PLASTIC WASTE INTO FUEL USING PYROLYSIS PROCESS

Mantesh Basappa Khot[1], S Basavarajappa[2]

[1]UG STUDENT, University B D T College of Engineering, Davangere
[2]Professor, University B D T College of Engineering, Davangere Karnataka, India.

Abstract - *This paper discuss about the fuel preparation from low density plastic wastes. Plastics have woven their way into our daily lives and now pose a tremendous threat to the environment. Over a 280 million tone's of plastics are produced annually worldwide, and the used products have become a common feature at overflowing bins and landfills. Here, the process of converting waste plastic into value added fuels is explained as a viable solution for recycling of plastics. Thus two universal problems such as problems of waste plastic and problems of fuel shortage are being tackled simultaneously. In this study, plastic wastes (low density polyethylene) were used for the pyrolysis to get fuel oil that has the same physical properties as the fuels like petrol, diesel etc. Pyrolysis runs without oxygen and in high temperature of about 300°C. The waste plastics are subjected to pyrolysis to obtain different value added fuels such as petrol, kerosene, and diesel, etc. 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.*

Key Words: **Low density plastic waste, waste plastic oil, Pyrolysis, Thermal cracking.**

1. INTRODUCTION

Majority of plastics that are used are non-biodegradable in nature, they remain in environment for long period of time which affects the environmental quality. Plastics are non-biodegradable polymers [1]. Plastics contains mainly hi gh density poly ethylene, polyethylene, polypropylene, low density polyethylene. According to national survey approximately 10000 tons plastic wastes were produced every day in our country, but out of which only 60% waste plastics are recycled [5]. 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, plastic shopping bags, PET bottles and other goods/appliances which uses plastic as the major component. This increase has turned into a major challenge for local authorities, responsible for solid waste management and sanitation. Due to lack of integrated solid waste management, most of the plastic waste is neither collected properly nor disposed of in appropriate manner to avoid its negative impacts on environment and public health. 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 general, the conversion of waste plastic into fuel requires feed stocks which are non-hazardous and combustible. The composition of the plastics used as feedstock may be very different and some plastic articles might contain undesirable Substances nitrogen, halogens, sulphur or any other hazardous substances which pose potential risks to humans and to the environment [7]. The broad classification of plastic includes high density polyethylene, low density polyethylene, polypropylene and polystyrene [2]. Also, plastics are classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, poly addition, and cross-linking. Low-density polyethylene (LDPE) is used for its toughness, flexibility, and relative transparency. LDPE is used to make bottles that require extra flexibility. To take advantage of its strength and toughness, it is used to produce grocery bags and garbage bags, squeezable bottles, shrink wrap, stretch films, and coating for milk cartons. It can also be found in toys, container lids, and packaging. Polypropylene (PP) is known for its high melting point, which is used to make containers for yogurt, margarine, takeout meals, and deli foods. It is also use for medicine bottles, bottle caps, and some household items.

II. Fuel Demand

The present rate of economic growth is unsustainable without saving of fossil energy like crude oil, natural gas or coal. International Energy Outlook 2010 reports the world consumption of liquid and petroleum products grows from 86.1 million barrels per day in 2007 to 92.1 million barrels per day in 2020 and 110.6 million barrels per day in 2035 and natural gas consumption increases from 108 trillion cubic feet in 2007 to 156 trillion cubic feet in 2035. This way, the oil and gas reserve available can meet only 43 and 167 years further. Thus mankind has to rely on the alternate/renewable energy sources like biomass, hydropower, geothermal energy, wind energy, solar energy, nuclear energy, etc. Waste plastic to liquid fuel is also an alternate energy source path, which can contribute to depletion of fossil fuel as in this process liquid. Fuel with similar properties as that of petrol fuels is obtained.

III. PYROLYSIS

Pyrolysis is generally defined as the controlled heating of a material in the absence of oxygen. In plastics Pyrolysis, the macromolecular structures of polymers are broken down into smaller molecules and sometimes monomer units. Further degradation of these subsequent molecules depends on a number of different conditions including (and not limited to) temperature, residence time, presence of catalysts and other process conditions. The Pyrolysis reaction can be carried out with or without the presence of catalyst. Accordingly, the reaction will be thermal and catalytic Pyrolysis. Plastic waste is continuously treated in a cylindrical chamber. The plastic is pyrolised at 300^{0}C- 500^{0}C.

IV. METHODOLOGY

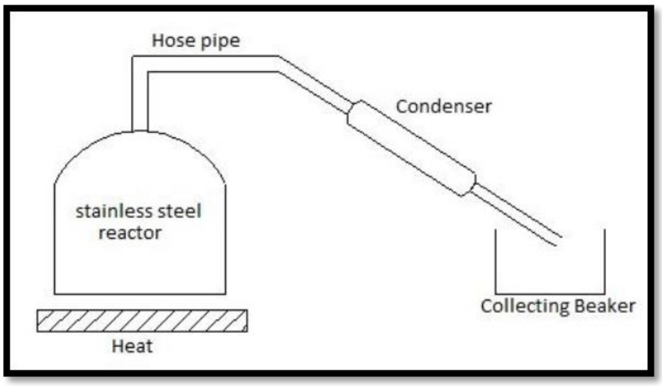

Fig -1: Schematic diagram of Experimental setup

IV.I Condenser

It cools the entire heated vapour coming out of the reactor. It has an inlet and an outlet for cold water to run through its outer area. This is used for cooling of the vapour. The gaseous hydrocarbons at a temperature of about 350°C are condensed to about 30 – 35°C.

IV.II Reactor

It is a stainless steel cylindrical container of length 1000mm, internal diameter 300m, outer diameter 320mm sealed at one end and an outlet tube at the other end. The whole cylindrical container is placed inside the reactor. The external heating is carried out using the raw material viz., cole, wood, coke, etc., below the container and inside the reactor. The reactor is made with the following: stainless steel, mild steel and clay for lagging. The reactor is heated to a temperature of about 450°C and more.

IV.III Process Description

Thermal cracking process without catalyst was used in converting waste plastic into liquid fuel. Only one type of waste plastic is selected for this particular experiment i.e., Low density polyethylene. Waste plastic are solid soft form. Collected waste plastic was cleaned using liquid soap and water. Washed waste plastics are cut into 3-5 cm size to fit into the reactor conservatively. For experimental purpose we used 6.5 Kg of LDPE. The experiment is carried out under a closed air system with no vacuum process applied during this thermal cracking process. We used low density polypethylene plastics in a batch process system because conversion temperatures for these plastics are relatively low. Heat is applied from 100°C at start to begin melting the waste plastics, the melted waste plastic turn into liquid slurry form when temperature is increased gradually. When temperature is increased to 270° C liquid slurry turns into vapour and the vapour then passes through a condenser unit. At the end we collect liquid fuel. Between 100º C and 250º C around 20 -30% of the fuel is collected and then when raised to 325º C the next 40% is collected and finally when held at 400º C the yield is fully completed. During the thermal cracking process plastic portions are not and finally when held at 400º C the yield is fully completed. During the thermal cracking process plastic portions are not broken down immediately because plastics have short chain hydrocarbon to long chain hydrocarbon. 1st stage of heat applied breaks down only the short chain hydrocarbon. When temperature profile is increased the plastic carbon-carbon bond breakdown slowly. As the temperature is increased the long chains are breakdown step by step. During in this thermal cracking process some light gas such as methane, ethane, propane and butane are produced. These compounds are not able to condense because they have negative boiling point. These light gases could be alkane or alkene group and it can also contain CO or CO2 emissions. Light gas production percentage is about 6%. This gas portion analysis is under consideration. The method which is considered for treating the light gas is an alkali wash system. After experiment is concluded some solid black residue is collected from the reactor. This solid black residue percentage is about 4%. Liquid fuel yield percentage is 90%. To purify the liquid fuel a purification system to remove water portion and ash or fuel sediment is used And it is also filtered with filter paper to remove some solid waste mixed in fuel while collecting in bottle. Liquid fuel density is 775kg/m^3. Finally we obtained 4 liters of plasto-fuel.

V. RESULTS and DISCUSSION

Physical manifestation may be like a viscous fluid with dim yellowish colour with an obnoxious odor. Flammability is that highly flammable Furthermore smoldered completely without any left-over residue. Starting with those outcomes it camwood make finished up that those specific gravity from claiming plasto fuel will be more than those petrol and less than the diesel Furthermore density of plasto fuel is more than those petrol and less than the diesel may be indicated in table no. 1. From the fig. 2. Should be obvious that those kinematic viscosity and dynamic viscosity from claiming plasto fuel is more than those petrol and less the diesel, it need closest esteem of the standard petrol. The fig. 3. Indicates that the sulfur content plasto fuel may be About equivalent to diesel more than that of petrol and there will be a absent of carbon residue in plasto-fuel. From the fig.4. we can see that the flash point and fire point of plasto fuel is more than the petrol and less than the diesel. From the fig.5. we can see that the gross calorific value of plasto fuel is less than the petrol and more than the diesel.

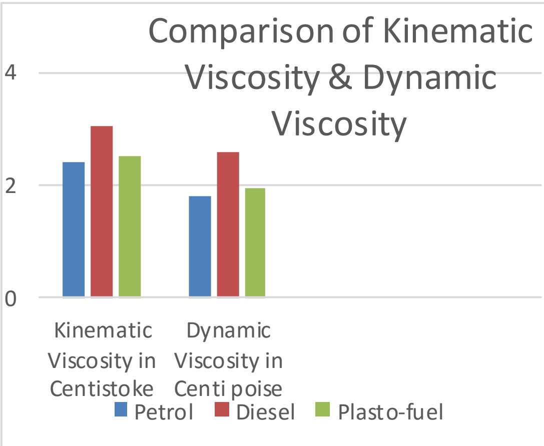

Fig -2: Comparison of Kinematic and Dynamic viscosity

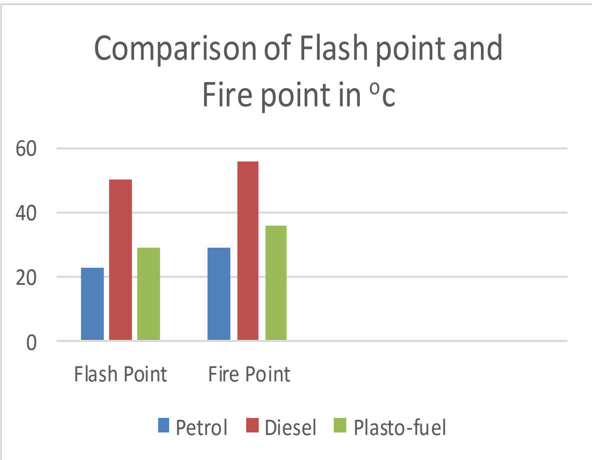

Fig -3: Comparison of flash and fire point Carbon

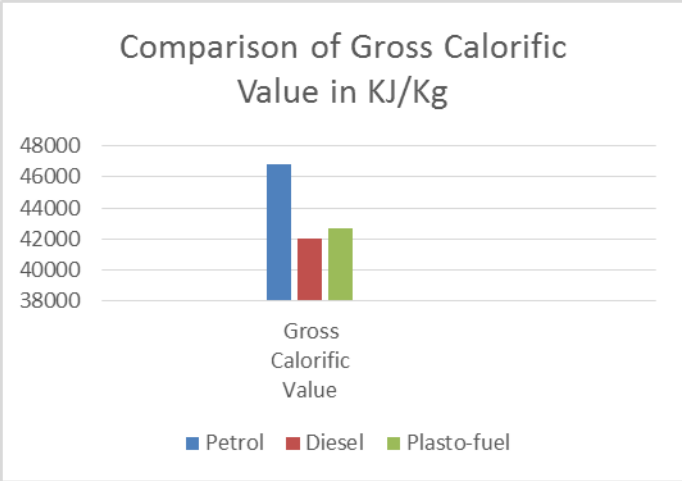

Fig -4: Comparison of gross calorific valve

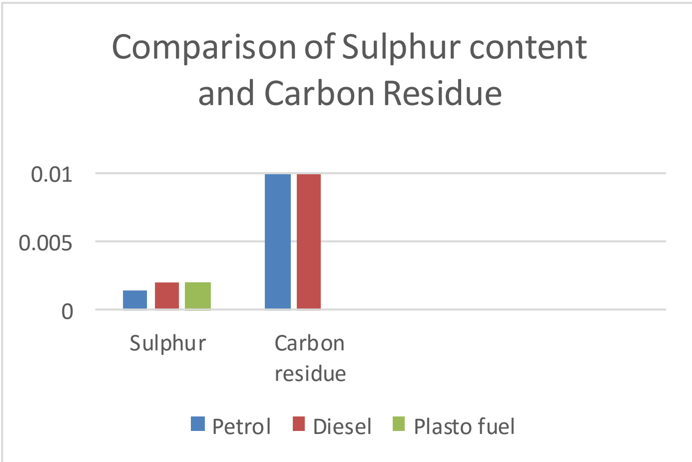

Fig -5:Comparison of Sulfur content and Carbon Residue

Table -1: Comparison of obtained Plasto-Fuel with Regular Petrol and Diesel

Sl. No.	Properties	Regular Petrol	Regular Diesel	Plasto–Fuel
1.	Specific Gravity	0.742	0.85	0.775
2.	Density (Kg/m³)	742	850	775
3.	Kinematic Viscosity(centistoke)	2.42	3.05	2.525
4.	Dynamic Viscosity (centiPoise)	1.796	2.592	1.957
5.	Gross Calorific Value (KJ/Kg)	46858	42000	42686
6.	Flash Point (⁰C)	23	50	29
7.	Fire Point (⁰C)	29	56	36
8.	Sulphur (%	0.0015	< 0.002	0.002

	w/w)			
9.	Carbon residue (% w/w)	< 0.01	0.01	Nil

CONCLUSIONS

In view of survey for our project, it may be closed that those waste plastic pyrolyzed oil represents a good alternative for diesel and petrol engine, subsequently must make thought seriously about later on to transportation reason for existing. Plastics present a major threat to today's society and environment. Over 14 million tons of plastics are dumped into the oceans annually, killing about 1,000,000 species of oceanic life. The transformation about these waste plastic under fuel serves us will spare the sea marine an aggregation. The oil that has been generated by the LDPE plastic by prescribed experimental process shows that the properties are very much comparable to the petrol. Ultimately, pyrolysis of LDPE does not only recover the energy contained in the plastic, but also manage the environment by alternate disposal technique of the waste plastic. This double beneficiary, if will exist just Concerning illustration long Likewise the waste plastics last, in any case will definitely gatherings give a solid stage to us with expand on a sustainable, clean and green future. By taking under record the budgetary profits of such An project, it might a chance to be an incredible help will our economy.

REFERENCES

1) Santosh UKumar, Ketan Nalawade, Anil Jadhav &T. Vijay Kumar, " Extraction of Plastic Oil From Plastic Oil From Plastic By De-Polymerization Technique as an Alternative Fuel". International Journal of Applied Engineering &Research (2013).

2) Roopa Farshi, Chirayu Belthur, Anjan Athreyas &George Jeevan, Ramesh, "Catalytic Degradation Of Municipal Waste Plastics To Produce Fuel Range Hydrocarbons Using Bentonnite". Department of Chemical Engineering DSCE, Bangalore. International Journal of Current Engineering &Technology (2013).

3) Yasabie Abatneh, Omprakash Sahu, "Preliminary Study On The Conversion Of Different Waste Plastics Into Fuel Oil". ISSN (2013).

4) Anup T J, Vilas Watwe, "Waste Plastic Pyrolysis Oil As Alternative For SI And CI Engines", International Journal of Innovative Research In Science, Engineering and Technology (2014).

5) Dr. P.V. Thorata, Miss. Sandhya Warulkara ,Miss.Harshal Sathonea, "Thermo fuel Pyrolysis Of Waste Plastic To Produce Liquid Hydroocarbons", Advances in Polymer Science and Technology: An International Journal ISSN 2277 – 7164.

6) Gaurav, Madhukar M, Arunkumar K.N., N Lingegowda "Conversion Of LDPE Plastic Waste Into Liquid Fuel By Thermal Degradation", International Journal of Mechanical and Production Engineering, ISSN: 2320-2092.

7) Pawar Harshal R. and Lawankar Shailendra M., "Waste Plastic Pyrolysis Oil Alternative Fuel for CI Engine", A Review Research Journal of Engineering Sciences ISSN 2278 – 9472Vol. 2(2), 26-30, February (2013).

8) Dipak Kumar Shaw, Pranav Sahni, "Plastic To Oil", IOSR Journal Of Mechanical and Civil Engineering (IOSR-JMCE) E-ISSN: 2278-1684, P-ISSN: 2320-334X PP 46-48.

9) Y B Sonawane, MR Shindikar, MY Khaladkar,Onsite, "Conversion Of Thermoplastic Waste Into Fuel By Catalytic Pyrolysis", International Journal of Innovative Research In Science, Engineering and Technology.

10) K Naima and A. Liazid, "Waste Oils As Alternative Fuel For Diesel Engine Journal of Petroleum Technology and Alternative Fuels", Vol. 4(3), Pp. 30-43, March 2013.

11) Mohammad I. Jahirul, Mohammad G. Rasul ,Ashfaque Ahmed Chowdhury and Nanjappa Ashwath, "Biofuels Production Through Biomass Pyrolysis", A Technological Review Energies 2012.

12) Antony Raja and Advaith Murali, "Conversion of Plastic Wastes Into Fuels", Journal Of Materials Science and Engineering B 1 (2011) 86-89 . Formerly Part Of Journal Of Materials Science And Engineering, ISSN 1934-8959.

13) C Wongkhorsub, N. Chindaprasert, "A Comparison Of The Use Of Pyrolysis Oils In Diesel Engine Energy And Power Engineering", 2013, 5, 350-355.

14) Dr.S.Vinothkumar, P.Sudarventhan, "Production of Crude Oil from the Plastic Bag"s SSRG International Journal of Chemical Engineering Research (SSRG-IJCER) – volume 1 Issue1 Nov 2011.

15) Moinuddin Sarker, Mohammad Mamunor Rashid , "First Simple And Easy Process of Thermal Degrading Municipal Waste Plastics Into Fuel", Resource IOSR Journal of Engineering (IOSRJEN) E-ISSN: 2250-3021, P-ISSN: 2278-8719.

16) M.Ringer, V.Putsche, and J.Scahill "Large-Scale Pyrolysis Oil Production" A Technology Assessment and Economic Analysis A national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy A national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy.

17) Manish Chand Sharma , 2,Neelesh Soni "Production of Alternative Diesel Fuel from Waste Oils and Comparison with Fresh Diesel" A Review The International Journal Of Engineering And Science (IJES) Volume 3,Issue 4, Pages 54-58, 2013 ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805.