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CONVERSION OF WASTE PLASTIC INTO FUEL OIL IN THE PRESENCE OF BENTONITE AS A CATALYST

ARUNKUMAR B Y[1], C N NATARAJ[2]

[1]PG STUDENT, University BDT College of Engineering, Davangere
[2]Associate Professor, Department of Mechanical Engineering, University BDT College of Engineering, Davangere, Karnataka, India.

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Abstract- *The objective of the paper is to convert waste plastic which is available in our day today life into fuel oil which can be used for the different purpose.in my project work I used low density polyethylene plastic .plastic are those substances which can take many years to decompose if dispose of simply to environment. Waste plastic should be changed into usable resources. The different waste plastics were thermally cracked at different temperature and then it was tried to measure the oil produced. Use of catalyst increases the quantity of fuel oil and its properties. Then a property of plastic waste oil is compared with petrol and diesel.*

Keywords-Low density plastic waste, Fuel, Pyrolysis.

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. Plastics contains mainly high 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. 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 particles might contain undesirable substances nitrogen, halogens, sulphur is hazardous to human beings.

1.1 Fuel Demand

The present rate of monetary development is unsustainable without sparing of fossil vitality like unrefined petroleum, flammable gas or coal. Universal Energy Outlook 2010 reports the world utilization of fluid and oil based commodities develops from 86.1 million barrels for each day in 2007 to 92.1 million barrels for every day in 2020 and 110.6 million barrels for every day in 2035 and petroleum gas utilization increments from 108 trillion cubic feet in 2007 to 156 trillion cubic feet in 2035. Along these lines, the oil and gas hold accessible can meet just 43 and 167 years further. In this manner humankind needs to depend on the other/sustainable power sources like biomass, hydropower, geothermal vitality, wind vitality, sun based vitality, atomic vitality, and so forth. Squander plastic to fluid fuel is likewise an other vitality source way, which can add to consumption of petroleum product as in this procedure fluid. Fuel with comparable properties as that of oil energizes is gotten.

1.2 Types of Plastics

There are two principle sorts of plastics:

- Thermo Plastics
- Thermosetting Plastics

1.2.1 Thermo Plastics

Plastics once produced can be formed to various shapes over and over until the point that it loses its property.

Thermoplastics can more than once mellow and liquefy if enough warmth is connected and solidified on cooling, with the goal that they can be made into new plastics items.

Illustration:

Polypropylene, Polyethylene, Polystyrene, Nylon, and so forth.

Applications:

Low Density Polyethylene (LDPE) utilized as a part of plastic packs and adaptable compartments. High Density Polyethylene (HDPE) utilized as a part of channeling, cleanser bottles, oil bottles. Polyethylene is utilized as a part of basins and sustenance compartments, Nylon ropes; Polystyrene is utilized as a part of glasses and plates, and so on.

1.2.2 Thermosetting Plastics

Plastics which once delivered can't be re-adjusted by the use of warmth. In the event that the warmth connected builds, plastic will swing it to scorch.

Thermosets or thermosetting can soften and come to fruition just once. They are not appropriate for rehashed warm medicines; along these lines after they have set, they remain strong.

Illustration:

Polyester, Phenol formaldehyde, Melamine Formaldehyde, Urea Formaldehyde, and so forth.

Applications:

Melamine cutlery for electrical protections, Electrical switches, Formica table tops, and so on

2. LITERATURE SURVEY

Keeping in mind the end goal to have an appropriate foundation think about on innovations accessible for transformation of waste plastics to fuel, writing review is done to know its different connected technique all through the globe, they are abridged beneath.

YB Sonawane et al. (9) contemplated Pyrolysis of high thickness polyethylene (HDPE) squander as carrybags was completed in an inhouse manufactured glass reactor of one liter limit. An inactive air was made in the reactor by cleansing nitrogen gas. The most extreme temperature in a reactor was kept around 5500C. Response was done with and without utilizing characteristic zeolite (NZ) and alumina impetuses. It was discovered that, time required for finish of the pyrolysis procedure was 3.5 hrs without impetus and 2.5 hrs with impetuses. Upon examination between fuel got with and without impetuses, it is watched that without impetus, process gives around 60-62% yield, with 5 % common zeolite yield is 65-67 % and with 5 % alumina impetus it is around 70-71 %. An expansion in the yield % and calorific esteem is seen with both the impetuses yet higher impact is found if there should be an occurrence of oil acquired with alumina.. As of now there are mechanical frameworks accessible for reusing of plastic waste however these frameworks include more cost in transportation than reusing. Scaling up of the present technique would considerably decrease the transportation cost and would likewise help in the journey of investigating financially suitable reusing framework for plastic waste.

3. PYROLYSIS

Pyrolysis is process of controlled heating of a material in the absence of oxygen. In the process of plastic pyrolysis macromolecular structure of polymer are broken into smaller molecules and sometime monomer units. Further degradation is of these subsequent molecules depends on a number of different conditions including(and not limited to) temperature, residence time, presence of catalyst and other process conditions. The pyrolysis reaction is carried out with and without catalyst. Accordingly, the reaction will be thermal and catalytic pyrolysis. Plastic waste is continuously treated in a cylinder chamber. The plastic is pyrolysis at 300°C-500°C and pyrolysis gas is condensed through a cooling twoer to convert it into liquid form.

4. METHODOLOGY

4.1 Condenser

The condenser is unit used to cool the heated vapour coming out of the reactor.it has an inlet and outlet for cold water to run through its outer area . this is used to condense vapour of plastic oil which is at a temperature of 350°C to 30-35°C

4.2 Reactor

It is a stainless steel cylindrical container of length 1500mm, 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.

4.3 Process Description

Fig1. Experimental setup

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 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 (see figure b). 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 775 kg/m^3. Finally we obtained 4 liters of plasto-fuel.

5. RESULTS AND ANALYSIS

5.1 PROPERTIES AND PURITY OF FUEL

The properties of fluid distillate coordinate with properties of consistent oil and diesel. The fills acquired in the waste plastic process are for all intents and purposes free from contaminants, for example, lead, sulfur and nitrogen. In the process i.e. the change of waste plastic into fills, the properties specified above of petroleum and Diesel divisions got are of better quality with deference than normal business oil and diesel acquired locally and has been demonstrated by the execution test.

5.2 QUALITY OF FUEL

The quality of obtained Plasto-Fuel has distilled fraction with residue. The physical properties obtained from Plasto-Fuel is compared with regular petrol and diesel.

5.3 PHYSICAL PROPERTIES

A portion of the properties of the plasto-fuel is talked about and as takes after.
Physical Appearance: Viscous fluid with Brown shading with a repulsive smell.
Combustibility: Highly combustible and consumed totally with no left-finished buildup.

5.3.1 Specific Gravity

It is defined as the ratio of weight density (density) of a fluid to the weight density of a standard fluid. To determining the specific gravity value we sent a sample of fuel to the Bangalore Testing House. The standard liquid is water and the standard gas is air. The specific gravity can be measured using the hydrometer. The hydrometer shows in Figure No.2. Fill the plasto-fuel in a container then dip the hydrometer in that. It shows reading and note down. The obtained value is 0.8. From the results it can be concluded that the specific gravity of plasto fuel is more than the petrol and less than the diesel.

Fig2: Hydrometer for measurement of Specific Gravity

5.3.2 Density

It is the ratio of mass of fuel to volume of fuel. The S I unit is (kg/m^3). To determining the density value we sent a sample of fuel to the Bangalore Testing House. It can be measured using the hydrometer. But the obtained value is in form of specific gravity and multiplied by density of water then we get the density of plasto fuel. Hence the density of fuel is 798kg/m^3. From the Figure No.3 we can see that the density of plasto fuel is more

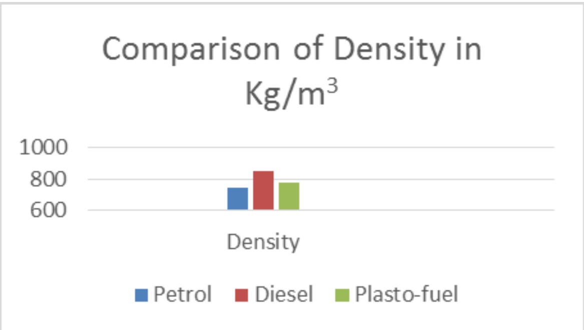

Fig3: Comparison of Density of plasto-fuel with petrol & diesel

5.3.3 Kinematic Viscosity

It is the ratio of two physical properties of fluid . It is defined as the ratio between the dynamic viscosity and density of a fluid. The S I unit is centistoke. To determining the kinematic viscosity value we sent a sample of fuel to the Bangalore Testing House. The kinematic viscosity is measured using the Ostwald's viscometer and shown in figure no.3.The sample of fuel is filled into ostwald's apparatus up to mark. It is immersed in the water bath at 40 ^{0}C. The time required for the flow of fuel from upper mark to lower mark of tube is noted. That time obtained i.e. 106 seconds is multiplied is constant of proportionality i.e. 0.0238. Thus we get the kinematic viscosity of plasto fuel is 2.3 centi stokes. From the figure no. 12 we can see that the kinematic viscosity of plasto fuel is more than the petrol and less than the diesel. And also it has nearest value to the regular petrol.

5.3.4 Dynamic Viscosity

It is defined as the property of fluid which offers resistance to movement of one layer of fluid over another adjacent layer of fluid. The S I unit is centi Poise. Dynamic viscosity is calculated using the formula. Thus we obtained dynamic viscosity value i.e. 1.8354 Centi poise. From the figure no.4we can see that the dynamic viscosity of plasto fuel is more than the petrol and less than the diesel.

Dynamic Viscosity = Kinematic viscosity * Density of fluid.

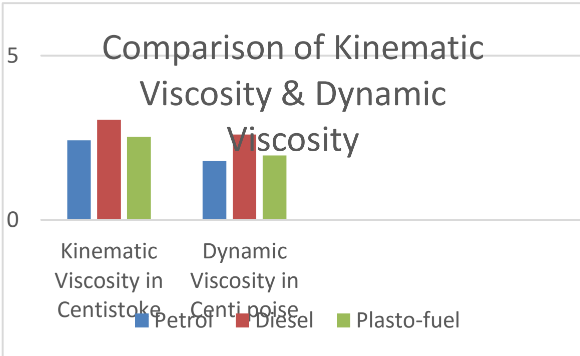

Fig4: Comparison of kinematic viscosity & dynamic viscosity of plasto-fuel with petrol & diesel

Fig5: Ostwald's Viscometer

5.3.5 Gross Calorific Value

The amount of heat produced by combustion of unit quantity of fuel. The S I unit is KJ/Kg. To determining the gross calorific value we sent a sample of fuel to the Bangalore Testing House. From the result it has value of 10684.7 Cal/g (Protocol – IS: 1448). The result is multiplied by 4.18 for the conversion of unit. Thus we got 44662.4 KJ/Kg. From the figure no. 6 we can see that the gross calorific value of plasto fuel is less than the petrol and more than the diesel.

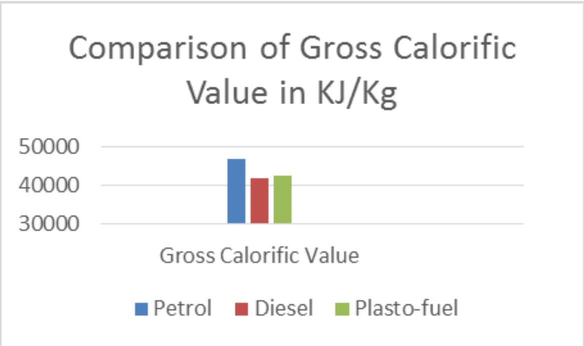

Fig6: Comparison of Gross calorific value in KJ/Kg of plasto-fuel with petrol & diesel

5.3.6 Flash Point

Flash point is the lowest temperature at which a liquid can form an ignitable mixture in air near the surface of liquid. The S I unit is ^{0}C. To determining the flash point value we sent a sample of fuel to the Bangalore Testing House. Flash point is measured using the Pensky-Martens closed sup tester. It is shown in figure no. 15 A sample of fuel i.e. 75ml is filled in the cup. Then it is heated at constant rate and stirred. After some time it ignites for fraction of second note down that temperature. That temperature is known as Flash point. Flash point of plsto fuel is 50^{0}C .From the figure no. 15we can see that the flash point of plasto fuel is more than the petrol and less than the diesel.

5.3.7 Fire Point

Fire point is the lowest temperature where the vapour of a liquid will initiate and sustain a combustion reaction. The S I unit is^{0}C. To determining the fire point value we sent a sample of fuel to the Bangalore Testing House. Fire point is measured using the Pensky-Martens closed sup tester. It is shown in figure no. 15 A sample of fuel i.e. 75ml is filled in the cup. Then it is heated at constant rate and stirred. After some time it ignites continuously note down that temperature. That temperature is known as Fire point. Fire point of plasto fuel is 54^{0}C . From the figure no.7 we can see that the fire point of plasto fuel is more than the petrol and less than the diesel.

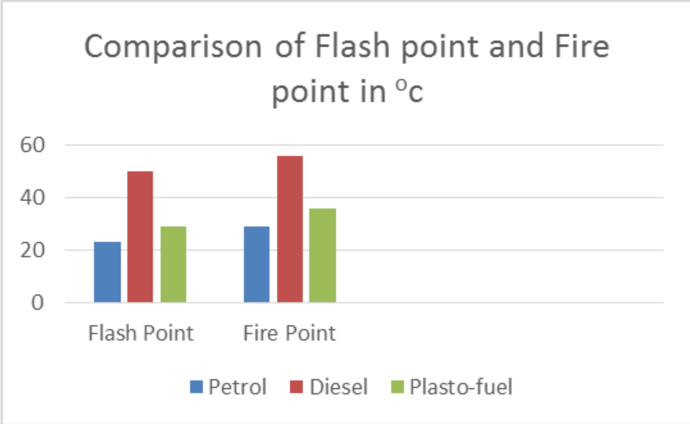

Fig7: Comparison of flash point and fire point in ^{o}C of plasto-fuel with petrol & diesel

Fig8: Fire Point & Flash Point Tester

5.3.8 Sulphur Content & Carbon Residue

After burning the plastic we got certain residue which contains sulphur, carbon etc. To determining the sulphur content and carbon residue, we sent a sample of fuel to the Bangalore Testing House. From the result it has value of Sulphur as 0.12 %w/w (Protocol – IS: 1448) and carbon residue as nil (protocol – IS1448). From the figure no.9 shows that the comparison of sulphur content and carbon residue of plasto-fuel with regular petrol anddiesel.

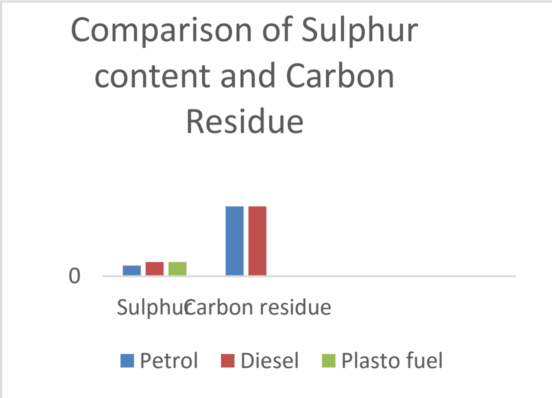

Fig9: Comparison of Sulphur content & Carbon residue of plasto-fuel with petrol & diesel

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

Sl. No	Properties	Petrol	Diesel	PlastoFuel
1.	Specific Gravity	0.742	0.85	0.8
2.	Density	742	850	798
3.	Kinematic Viscosity	2.42	3.05	2.3
4.	Dynamic Viscosity	1.796	2.592	1.835
5.	Gross Calorific Value	46858	42000	44662
6.	Flash Point	23	50	50
7.	Fire Point	29	56	54
8.	Sulphur	0.0015	0.002	0.12
9.	Carbon residue	< 0.01	0.01	Nil

6. CONCLUSION

In light of audit of our venture, it is presumed that the waste plastic pyrolysis oil speaks to a decent option for diesel and oil motor, in this way should be contemplated later on for transportation reason.

Plastics exhibit a noteworthy danger to the present society and condition. More than 14 million tons of plastics are dumped into the seas yearly, slaughtering around 1,000,000 types of maritime life. The transformation of these plastic into fuel spares the sea marine life.

The oil that has been created by the LDPE plastic by endorsed test process demonstrates that the properties are especially practically identical to the oil.

At last, pyrolysis of LDPE does not just recoup the vitality contained in the plastic, yet additionally deal with the earth by exchange transfer method of the waste plastic.

By changing over plastics to fuel, we understand two issues, one of the expansive plastic oceans, and the other of the fuel deficiency. This double recipient, however will exist just as long as the waste plastics last, yet will most likely give a solid stage to us to expand on a feasible, perfect and green future. By considering the budgetary advantages of such a venture, it would be an extraordinary aid to our economy.

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