RESEARCH ARTICLE OPEN ACCESS

Preparation of Petroleum Product from Waste Plastic

Abhijeet P. Akhare*, Sumit S. Rathod**
*(Department of Chemical Engg, SGGSIE&T, SRTM University Nanded,
** (Department of Chemical Engg, SGGSIE&T, SRTM University Nanded,

ABSTRACT
The world's annual consumption of plastic materials has increased from around 5 million tonnes per year in the 1950s to nearly 100 million tonnes; thus, 20 times more plastic is produced today than 50 years ago. This implies that on the one hand, more resources are being used to meet the increased demand of plastic, and on the other hand, more plastic waste is being generated. 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 using plastic as the major component. As landfill and incineration of waste plastic become more expensive and less accepted, because of this recycling of plastic wastes is gaining increasing importance. More emphasis is thus being given to new disposal options, which have high energy recovery values and are more environmentally attractive. Pyrolysis is one promising method for the treatment of mixed and contaminated plastic wastes. Plastics are thermally degraded to produce useful liquid hydrocarbons, which can then either be added to existing fuel or solvent product, or returned to a refinery where they can be added to the feedstock's. A simple pyrolysis reactor system is described. Results of pyrolysis tests showed that pure samples of polyolefin and Polystyrene resin can readily be pyrolysis to produce liquid yields in excess of 70%. However, liquid yields were affected by heating rates and heat loss patterns in the reactor system. Further experimental work suggests that when pyrolysis, mixed plastic wastes behave much like the resins from which they originate. In light of the results from the experiments, the technical feasibility of setting up a pyrolysis plant in Victoria to process waste plastics into liquid fuel was discussed. This study thus forms the ground work needed for the design of a small pyrolysis plant.

I. INTRODUCTION

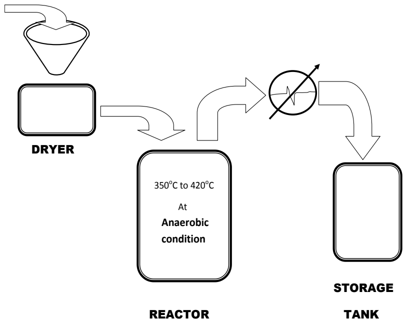
.Conversion of waste plastics already occurs on a wide scale. Extensive recycling and reprocessing of plastics are performed on homogeneous and contaminant free plastic wastes. However, a substantial fraction of the plastics in municipal waste still ends up in landfills. Minimising the amount of otherwise unrecyclable waste plastics going to landfill is thus the motivation of this research project. The main hindrance to the implementation of plastics recycling is the inhomogeneity of many plastic wastes. Most recycling schemes require a feedstock that is reasonably pure and contains only items made from a single polymer type, such as high density polyethylene (HDPE) commonly used to make milk bottles or polyethylene terephthalate (PET) soft drink bottles. Realistically, most post consumer wastes contain a mixture of plastic types, and are often contaminated with non-plastic items.

II. PROCESS TECHNOLOGY

Pyrolysis

The pyrolysis by direct heating was adopted to produce the paraffin and crude oil from the plastic wastes in the 1990s. The small-scaled process is featured by facilitation, convenience and low equipment investment However, the temperature caused by pyrolysis is higher andall the reactive time is longer than the other methods. The octane number of gasoline gained is relatively low and the pour point of diesel oil is high. More paraffin is produced in the process of pyrolysis. Although this process is simple and convenient, the converting rate and of fuel oil is 50-65%. It is strongly recommended to establish a reasonable sorting system and apply an efficient technique to eliminate the toxic emissions and highly corrosive hydrochloric acid that is formed for avoid the corrosion problem. Since the total yield of fuel oil with pyrolysis is still lower and the quality of oil is not satisfied as gasoline and diesel oil, the upgrade by catalytic cracking for the crude products gained with pyrolysis can be used. Having improved the quality of finished oil, this process has been widely used in many factories .The system consists of the knapper, extrusion machine, pyrolysis reactor, catalytic cracking reactor, fractionating tower, heating and temperature controller, separator of oil and water etc. An improved apparatus apart from the pyrolysis reactor, consists of a cylindrical rectangular vessel heated by electrical heating coils or any other form of energy, the said vessel is made of stainless or mild steel, surrounded by heat reflector and insulator to avoid heat loss. It is provided at its side an outlet vents which connect with the condensing section which is made up of stainless or mild steel provided with an outer jacket for circulating cold water or any coolant, the condenser is connected to the receiving section. Milling the said ingredients and making slurry using demineralized water, spray drying the slurry to micro-spheres, and calcining at 500 °C for 1 h. The finished oil consists of gasoline (52%) and diesel oil (40%) and remaining other constituents.

Figures and Tables
Comparison of Petrol from waste plastics with regular Petrol.



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.) theconversion 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.

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 0.7290 ,Ash, calorific value etc but it is also better in terms of quality in test like flash point, API gravity.

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 meet BIS characteristics before it is introduced to market. However the fuel (Gasoline, Diesel) fractions obtained in the process can be utilized without much processing.

Yield

The average percentage output yield of the products in the first phase of reaction depending on the composition of the waste plastic. During the second phase of reaction (i.e.) fractional distillation, the average percentage yields of various fuel fractions obtained.

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 described follow.

Sr. No	Specification	Petrol obtained from cruide	Petrol obtained from waste plastic
1	Specific Gravity at 25^0C	0.7592	0.7399
2	Specific Gravity at 15^0C	0.7422	0.7290
3	API Gravity	50.42	60.65
4	Aniline Point at		
5	Gross Calorific value	11209	11250
6	Flash point	23	21
7	Pour Point	< -19 ^{0}C	< -18^0C

Input	Quantity (kg)	Rate	Amount	Out-put	Quantity (l)	Rate	Amount (Rs.)
Plastic	1	14	14	Petrol	0.550	35	20
Labour			5	Diesel	0.300	20	6
Service Charge				Heavy Oil	0.200	15	3
Total	1						

III. CONCLUSION

Thermal cracking was performed at the different temperature to obtain oil from the different waste plastic. It was also done measurement of residue, oil, and gas produced for the purpose of comparison which type of waste plastic can produce higher amount of oil. The resident time also has the effect on the yield of the oil. At the start of reaction the time required to get the first droplets of oil is higher. The yield of the different waste plastics are 1.17% for the pyrolysis of low density polyethylene ,15% from the pyrolysis of polystyrene, and 13.88% from the pyrolysis of high density polyethylene. The reduction in the yield of the oil is due to the effectiveness of the reactor seal which means the gases which is going to be condensed is leaking out. This difference is brought about by the different in the structure of the polymer of the waste plastic. Because the bond at the C-C is weaker than the bond between the C-H. Therefore, for plastic which has more number of C-C combinations the yield is higher than those which has C-H yield. From the work it has been tried to concluded that the major parameter which affect the yield of the oil from the waste plastic such as, the structure of the polymer, the operating temperature and the hold time. As it is seen from the results of the different experiments the temperature at which the first droplet of oil obtained is determined for the respective plastic type being cracked.

ACKNOWLEDGEMENTS

It Gives Me Great Pleasure To Express My Deepest Gratitude To My Thesis Advisors Prof.D.D. Awachar For His Interest, Guidance, And Encouragement, Without Which All My Efforts Would Be Fruitless. I Am Also Grateful To Dr. P. G. Jadav "Hod Of Chemical Dept In Sggs Ie&T", Nanded

REFERENCES

[1] Hegberg, B. A., Brenniman, G.R., Hallenbeck, W.H., (1992), *Mixed Plastics Recycling Technology*.Noyes Data Corp. New Jersey.
[2] Australian and New Zealand Environmental Council (1990), Plastic waste and the economic potential forrecycling, pp. 31, Technisearch Ltd.
[3] Mader, F., Mennicken, T., (1995), The Feedstock Option. *Shell Chemicals Europe Magazine*, 20-23.
[4] Lascelles, D. (1994), Place for Plastics, pp. 18: *Financial Times*.
[5] Anon (1995), BASF Shutters Plastic Feedstock Recycling Plant. *Chemical Market Reporter*, 7.
[6] Buekens, A. G., Schoeters, J.G., (1980), Basic Principles of Waste Pyrolysis and Review of European
[7] Processes, pp. 398-421. In J. L. James, Radding, S.B., (Ed.): *Thermal Conversion of Solid Wastes andBiomass*, American Chemical Society, Washington.
[8] Kaminski, W. (1995), Pyrolysis with respect to recycling of Polymer.*Die AngewandteMakromolekularChemie*, 232, 151-165.

Books

[9] Introduction to petrochemicalsBySukumarMaiti volume -1(page 133.24)
[10] 9.Industrial organic chemistryBy Weissermel et al. (page 432)
[11] Petrochemicals By Bhaskar Rao volume-2
[12] (page 336)
[13] Out lines of chemical technology By Dryden's
[14] Tabone, M.D., Cregg, J.J., Beckman, E.J. & Landis, A.E. (2010) Sustainability Metrics: Life Cycle Assessment and Green Design in Polymers. Environmental Science& Technology. 44 (21): 8264–8269