



JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

CONVERSION OF WASTE PLASTICS TO FUELS

¹DURGAPRASAD KOLLIPARA, GSD GANESH, R.SUNDEEP, N.GOPALA KRISHNA KISHORE,
T.DILEEP

¹ASSOCIATE PROFESSOR, STUDENTS
V.K.R.,V.N.B & A.G.K COLLEGE OF ENGINEERING

ABSTRACT:

The objective of the project 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 our project work we 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.

INTRODUCTION:

Plastics play an important role in day- today life. It is unique material because of their toughness, light weight, resistance to water and chemicals, resistant to heat and cold, low electrical and thermal conductivity, ease of fabrication, remarkable color range, more design flexibility, durability and energy efficiency. Due to above properties it is used in packaging materials, agriculture, construction, insulation, automobile sector, electronic devices, textiles and sports equipment and toys. Plastics constitutes in two main categories. It is thermoplastics and thermoset plastics. Thermoplastics make up 80% of the plastics

and thermoset plastics make up of remaining 20% of plastics produced today (Birley et al, 1988), etc. Thermo plastics can re-melt or re-mould and therefore

it recyclable easily but thermoset plastics cannot re-melt or reshape and therefore it is difficult to recycling.

Use of different type of some thermoplastics is given in table1 below. Plastics are relatively cheap, easy available, easy to manufacture and their versatility replace to conventional materials. Plastic waste management is biggest problem now due to their nonbiodegradability nature. Now plastics manage by plastics recycling technologies.

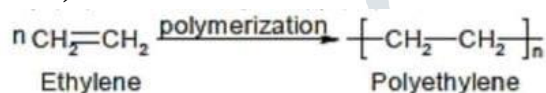
FACTORS EFFECTING PLASTIC PYROLYSIS:

The major factors influencing the plastic pyrolysis process and pyrolysis product molecular distribution include chemical composition of the feedstock, cracking temperature and heating rate, operation pressure, reactor type, residence time and application of catalyst. These factors are summarized in this section as follows.

CHEMICAL COMPOSITION OF FEEDSTOCK:

The pyrolysis products are directly related to the chemical composition and chemical structure of the plastics to be pyrolyzed. In addition, the chemical composition of the feedstock also affects the pyrolysis processes. In reality, waste plastics are possibly contaminated before recycling which could also have

effects on the pyrolysis process and products. PE, PP and PS are most commonly used polymeric hydrocarbons and were selected as the investigated materials in this study. Polyethylene is formed from ethylene through chain polymerization which is shown in Formula. Plastics can be classified, according to structural shape of polymer molecules, as linear, branched, or cross-linked in Figure. The units in linear polymer are linked only to two others, one to each ends. The polymer is termed branched when branches extend beyond the main polymer chain randomly. Regularly repeating of side groups are considered to be part of the unit but not considered as branches. There is a significant relationship between the density and the branching intensity of polymers. The PE with more branches has relatively lower density. The branched polyethylene is also called low density polyethylene (LDPE), which is different from linear polyethylene that is called high density polyethylene (HDPE).



9 Based on the above description, polystyrene is called linear polymer although it contains functional groups as part of the monomer structure. In branched polymers, at least one of the monomers is connected to more than two functional groups due to the branching points produced from the polymerization process. The functional side group and the branch structure have significant effects on the pyrolysis product. For example, the dominant component in PS pyrolysis products is styrene that is the side group come off from PS carbon backbone. In pyrolysis process, cross linked polymer will crack rather than melt or evaporate. This is different from the reactions of linear or branched polymers in pyrolysis process. A cross linked polymer can be described as an interconnected branched polymer with all polymer chains are linked to form a large molecule. Thus, the cross linked polymer constitutes large molecule. Theoretically, the molecular weight of a cross linked polymer can be infinite. In reality, the molecular weight of a cross linked polymer will be limited due to breaking down of the molecular interconnections during the processing or the weight of the polymer sample. The cross linked polymer cannot be dissolved in solvents or be melted by heat because of their network structure.

PYROLYSIS PROCESSES AND TARGET PRODUCTS:

Process	Heating rate	Residence time	Temperature (°C)	Target Products
Slow carbonization	Very low	Days	450-600 l	Charcoal
Slow pyrolysis	10-100K/min	10-60 min	450-600	Gas, oil, char
Fast pyrolysis	Up to 1000K/s	0.5-5 s	550-650	Gas, oil, (char)
Flash pyrolysis	Up to 10000K/s	<1 S	450-900	Gas, oil, (char)

Table 1 PYROLYSIS PROCESSES AND TARGET PRODUCTS

Except for the batch pyrolysis reactor in a closed system, residence time is difficult to be controlled directly but can be adjusted by altering other operation parameters such as feeding rate, carrier gas flow rate and product discharge rate. Residence time was, then, calculated for these controllable operation parameters. Secondary pyrolysis cracking occurs when residence time is long enough, which enhances the yield of gaseous product. Higher value of V/m represents longer residence time in Figure 2.3 .The Y axis is the conversion of HDPE to 35 gaseous product. There is a significant effect on the conversion when the residence time varies in a certain range during the non-catalyst thermal reaction.

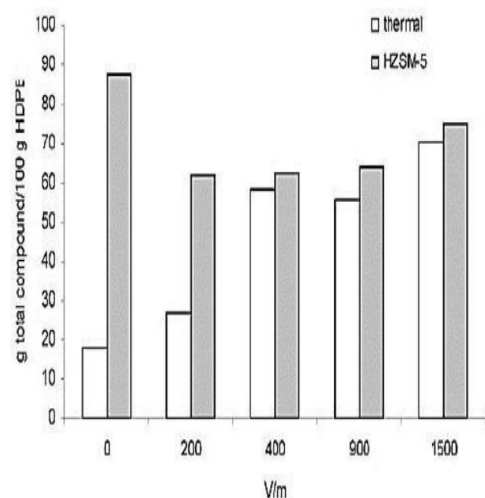


Fig: 2 Influence of residence time on the production of gaseous product (from HDPE thermal and catalytic cracking)

USE OF CATALYST:

ADVANTAGES OF USING CATALYST:

In order to optimize plastic pyrolysis reactions and modify the distribution of pyrolysis products, catalysts are widely used in research and industrial pyrolysis processes. Petroleum fuels, such as LPG, petrol, kerosene, and diesel, are hydrocarbons from C1 to C24. The PE pyrolysis products are mainly straight hydrocarbons from C1 up to C80, which contain much heavier molecular weight components. One of the main purposes of using catalysts is to shorten the carbon chain length of the pyrolysis products and thus to decrease the boiling point of the products. Catalysts are found to be mainly applied to PE pyrolysis because the primary product from other plastics, such as PP and PS, are mainly light hydrocarbons, with similar carbon chain length to the range of commercial fuels. 36 The products from non-catalytic PE pyrolysis contain high proportion of 1-alkenes and dialkenes. Some catalysts are applied specifically to reduce the unsaturated hydrocarbons and promote the yield of aromatics and naphthenes. This can significantly increase the stability and cetane number of the oil products. Moreover, it is reported that activation energies (E_a) measured in the PE pyrolysis with catalysts (such as HZSM-5, HY, and MCM-41) were much lower than those when no catalyst was added.

CATALYST CLASSIFICATION:

The catalyst are classified into two. They are

- Homogeneous
- Heterogeneous

Homogeneous catalysts used for polyolefin pyrolysis have mostly been classical Lewis's acids such as $AlCl_3$. Generally, heterogeneous catalysts are preferred due to their easy separation and recovery from the reacting medium. Heterogeneous catalysts can be summarized as nanocrystalline zeolites, aluminum pillared clays, conventional acid solids, mesostructured catalysts, super acid solids, Gallo silicates, metals supported on carbon, and basic oxides. Among the mentioned catalysts, nanocrystalline zeolites have been extensively studied for polyolefin pyrolysis and this type of catalysts will be discussed in more details as follows. A zeolite is a crystalline aluminosilicate with a three-dimensional framework structure that forms uniform pores of molecular dimensions. Zeolites act as sieves on a molecular scale and exclude molecules that are too large to pass through the pores. The three-dimensional frame structure significantly increases the area of the sieves and absorbs molecules that have similar sizes as the pores. According to the structure of zeolites, 176 zeolite framework types have been confirmed. A three-letter code, such as MFI, is assigned to framework types by the Structure Commission of the International Zeolite Association. The codes are derived from the name of the zeolite, for example, MFI from ZSM-5. The pore openings and sizes are key parameters for the catalytic effect in the plastic pyrolysis, which are determined by the size of single ring and the structure features

PRESSURE:

Operating pressure has significantly affect on both the pyrolysis process and the products. The boiling points of the pyrolysis products are increased under higher pressure, therefore, under pressurized environment heavy hydrocarbons are further pyrolyzed instead of vaporized at given operation temperature. Figure 2.4 shows Effect of pressure on the distribution of PE pyrolysis products In effect, under pressurized pyrolysis, more energy is required for further hydrocarbon cracking. It was also found that high pressure increases the yield of non-condensable gases and decreases the yield of liquid products. (Figure 2.5) The average molecular weight of gas product also decreases with the increase of pressure. The influence of pressure on the concentration of double bond, $C=C$, of the liquid product was not significant. In summary, pressure has major effects on the pyrolysis reaction

and the distribution of PE pyrolysis products, but has minor effect on the double bond components

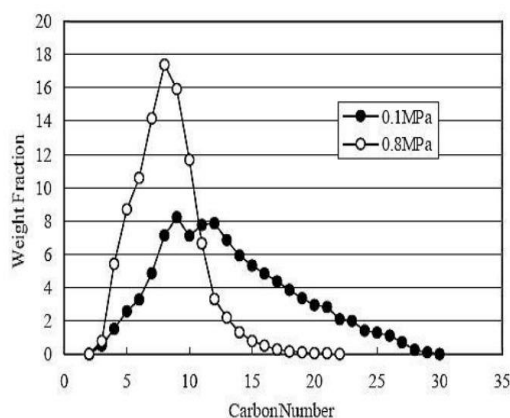


Fig:3 Effect of pressure on the distribution of PE pyrolysis products.

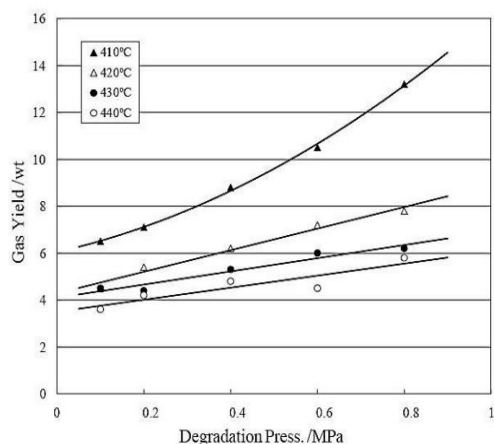


Fig: 4 Effect of pressure on the yield of gas at different temperature

METHODOLOGY:

Process for turning plastic to fuel

Over 500 billion pounds of new plastic is manufactured each year and roughly 33% of that is single use and thrown away. As so little plastic is recycled, we need to reframe plastic waste as an underused resource vs. one that's destined for the landfill. If all plastic waste made it into the landfill, it would surely be mined in the future, but currently all plastic waste does not make it into our landfills. The United Nations estimates plastic accounts for four-fifths of the accumulated garbage in the world's oceans. We need to stop polluting our oceans with plastic before it is too late, and start collecting all plastics suitable for this new, fairly simple, technology, a technology that is available now.

The technology is not overly complicated. plastics are shredded and then heated in an oxygen-

free chamber (known as pyrolysis) to about 400 degrees Celsius. As the plastics boil, gas is separated out and often reused to fuel the machine itself.

What plastic can be used

For this technology, the type of plastic you convert to fuel is important. If you burn pure hydrocarbons, such as polyethylene (PE) and polypropylene (PP), you will produce a fuel that burns fairly clean. But burn PVC, and large amounts of chlorine will corrode the reactor and pollute the environment.

Burning PETE releases oxygen into the oxygen deprived chamber thereby slowing the processing, and PETE recycles efficiently at recycling centers, so it is best to recycle PETE traditionally. HDPE (jugs) and LDPE (bags and films) are basically polyethylene so usable as fuel as well, just slightly more polluting as a thicker heavier fuel is created. But additional processing can turn even HDPE into a clean diesel.

"Polyethylene and polypropylene are pure hydrocarbons, only they are arranged in long chains. If you chop those chains into shorter ones, you get oil, if you chop them even shorter, you get diesel, and if you chop them again, you get gasoline and eventually burnable gas."

Machines' that turns plastic to fuel

In Niagara Falls, NY, John Bordynuk's "Plastic Eating Monster" can even vaporize thick HDPE plastic into a cleaner burning number 2 fuel. Put plastic in one end of the machine and out the other end comes diesel, petroleum distillate, light naphtha and gases such as methane, ethane, butane and propane.

The machine accepts unwashed, unsorted waste plastics, composites and commingled materials and returns about 1 gallon of fuel from 8.3 pounds of plastic. And the processor uses its own off-gases as fuel, therefore using minimal energy to run the machine. John has two massive steel processors up and running, with financing secured for three more to be built in the very near future.

In the Philippines, Poly-Green Technology and Resources Inc. was started by Jayme Navarro whose sister asked him to come up with a way to recycle plastic bags. A plant is being built that will produce 5,000 kilos of fuel per day. Estimates show that less than 5% of the plastic manufactured each year is recycled, with production of the material set to increase by 3.8% every year until 2030, adding to the

6.3 billion tones churned out since production began 60 years ago. The majority ends up in our oceans, posing a disruption to marine ecosystems, which researchers predict would take a minimum of 450 years to biodegrade, if ever.

The solution of plastics-to-fuel holds promise in not only curbing such pervasive pollution but also providing a significant economic benefit to regions. The American Chemistry Council estimates plastic-to-fuel facilities in the US alone would create nearly 39,000 jobs and almost \$9bn in economic output, making the global market potential of such an industry huge.

Plastic-derived fuels are also capable of producing a cleaner burning fuel than traditional sources due to their low sulphur content, considering the majority of developing nations use sulphur-heavy diesel.

The team added a light-absorbing photo catalyst to plastic products, a material that absorbs sunlight and transforms it into chemical energy in a process called 'photo reforming'. The plastic and catalyst combination was then left in an alkaline solution exposed to sunlight, breaking down the material and producing bubbles of hydrogen gas in the process.

Table.2 information of ingredients

CHEMICAL NAME	CONTENT (Normal)*	GAS NUMBER	EXPOSURE LIMITS IN AIR		
			ACGIH TLV-TWA (inhalable fraction)	ACGIH TLV-STEL	IDLH
Polypropylene	99.25 wt%	9003-07-0		NA	NA
Proprietary additives	<=0.75 wt%	Mixture			

* For different grades of PP; minor changes may be there.

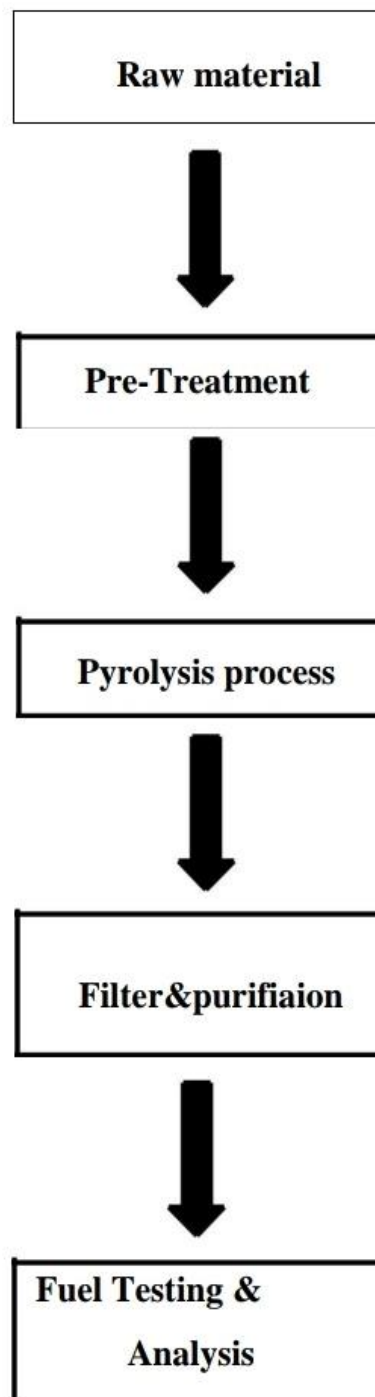
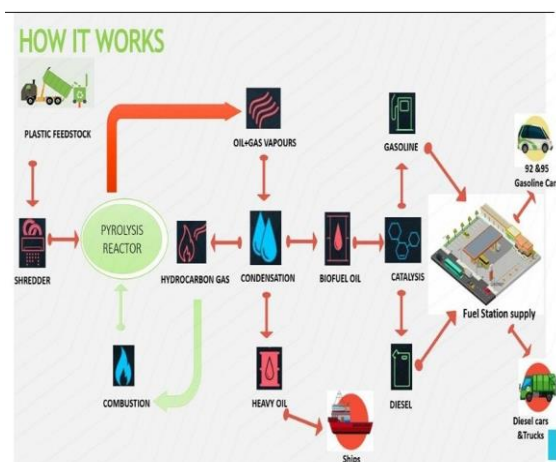


Fig.5 working process

PROCESS:**RAW MATERIAL:**

The Raw material used for extracting oil by the process of Pyrolysis is Polypropylene (PP). The Material Safety Data Sheet taken from Indian Oil Corporation gives detailed information about various safety aspects of the material used.

**RESULT:**

Sr.No	properties	petrol	diesel	Plastic oil	Exp values
1	Colorific value(Kj/Kg)	43,000	42,000	41,893	42,000
2	Fire point	48	56	44	45
3	Flash point	43	50	40	40
4	Kinematic viscosity 310k	2.5	3.97	2.23	2.149
5	density	0.77	0.84-0.88	0.78	0.793
6	Dynamic viscosity	1.925	3.4	1.73	1.7

Table.3 RESULT**CONCLUSION & FUTURE SCOPE****CONCLUSION:**

Pyrolysis of hydrocarbon polymers is a very complex process, which consists of hundreds of reactions and products. Several factors have significant effects on the reactions and the products. Based on previous

research, this chapter investigated the fundamental plastic processes and reactions. With temperature increasing, plastic will go through glassy state, rubbery state, liquid state, and decomposition. Decomposition of plastic in an inert environment into liquid is called pyrolysis. There are four stages of reactions during the plastic pyrolysis process: initiation, propagation, hydrogen transfer, and termination reactions. It was found that heavy molecular weight hydrocarbons produced from primary cracking can be further cracked into light molecular weight products through a secondary cracking process. This secondary cracking process has significantly influence on the distribution of the product. This process converts heavy hydrocarbons into gas or light liquid product.

FUTURE SCOPE:

The project shows some light on the possibility of manufacturing liquid fuels which could be used as feed stock refinery for further modification or commercial use. By using this technology we could solve the waste plastic problem and also significantly reduce the landfills-which are the cause of infertility of Agriculture land. Waste plastics can also become a very good source of energy and an alternative to fossil fuel which have caused an environment imbalance.

REFERENCE:

1. Yuan, X., Converting Waste Plastics into Liquid Fuel by Pyrolysis: Developments in China, in Feedstock Recycling and Pyrolysis of Waste Plastics, J. Scheirs and W. Kaminsky, Editors. 2006, John Wiley & Sons, Ltd: Changsha, P.R. China.
2. Material Safety Data Sheet Polypropylene (PP) Indian Oil Corporation Ltd.
3. Ciliz, N.K., E. Ekinici, and C.E. Snape, Pyrolysis of virgin and waste polypropylene and its mixtures with waste polyethylene and polystyrene. Waste Management, 2004.
4. Aguado, J., D.P. Serrano, and J.M. Escola, Catalytic Upgrading of Plastic Wastes, in Feedstock Recycling and Pyrolysis of Waste Plastics, J.Scheirs and W. Kaminsky, Editors. 2006, John Wiley & Sons, Ltd: Mostoles, Spain.
5. Williams, P.T., J. Scheirs and W. Kaminsky, Editors. 2006, John Wiley& Sons, Ltd: Leeds. Yield and composition of gases and oils/waxes from the feedstock recycling of waste plastic, in Feedstock Recycling and pyrolysis of waste plastics
6. Moinuddin Sarker, Mohammad Mamunor Rashid and Muhammad Sadikur Rahman. International

Journal of Modern Engineering Research (JMÉR),
Vol.2, Issue.4, July-Aug. 2012 pp-2168-2173, ISSN:
2249- 6645. Natural State Research, Inc. Department
of Research and Development USA.

7. British Plastics Federation website:
<http://www.bpf.co.uk/Recycling>.

8. Preliminary study on the conversion of different
waste plastics into fuel oil, Munich, GRIN Verlag,
[http://www.grin.com/en/e-book/206451/preliminary-
study-on-theconversion-of-differcnt-wastc-plastics-
into-ruel](http://www.grin.com/en/e-book/206451/preliminary-study-on-theconversion-of-differcnt-wastc-plastics-into-ruel)

9. European Association of Plastics Recycling
website:<http://www.europlasticsrecycling.com>.
10. CONVERTING WASTE PLASTICS INTO A
RESOURCE (Compendium of Technologies) United
Nations Environmental Programme Division of
Technology, Industry and Economics International
Environmental Technology Centre Osaka/Shiga,
Japan.

11. Oluwafunmilayo A. Aworanti, Samuel E. Agarry,
Ayobami O. Ajani. Advances in Chemical Engineering
and Science, 2012 [http://dx.doi.org/10.4236/aces.2012](http://dx.doi.org/10.4236/aces.2012.24054)
.24054 Published Online October 2012 ([http://www](http://www.SciRP.org/journal/aces)
.SciRP.org/journal/aces)

