International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 12 | Dec 2019 www.irjet.net p-ISSN: 2395-0072

Conversion of Plastic Waste to Energy: Pyrolysis

Gadhe Supriya Sampat[1], Rasal PrasadPramod[2], Tambe Ravindra Shivaji[3]

[1,2]Assistance Professor, Dept. of Mechanical Engineering, DVVPCOE Ahmednagar, Maharashtra, India
[3]Assistance Professor, Dept. of computer Engineering, SCSMCOE Nepthi, Ahmednagar, Maharashtra, India

---

Abstract - *Pyrolysis is a common technique used to convert plastic waste into energy, in the form of solid, liquid and gaseous fuels. Pyrolysis is the thermal degradation of plastic waste at different temperatures (300–900°C), in the absence of oxygen, to produced liquid oil. Different kinds of catalysts are used to improve the pyrolysis process of plastic waste overall and to enhance process efficiency. Catalysts have a very critical role in promoting process efficiency, targeting the specific reaction and reducing the process temperature and time.*

***Key Words*: Pyrolysis, Fuels, Waste, Plastic**

1. INTRODUCTION

Plastic Pyrolysis is a chemical reaction. This reaction involves the molecular breakdown of larger molecules into smaller molecules in the presence of heat.Pyrolysis is also known as thermal cracking, cracking, thermolysis, depolymerization. Waste Plastics can be broken down into microplastics and can cycle into human food chain. The proposed methodology renders a promising alternative diesel fuel. Pyrolysis oil is an excellent ignition quality fuel.

Extraction of oxidized sulphur compounds with polar solvent allow lowering total amount of sulphur and its compounds.

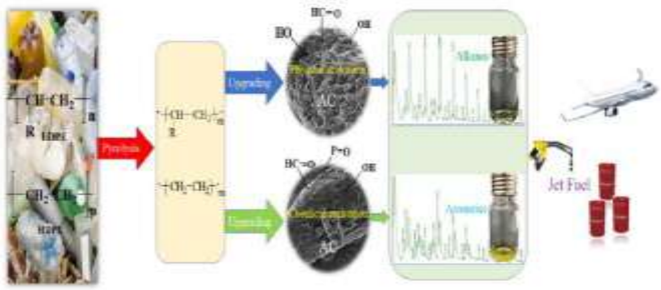

Fig1.1 Chemical reaction in pyrolysis

1.1 OBJECTIVE

Production of Jet fuel from waste plastics via catalytic pyrolysis with activated carbons. Pyrolysis of four waste plastics, polystyrene, polypropylene, low density polyethylene and high density polyethylene, was achieved at a bench scale (1 kg per batch) to produce useful fuel products.

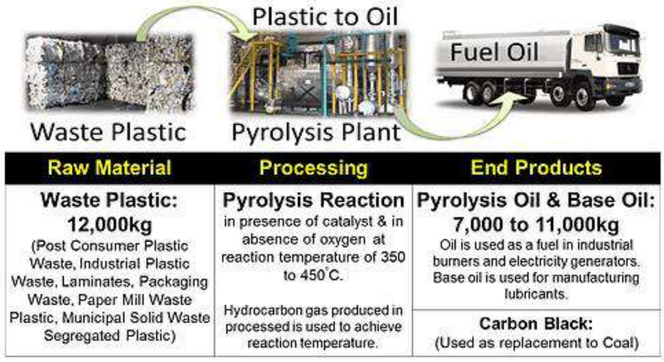

Fig 1.2: Steps of Pyrolysis

1.2 CATALYTIC PYROLYSIS SYSTEM OF DAILY WASTE PLASTICS

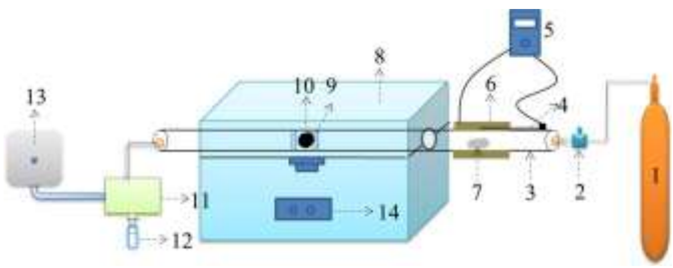

Fig1.2.1 Catalytic Pyrolysis

The catalytic pyrolysis system of daily waste plastics (separating feedstock and catalyst)

1-Nitrogen Gas,**2**-Gas flow meter,**3**-Quartztube,**4**-Therocouple for heating tape,**5**-Heating tape controller,**6**-Heating tape,**7**-Waste Plastic,**8**-Fixed bed furnace,**9**-Quartz wool,**10**-Activated carbon catalyst,**11**-Condensor,**12**-Liquid product collector,**13**-Non-condensable gas collector,**14**-Control panel of the furnance

2. MATERIALS FOR EXPERIMENT

1) Low-density polyethylene (LDPE) in the form of pellets and waste plastic was collected from daily wastes, which mainly consisted of water bottles, milk bottle, and plastic bags.

2) The composition of these waste plastics was estimated to mainly contain polystyrene (PS), polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET). Waste plastics were mixed and ground to be around 3mm particles

3) Activated carbons were provided by Cabot Norit Activated Carbon Americas (Marshall, TX, USA), namely, PETRODARCO 8X30, NORIT GAC 1240, MRX, NORIT GCN 1240 PLUS, NORIT C GRAN, and GAC 830 PLUS, which were marked as CAC1 to CAC6, respective.

3. EXPERIMENTAL TEST RIG

Details of experiment is as follows:

1)Betonite clay was used to study the plastic wastes.

2) 20mg sample of plastic was placed in 4mm diameter pan. Thermal decomposition was carried out at 700 degree celsius in a furnace, to record percent of weight loss and temperature.

3) Under the action of Porosimetry and by Brunauer Emmet Teller Method powerded clay was compressed by hydraulic press at 50bar pressure with catalytic pellets.

4) Stainless Steel batch Reactor was used for production of oil from the plastic wastes.

5) 1kg of plastic waste was loaded for each pyrolysis reaction.

6) The pyrolysis gas was passed through catalyst column at a ratio of 0.05,0.1,0.15 and 0.2 by weight of catalyst to plastic.

7) Blinders were not used and powder form catalyst were also not used because they creates pressure difference

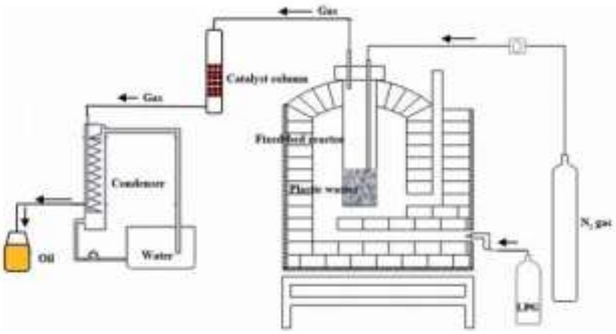

Fig 3.1 Experimental Test Rig

3.1TESTING

Standards Use for Testing

1. ASTM D1298 for testing.

2. ASTM D93 for kinematic viscosity(at 40 degree celcius)

3. ASTM D93 for flash point.

4. ASTM D79 for pour point

Engines Used For Testing

1. Four stroke engine: single piston diesel pump, max.speed 3000 rpm, power 2.2kw & maximum flow rate 40 cubic meter per hour.

2. Four stroke engine gasoline brush cutter: 6000 rpm speed, power 2.6 kw and 40 cubic cm displacement.

EMS 5002 gas analyser used for analysing exhaust gas composition.

Engine temperature measured by GM 700 infrared thermometer. Engine current is measured by MX655 multimeter.

4. RESULT AND DISCUSSION

The TG curves of each plastic waste demonstrated similar behaviour but at different thermal decomposition temperatures.

The polycyclic structures gets degraded at temp range of 280-580°C

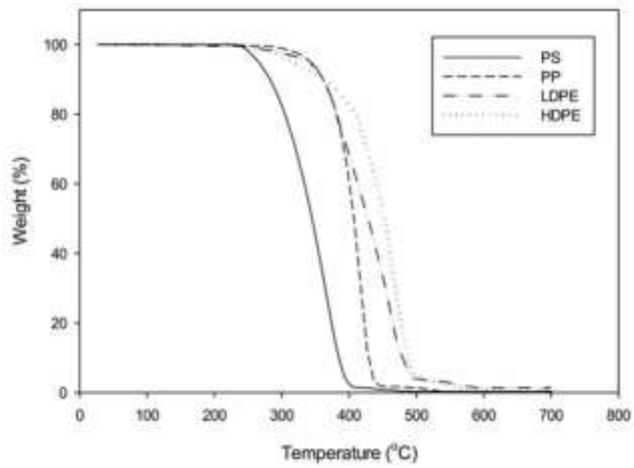

Fig 4.1 TG Curve

The chemical composition of betonite clay from product was found to be SiO2=46wt%, Al2O3=17wt%, Fe2O3=6%wt, Na2O=1.5%wt, CaO=2.5%wt,

Tio2=0.2%wt

Betonite has similar composition that of SiO2 and Al2O catalyst.

N2 adsorption-desorption isotherms of the catalyst.

According to IUPAC classification, the shape isotherms is type 4 with the increasing in relative pressure, capillary condensation occurs.

The steep jump observed at high relative pressure indicates some macropore existences.

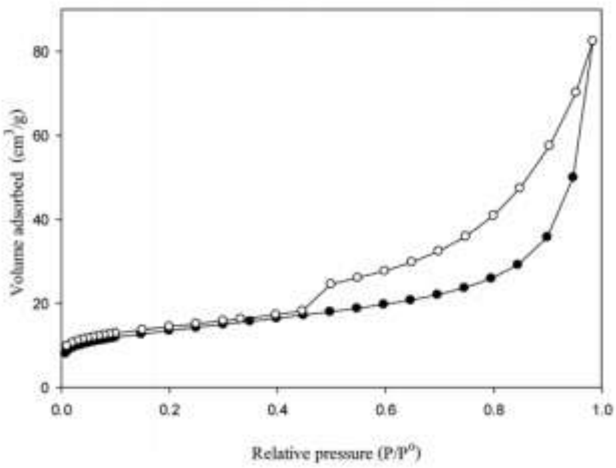

Fig 4.2 Graph of Volume Verses Relative Pressure

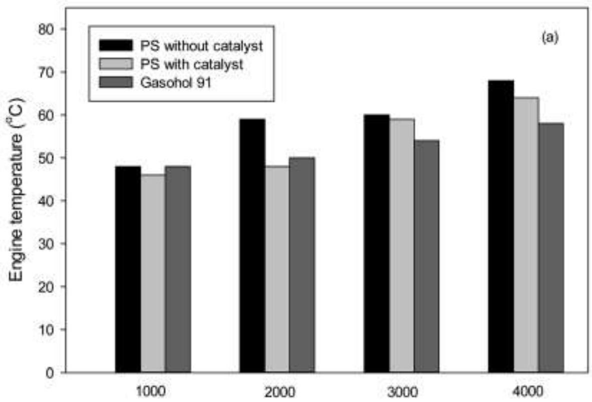

Fig 4.3 Variation of engine temperature with speed for gasoline brush cutter

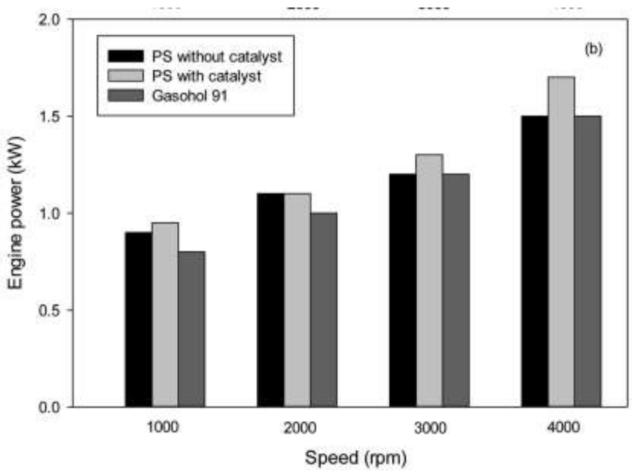

Fig 4.4 Variation of engine Power with speed for gasoline brush cutter

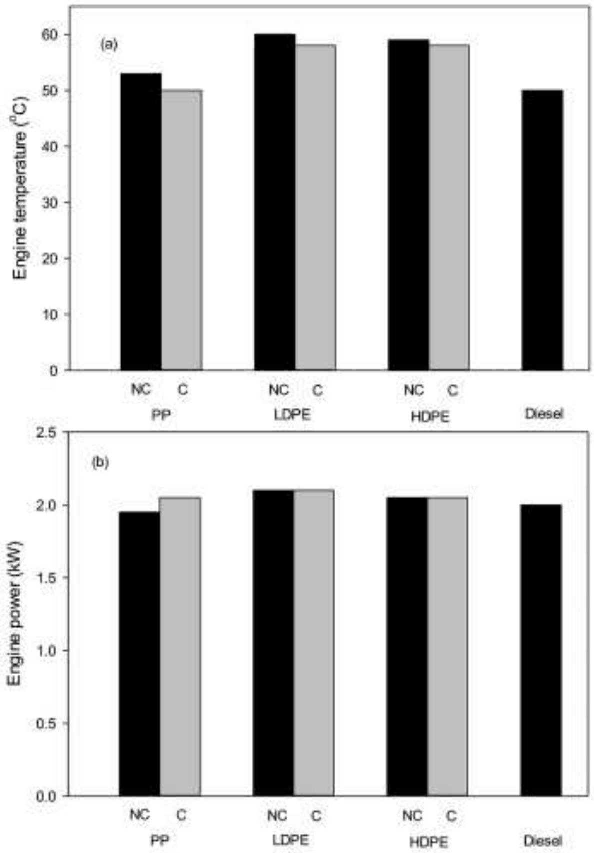

Fig 4.5 Engine temperature and (b) power of diesel pump at speed of 2000 rpm (NC ¼ no catalyst and C ¼ catalyst).

5. CONCLUSIONS

After pyrolysis with bentonite, the calorific value of liquid oils higher than thermal experiments. The GC-MS and FTIR results showed that the oils from PS had mainly aromatic hydrocarbons in gasoline range (C5–C9), while PP, LDPE and HDPE had longer aliphatic hydrocarbons making them suitable for use in diesel engines.

No wax formation was observed when using the bentonite clay pellets as a catalyst.

The emissions and performance of diesel and gasoline engines were investigated which resulted into the lowering of CO and CO2. percentage .

Catyaltic Oil produced from the PP, LDPE and HDPE resulted into higher gasoline engine power.

Thus we conclude that Bentonite could be used as a effective catalyst and may open doors to the production of liquid fuels from waste.

REFERENCES

[1] Tapanee Sangpatch, Nuta Supakata, Varapot Kanokkantapong, Bunjered Jangosomit, "Fuel oil generated from the cogen grasss derived Al-Si (Imperata cylindrica(L) Beauv catylsed pyrolysis of waste plastics", "Heliyon", "2019", "1-8

[2] S.M. Al-Salem, "Feedstock and Optimal Operation for Plastics to Fuel Conversion in Pyrolysis", "Plastics to Energy", "2019", "117-146"

[3] Supattra Budsaereechai, Andrew J.Hunt, Yuvarat Ngerneyen, "Catyaltic prolysis of plastic waste for the production of liquid fuels for Engine

[4] Stella Bezeragianni, Athanasios Dimtriadis, Gia-Claudio Faussone, Dimitrios Karonis, "Alternative Diesel from Waste Plastics", "Energies", "2017", "1-12"

[5] Anandhu Vijaykumar, Jilse Sebastian, "Prolysis process to produce fuel from different types of Plastic", "RAEREST", "2018", "2-8"

[6] Yayun Zhang, Dengale Duan,Hanwu Lei, Elmar Villota, Roger Ruan", "Jet Fuel Production from plastic waste via catyltic pryolysis with activated carbons", "Applied Energy",2017,1-15

[7] Klinger JL, Westover TL, Emerson RM, Williams CL, Hernandez S, Monson GD, et al. Effect of biomass type, heating rate, and sample size on microwave-enhanced fast pyrolysis product yields and qualities. Appl Energy 2018; 228:535–45.

[8] Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. Sci Adv 2017;3:E1700782