© January 2021| IJIRT | Volume 7 Issue 8 | ISSN: 2349-6002

Alternative Strategy for Conversion of Waste Plastic into Petroleum Fuel

Prof. Priyeshnath Rathod[1], Ronak Dave[2], Dhruvin Patel[3], Aashray Patel[4]
[1,2,3,4]*Parul Institute of Technology*

***Abstract* - This project is about the recycling of plastic and converting it into the useful industrial fuels.so the dumping problem of the plastic is reduced and the pollution due to dumping of plastic can be reduced and also the use of petroleum fuels are replaced by this fuel and the other natural fuels are conserved.it is the simple process of doing catalytic cracking of plastic in absence of oxygen by pyrolysis process and doing distillation process to convert the plastic into crude oil carbon char and other useful gases. Plastic is an indispensable part of our daily life. Its production and consumption have been rising very rapidly due to its wide range of application. Due to its non-biodegradable nature, it cannot be easily disposed of. So, nowadays new technology is being used to treat the waste plastic one of such process is pyrolysis. Under the pyrolytic and cracking conditions, the plastic wastes can be decomposed into three fractions: gas. Liquid and solid residue. The waste plastics consisting of high-density polyethylene (HDPE) was pyrolyzed in this study. The pyrolysis of plastic wastes produces a whole spectrum of hydrocarbons including paraffin's. Olefins, naphthalene's and aromatics. The liquid product yield is about 76% in all the cases. In thermal pyrolysis, the product obtained gets solidified but in catalytic cracking good liquid product can be obtained which can be used as fuel. This application is further combined with technologies of municipal plastic wastes collection, classification and pre-treatment at front end and product purification and testing at back end to determine the properties of the various products obtained.**

***Index Terms* - waste plastic, thermal degradation, pyrolysis, and catalyst degradation**

I.INTRODUCTION

Due to the fossil fuel crisis in past decade, mankind has to focus on developing the alternate energy sources such as biomass, hydropower, geothermal energy, wind energy, solar energy, and nuclear energy. The developing of alternative-fuel technologies is investigated to deliver the replacement of fossil fuel. The waste to energy technology is investigated to process the potential materials in waste which are plastic, biomass and rubber tire to be oil. Pyrolysis process becomes an option of waste-to-energy technology to deliver biofuel to replace fossil fuel. Waste plastic and waste tire are investigated in this research as they are the available technology. The advantage of the pyrolysis process is its ability to handle un-sort and dirty plastic. The pre-treatment of the material is easy. Economic growth and changing consumption and production patterns are resulting into rapid increase in generation of waste plastics in the world. For more than 50 years the global production of plastic has continued to rise. And since plastic being a non-biodegradable material it remains into the soil. There by polluting the environment. As we know that both Plastics and Petroleum derived fuels are Hydrocarbons that contain the elements of Carbon & Hydrogen. Pyrolysis process becomes an option of waste-to-energy technology to deliver biofuel to replace fossil fuel. The advantage of the pyrolysis process is its ability to handle unsort and dirty plastic. The pre-treatment of the material is easy. Plastic is needed to be sorted and dried Pyrolysis is also no toxic or non-environmental harmful emission unlike incineration.

II. DESCRIPTION OF THE EQUIPMENT

A. REACTOR

This is an insulated stainless steel cylindrical reactor heated by electrical heating coils to achieve a maximum heating temperature of 500 °C. The necessary provision is made on the reactor for mounting the gadgets for measuring pressure, temperature, and collection of hydrocarbons from the reactor.

B. CONDENSER

The gaseous output from the reactor is passed through a double walled condenser with inlets and outlets for cooling water. The gaseous hydrocarbons at a temperature of around 350°C condensed to around 30-35 °C.

C. RECEIVER

The condensed hydrocarbon in the liquid form is collected in the receiver. The provision is made for collecting the uncondensed gases into gas collector. The arrangement to measure the volume & rate of flow of distillate continuously or intermittently at any point of time is made in this section.

III. PROCESS

1.1 PYROLSIS (THERMAL PYROLYSIS)

Pyrolysis, which is also the first step in gasification and combustion, occurs in the absence or near absence of oxygen, and it is thus distinct from combustion (burning), which can take place only if sufficient oxygen is present. The rate of pyrolysis increases with temperature. This process can be thermal cracking that allows the conversion of polymers into gas and liquid hydrocarbon.

1.2 CATALYTIC PYROLYSIS

Catalytic pyrolysis is the breaking of large hydrocarbon molecules into smaller and more useful bits. It must be designed in such a way that the vapour from the reactor must have maximum surface contact with the catalyst. The catalyst will act as a molecular sieve which permits the passage of small molecules. The hydrocarbon molecules are broken up in a fairly random way to produce mixtures of smaller hydrocarbons, some of which have carbon-carbon double bonds.

IV. CATALYST FOR PYROLYSIS

1 ZSM-5

If we are using 100 kg of waste plastic, then required catalyst would be around 10-12 kg. In this process by using ZSM-5 catalyst result of yield would get around 80-85%.

2 FCC-R1

If we are using 100 kg of waste plastic, then required catalyst would be around 13-15kg. In this process by using FCC-R1 catalyst result of yield would get around 70-75%.

V. FLOWDAIGRAM OF WASTE PLASTIC FOR PYROLYSIS PROCESS

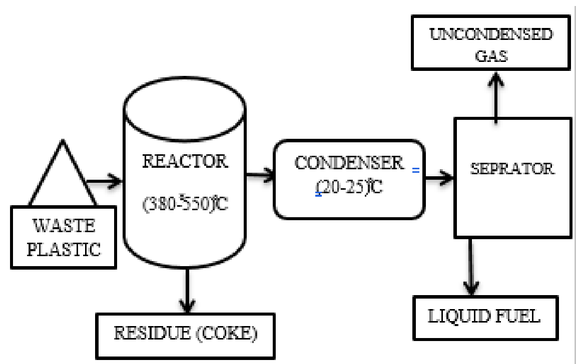

Figure: - 1 PYROLYSIS PROCESS

A. DESCREPTION OF METHOD: -

Waste plastic material, typically mainly containing polyolefins, typically between 70% to 90% (weight percentage) of high density polyethylene (HDPE) from 10 to 15% of polypropylene (PP), with major amounts (typically less than 5% for each) of polyvinylchloride and major amounts of other plastics that maybe polyurethane, polyester, polyamide , is dry cleaned processes into granular or flake form. It is then heated in an extruder and temperature around 350° C, and the molten plastic is then fed into the pyrolysis at a chamber. This is done under nitrogen purge, ensuring that no oxygen enters the system. The molten plastic is maintained at a temperature between 300°C to 500°C until the pyrolysis chamber is completely fed. As show in figure- 1 pyrolysis chamber, the plastic material is heated up to a temperature between 380°C and 550°C in a nitrogen purged system under agitation, and this temperature is maintained during the pyrolysis. The melted plastic material is thermally cracked into pyrolysis gases and char formation occurs simultaneously in the pyrolysis chamber. An industrial installation implementing the process according to the invention will typically contain at least two pyrolysis chambers, since the process is a semi batch process. As one pyrolysis chamber is active, char cooking and removal takes place in the other one. As pyrolysis of the melted plastic is being completed, the load on the agitator increases, showing that char drying is taking place and batch is ending. Cook off value of the char may then take place, with further heating of the char an above 600°C, to complete drying and remove remaining gases from it. And then get the products.

B. PROPERTIES AND PURITY OF FUELS

The properties of liquid distillate match with properties (Ex specific gravity and pour points) of high-quality imported crude. The fuels obtained in the waste plastic process are virtually free from contaminants such as lead, sulphur and nitrogen. In the process (i.e.) the conversion of waste plastic into fuels, the properties mentioned above of petrol & Diesel fractions obtained are of superior quality with respect to regular commercial petrol and diesel purchased locally and has been proved by the performance test. During the process, hazards related to health and safety is reduced to 90% as compared to regular refinery process.

I. TABLE 1: COMPARISON OF PETROL FROM WASTE PLASTICS WITH REGULAR PETROL

Sr. No	Specifications	Regular Petrol	Petrol from Plastic Waste
1	Specific gravity at 28℃	0.8054	0.8526
2	Specific gravity at 15℃	0.8085	0.8965
3	Gross calorific Value	12210	12850
4	Net calorific Value	11520	11846
5	Api gravity	52.56	62.23
6	Aniline point in℃	50	35
7	Aniline point in℉	123.4	85.23
8	Flash point	26	23
9	Pour point	< -19°C	< -19°C
10	Cloud point	< -19°C	< -19℃

1 QUALITY OF FUELS: - The quality of gasoline and diesel fractions obtained in the process is not only at par with regular fuels in tests like sp- gravity is 0.8365 /18°C CCR (Conradson carbon Residue) Ash, calorific value etc. but it is also better in terms of quality in test like flash point. API gravity. Table 1 gives the comparison of plastic derived petrol with regular petrol 191.

2 ADDITIVES: Regular fuels obtained from crude oil like gasoline and diesel are subjected to many reactions and various additives are added to improve combustion and met BIS characteristics before it is introduced to market However the fuel (Gasoline. Diesel) fractions obtained in the process can be utilized without much processing,

II. TABLE: 2 PROCESS BRIEFS FOR 1 KG INPUT AND THE YIELD OF OUTPUT

Input	Qty Kg	Output	Qty (L)	Rate Per Liter	Amount (Rs)
Plastic	1.00	Petrol	0.700	47.56	30.23
Labour		Diesel	0.400	43.50	15.65
Service Charge		Lube oil	0.200	32.23	6.50
Total	1.00		13.00		52.38

3) FEASIBILITY: The production of the fuels from the waste plastic of various sorts has been carried out a number of times to arrive at the unit cost of production. The break-up of the cost for per kg input of the plastic and the related output for the same is depicted in the Table 2.

VI. RESULT AND CONCLUSION

A. RESULT: - Through our experiment we concluded that about 600 to 750 ml of diesel fuel could be obtained by burning 1 kg of plastic. Burning 1 kg of plastic in an open environment produces 3 kg of CO_2, whereas by converting it into fuel and burning it reduces 80% of CO_2 emissions, which results in to be environment friendly. Lesser emissions of unburnt HYDROCARBONS in waste plastic pyrolysis oil compared to that of diesel. The diesel or oil thus obtained has a higher efficiency with around 30 to 40% low production cost compared to available in market.

B. CONCLUSION: - The implementation of this project can develop so many opportunities in the city. The analysis has observed the use of waste plastic, a factory planning and feasibility in metropolitan city. It can be a solution to control waste plastic, develop a new technique or idea, and detect the sources of diesel for the country.

REFERENCES

[1] Walendziewski, Engine fuel derived from plastics by thermal treatment, fuel 81 (2002) 473-481

[2] M. Mani, G. Nagaraja N. Influence of injection timing on performance emission and combustion characteristics of a DI diesel engine running on waste plastic oil Energy 34 (2009) 1617-1623

[3] F. Murphy, K. M. Donnell, E Butler, G. Devlin. The evaluation of viscosity and density of blends of Cyn-diesel pyrolysis fuel with conventional

diesel fuel in relation to compliance with fuel specifications EN 590:2009,

[4] N. Miskolczi. A. Angyal. L Bartha, 1. Valkai, Fuels by pyrolysis of waste plastics from agricultural and packaging sectors in a pilot scale reactor Fuel Processing Technology 90 (2009) 1032-104

[5] M. N. Siddiqui H.H. Redmi, Catalytic coprocessing of waste plastics and petroleum residue into liquid fuel oils Journal of Analytical and Applied Pyrolysis 86 (2009) 141-147

[6] A.K. Panda, R.K. Singh. D.K. Mishra, Thermolysis of waste plastics to liquid fuel a suitable method for plastic waste management and manufacture of value-added Products-A world prospective, Renewable and Sustainable Energy Reviews 14 (2010) 233-248

[7] A. Demirbas, Waste management, waste resource facilities and waste conversion processes, Energy Conversion and Management 52 (2011) 1280-1287

[8] M. F. Ali, S. Ahmed, M. S Qureshi, Catalytic coprocessing of coul and petroleum residues with waste plastics to produce transportation fuels Fuel Processing Technology 92 (2011) 1109-1120

[9] Mitsuhari, waste plastics to produce transportation fuels Fuel Processing Technology 72(2011)

[10] Anup TJl.et.al Waste Plastic Pyrolysis OD as Alternative For s and CI Engines" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 7. July 2014

[11] Sam Haig.et al Plastic to all IFM002 final report "Zero Waste Scotland

[12] Dr. Shinde Conversion of waste plastic into resources International Journal on Innovation in Engineering and Technology Volume 6 issue 3 February 2016

[13] Vijaykumar B, Chanashetty and B M Patil, Fuel from Plastic Waste International Journal on Emerging Technologies (Special Issue on NCRIET - 2015)

[14] Mohamed M Garib Alla, Almed I Al Med, Babiker K Abdalla, Conversion of Plastic waste into liquid fuel-Intemational Journal of Technical Research and Applications -Volume 2. Issue 3 (May June 2014).

[15] Coulson & Richardson's. Chemical engineering design textbook'. Volume 6. 151. P Baggio-Experimental & Modeling Analysis of a batch gasification Energy conversion & management 2009

[16] Merve Sogancioglu Comparative study on Waste Plastic. Pyrolysis liquid products quantity energy recovery potential 2017

[17] Thallada Bhaskar "Pyrolysis of waste plastic using CACO3 Progress in rubber, plastic & recycling technology Volume 20, 2004.

[18] P Senthil Kumar Conversion of waste plastic into low emissive hydrocarbon fuels through catalytic deploymerization in a new laboratory scale batch reactor, International Journal of Energy environment engineering Volume: 8, 2017

[19] Y. Skein and K. Fujimoto, “Catalytic degradation of PP with a Fe/activated carbon catalyst,” Journal of Material Cycles and Waste Management, vol. 5, no. 2, pp. 107–112, 2003.

[20] R. P. Lattimer, “Direct analysis of polypropylene compounds by thermal desorption and pyrolysis-mass spectrometry,” Journal of Analytical and Applied Pyrolysis, vol. 26, no. 2, pp. 65–92, 1993.

[21] H. R. Appel, Y. C. Fu, S. Friedman, P. M. Yavorsky, and I. Wender, “Converting organic wastes to oil,” U.S. Burea of Mines Report of Investigation 7560, 1971