

CATALYTIC CRACKING OF PLASTIC (TO OBTAIN HYDROCARBON FUEL)

Sagar Ekbote¹, Utkarsh Naik², Jatin Kulkarni³,
Almas Sangle⁴, Shailesh Awale⁵, Prof Vivek Nagnath⁶

^{1,2,3,4,5,6} Department of Engineering, Sciences & Humanities,
Vishwakarma Institute of Technology, Pune (India)

ABSTRACT

this project is designed to convert plastic into hydrocarbon fuel by the means of catalytic cracking .plastic waste are a big problem .these are those materials that take a very long time to naturally degrade, rather we can say that they are virtually non biodegradable. This study offers an efficient solution for this problem. In this study we crack many types of plastic like polythene and polypropylene in the presence of mainly two catalybetonies and zealots to obtain gasoline range fuel.

Keywords: *Catalytic cracking, Zeolite and Bentonite nano material*

I.INTRODUCTION

Plastic waste keeps increasing around the world. This is a seriously problem for the nature which includes all the animals, aquatic animal and also humans. Such organic wastes are disposed land filings, alternative method for disposal is incineration where the waste burns and the chemical heat energy is extracted.^[1]

Other methods are been suggested my various researchers, of these methods id converting the plastic to fuels by the process of paralysis.

The aim of this research is to recycling plastic by converting it into fuel in batch reactor using nano materials catalyst. And identify the role of the external catalytic surface on overall cracking reactions to obtain high gasoline range.

II.MATERIALS

- 1) Plastic wastes (plastic bags, plastic bottles. which are collected from garbage of houses) these plastic materials should be then washed, sorted and shredded.
- 2) Betonies nano materials
- 3) Micro porous natural elitemedian mordenite

III.CATALYST SELECTION

Most of the catalyst that are employed for the catalytic polymer cracking is acid micro porous solids. Several liquids and gases are obtained, in different proportions, based on catalyst selection. Main factor that is looked upon is that the acid sites, pore size, and acid strength. Alumina is normally used for the catalytic process in industries and this has Lewis acid sites or bronsted-lewis acid sites therefore increasing the alumina content in catalyst framework increases the bronzed acid sites. Bronzed acid sites lead to a high cracking activity. But rescuing the content of aluminium leads to stronger bronsted sites. In order to have relatively more control over the products obtained, it is convenient a

Catalyst with a regular pore structure and a uniform pore size distribution. Materials with pores of many different sizes tend to produce much more different products and by-products. In general terms, mesoporous materials favour liquid products, while micro porous materials produce a larger proportion of gas products. The catalytic cracking of polymer chains starts at the outer surface of the micro porous materials, but once the chain fragments enter the pores, where many active sites are located, small gas molecules come out from them. Zeolites with very small crystal size (of nanometres, instead of micrometers) and large external surface area may produce fewer amounts of gas molecules while having

High cracking activity ^[2]

IV.REACTION

The reaction mechanism of the catalytic cracking of polymer chains follows similar pathways of those of the hydrocarbon catalytic cracking in petroleum refinery plants. These mechanisms have been studied for a number of years. The catalytic cracking process takes place at temperatures high enough to have parallel thermal cracking reactions ^[3]. Some of the efforts for elucidating the thermal cracking mechanism of polyethylene go back to the end of the 1940's (Oaks and Richards, 1949). The thermal cracking reactions follow a free radical mechanism, by breaking covalent bonds by the action of heat, producing free radical species. Catalytic cracking reactions undergo either by the prolongation of carbon atoms in the polymer chain (protons coming from bronsted acid sites), or by the abstraction of a hydride ion from the polymer chain, by Lewis acid sites.

PROTONATION:

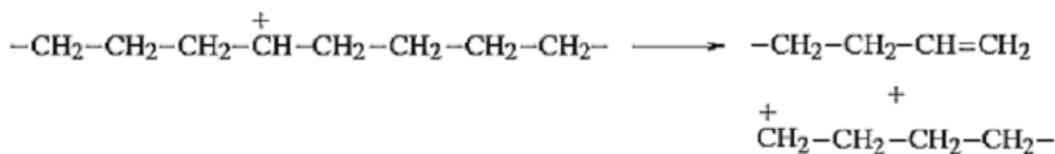


HYDRIDE ABSTRACTION;

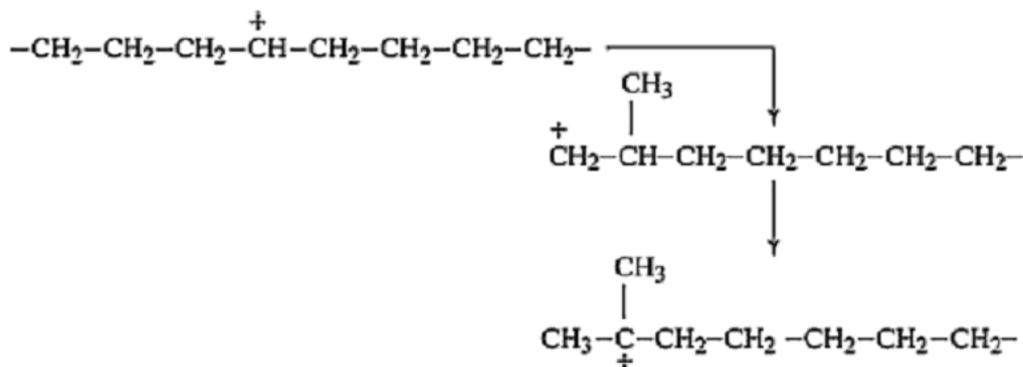


The resulting ions can be stabilized by β -scission, isomerisation or hydrogen transfer reactions. Scheme 2 shows different reactions that can take place, each one more or less favoured depending on the temperature (Kumar et al., 2011). The surface area and the porous structure of the catalyst also play an important role. The breaking down of polymer chains starts at the external surface of the catalyst. Small enough fragments may get inside the pores, where additional cracking reactions take place, resulting in small-size gas molecules. Unlike thermal cracking, a certain catalyst may promote the selectivity towards specific products [4]

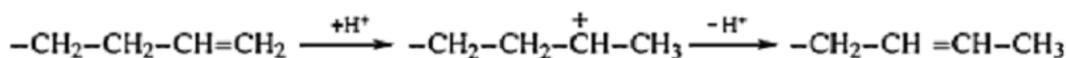
(A) β -scission



(B) Isomerization of carbon framework

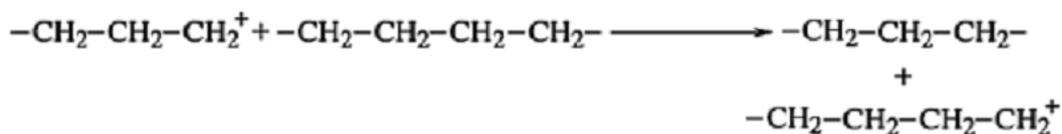


Isomerization of double bond



(C) Hydrogen transfer reactions

Intermolecular hydrogen transfer reactions



Intramolecular hydrogen transfer reactions



Scheme 2.

Reactions involved in the thermal and catalytic cracking of polymer chains [3]

V. REACTION CONDITIONS

Prior to carrying out the reaction, we activated the catalysts at 400 °C for 1 h inside our Reactor. The reactor had fitted glass fiber in order to keep the catalyst in place. For every test, We employed 0.9 g of polymer (LDPE). The polymer was melt at 290 C and then introduced into the reactor (0.04 cc/min) the temperature of the capillary tube was set at 330 C and the

Reactor temperature at 450 C. Catalytic cracking reaction conditions ^[5]

VI. RELATIONSHIP BETWEEN REACTION CONDITIONS AND PRODUCTS

The products distribution varies at different reaction temperatures; in general terms (for zeolites as well as for other acid solids) high reaction temperatures increase the yield of gas products and middle boiling point components (C5-C12 gasolines) whereas lower reaction temperatures increase the yield of heavier components (C13-C18) ^[6]. As the polymer to catalyst mass ratio increases, the system becomes less active however; this effect can be compensated by higher temperatures or larger reaction times. This relative loss of activity also tends to produce a higher yield of liquid products. It is not uncommon to observe some condensation in gas containers after the reaction, which can be avoided by reducing the flow rate of the carrier gas. Inside the reaction chamber, the heated carrier gas can cause the evaporation of liquid products and also transports them out of the system.

VII. ECONOMIC CONSIDERATIONS

The most important economic issues that influence the viability of primary and secondary (mechanical) plastic recycling are the price of the recycled polymer compared with virgin polymer and the cost of recycling compared with alternative forms of acceptable disposal.

More individuals, organizations, business, and government agencies are collecting materials for recycling than ever before. The number of curb side recycling programs has grown during the last decade and new economic opportunities allow the birth of new markets. Recycling also creates new businesses that haul, process, and broker recovered materials, as well as companies that manufacture and distribute products made with recycled content. By recycling 1 ton of plastic, you can help save the same amount of energy that two people use

In one year, or almost 2,000 pounds of oil (USEPA, 2009)

Important benefits of the catalytic cracking of polymer waste with respect to other chemical feedstock recycling methods is the possibility of controlling the selectivity towards desired products and the possibility of reducing energy consumption. The use of cheap catalysts is central under the actual circumstances and some of the current best options are natural materials and waste catalysts from other industries. To use existing industrial facilities is a way for much cost reduction. Since the catalysts and the reaction mechanism of the polymer catalytic cracking are about the same as for the hydrocarbon fluid catalytic cracking (FCC), it is possible to incorporate plastic waste into the FCC refinery feed, with the added benefit that plastic waste has almost no sulphur content and no heavy metals content

VIII. CONCLUDING REMARKS

Active plastic waste catalytic cracking materials involve Brønsted acid sites, present in zeolite catalysts and which we introduced in MCM-41 mesoporous materials by (i) the incorporation of Al and Ga and (ii), by

impregnation of the MCM-41 surface with tungstophosphoric acid. The several solid acid catalysts we tested yield gas and liquid products from the LDPE cracking reaction. The gas products consist of a mixture of ethane, Propane, butane and pentane, all of them of interest for petrochemical industries or as domestic energy source. Liquid products consist of gasoline, turpentine, kerosene, gas oil, and fuel oil, corresponding to fuel fractions obtained in industrial petroleum refinery plants. The selectivity towards particular products depends mainly on the choice of catalyst and reaction conditions. The study of the catalytic cracking of plastic waste has led to relevant scientific knowledge and to the development of innovative technologies. The large-scale application of these processes has been limited by economical and profitability reasons. Previous stages involve plastic separation from municipal waste and, since different mixtures of products are obtained, end stages involve product separation processes. Up to now, it is hard to compete with the still cheap option of producing fuels from natural gas and crude oil and to produce plastics from new raw materials. However, worldwide growing concerns about preserving our environment give plenty of room for imaginative ideas on how to scale up these processes to industry level.

IX. ACKNOWLEDGEMENT

We would like to acknowledge the guidance and support provided to us by

Our Hon. Director Prof. Dr. Rajesh Jalnekar Sir

Head of Department Prof. Dr. C.M. Mahajan Sir

Guide Prof. V.S. Nagnath Sir of

Vishwakarma Institute of Technology, Pune

REFERENCES

- [1] Jereme, I.A., C. Siwar, and M.A.H. Bhuiyan, Incineration and its implications: The need for a sustainable waste management system in Malaysia. *International Journal of Environmental Sciences*, 2013. 4(3): p. 367.
- [2] Covarrubias, C., Gracia, F. & Palza, H. (2010). Catalytic degradation of polyethylene using nanosized ZSM-2 zeolite. *Applied Catalysis A: General*, Vol. 384, pp 186–191.
- [3] Kumar, S., Panda, A. K. & Singh, R. K. (2011). A review on tertiary recycling of high-density polyethylene to fuel. *Resources, Conservation and Recycling*, Vol. 55, pp 893–910.
- [4] Pinto, F., Costa, P., Gulyurhu, I. & Cabrite, J. (1999). *J. Anal. Appl. Pyrolysis*, Vol. 51, pp 57-71.
- [5] Hernández, A., Noreña, L., Chen, L. F., Wang, J. A. & Aguilar, J. (2010). Refinery Oil Fraction Fuels Obtained From Polyethylene Catalytic Cracking Employing Heteropolyacid-MCM-41 Materials. *Advanced Materials Research*, Vol. 132, pp 236-245.
- [6] Gulab, H., Jan, M. R., Shah, J. & Manos, G. (2010). Plastic catalytic pyrolysis to fuels as tertiary polymer recycling method: Effect of process conditions. *Journal of Environmental Science and Health, Part A*, Vol. 45, No. 7, pp 908-915.