yields from thermal pyrolysis process

Type of condenser	Types of feedstock	Yield of liquid product	Residue
Straight Tube condenser	Plastic covers	35% – 39%	4.5% – 5%
	Medicine bottles	34% - 35%	5.5% - 7%
	Edible oil cover	45% - 50%	5.6% -7 %

Table 2: Analysis of liquid fuel yields from catalytic pyrolysis process Catalytic pyrolysis

Type of catalyst used- Dry wood powder and ash.
Ratio of catalyst used- 20-40gm/ batch
Used Catalyst– Wood powder and ash
Operating temperature = 300˚C- 350˚C
Quantity of sample – 1 kg/ batch

Type of condenser	Types of feedstock	Yield of liquid product	Residue
Straight Tube condenser	Plastic covers	45% –58%	4.5%-5%
	Medicine bottles	36% - 45%	4.5%-6%
	Edible oil cover	66% - 70%	5.6%-6%

B) Plastic liquid fuel and its different blends

Figure7: Plastic liquid fuel

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Special Issue
National Conference on Advances in Civil and Mechanical Engineering (NCACME 17)

Figure.8: Plastic liquid fuel with different blends

In the above Fig.7 and fig 8 shows the plastic liquid fuel obtained from the pyrolysis of waste plastic in both thermal pyrolysis and catalytic pyrolysis process and different blends with diesel.

V. CONCLUSION

The Polymer Energy system uses a process called pyrolysis to efficiently convert plastics into liquid fuel compounds. The conversion of municipal waste plastics to liquid hydrocarbon fuel was carried out in thermal and catalyst degradation. This method is superior in all respects (ecological and economical). By adopting this technology, efficiently convert waste plastics into 65% 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.

1. The properties of the blends 20%, 40% and 60 %and others blends are determined by various tests and experiments shows that it can be a good source of alternative for diesel
2. Biodiesel fuel and their different blends burn clearly and completely as that of the pure diesel
3. The production of plastic fuel from different plastics on a large scale can be beneficial economically
4. Therefore, this is most economic and efficient method to convert all types of plastic wastes into biofuel compounds and different blends of plastic fuel properties show that it can used as biodiesel.

REFERENCES

[1] **Achyut K. Panda R.K. Singh D.K. Mishra *[et al.]*.** Thermolysis of waste plastics to liquid fuel .A suitable method for plastic waste management and manufacture of value added Products A world prospective, 2009;

[2] **A. Adrados, I. de Marco, B.M. Caballero, A. Lopez, M.F. Laresgoiti, A.Torres*[et. al]*.** Pyrolysis of plastic packaging waste: A comparison of plastic residuals from material recovery facilities with simulated plastic waste.

[3] ***Alka zadagaonkar[et al].*** Conversion of Waste Plastic into Liquid Hydrocarbons / Energy—A major breakthrough in the arena of non-conventional sources ofenergy, Information Brochure and Technical Write-2009.

[4] ***Gupta S, Mohan K, Prasad R, Gupta S, Kansal A [et al.].*** Solid waste management in India: options and opportunities. Resources Conservation and Recycling 1998

[5] ***MoinuddinSarker [etal.].***Municipal Waste Plastic Conversion into Different Category of Liquid Hydrocarbon Fuel. ***Narayan P, Lindhqvist T, Tojo T [et al.].*** Analysing plastic waste management in India M.Sc.(Environmental Management and Policy) Thesis.2001.

[6] ***Lee KH, Shin DH, Seo YH [et al.].*** Liquid-phase catalytic degradation of mixtures of waste high-density polyethylene and polystyrene over spent FCC catalyst. Effect of mixing proportions of reactants. Polymer Degradation and Stability 2004.

[7] ***Mohammad Nahid Siddiqui a, Halim Hamid Redhwi [et al.].*** Pyrolysis of mixed plastics for the recovery of useful products

[8] ***Bockhorn H, Hornung A, Hornung U, Schawaller D[et al.].*** Kinetic study on thethermal degradation of polypropylene and polyethylene. Journal of Analyticaland Applied Pyrolysis 1998.