

## **Sustainable Utilization of Plastic Waste - An Overview**

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**Abstract**—Global industrialization leads to generation of solid waste and scarcity of fuel due to consumption of natural resources. Solid waste management is one of the most challenging issue causing health and environmental threats globally. Tones of Plastic waste are predominant non biodegradable content of solid waste. Disposal of solid waste by conventional techniques such as sanitary land filling leads to drastic environmental degradation. Recycling of plastic waste is one of the sustainable solutions. The present paper is an effort to reflect plastic waste disposal by pyrolysis. Pyrolytic decomposition of plastic waste may lead to production of by-products such as crude oil and gas which can be utilized as an alternative source of energy resolving residential and industrial fuel shortage, minimization of environmental and health issues.

**Key Words:** Plastic waste , Solid waste management, Pyrolysis, Energy source, Sustainable development.

### **I. INTRODUCTION**

Municipal solid waste management is one of the important components that leads towards sustainable development. Plastic is one of the element in municipal solid waste. It is found that plastic production growth is increasing throughout the globe. Inefficient plastic waste management causes environmental and health hazard. The conventional methods of solid waste disposal such as sanitary land filling, incineration etc causes water, soil and air pollution. The increase of petroleum and petrochemical prices poses economical burden and global economy.. To cope up with this problems wasted plastic pyrolysis can be used as a sustainable solution. Plastic includes polystyrene, poly (vinyl chloride), polypropylene, PE terephthalate , acrylonitrile-butadiene-styrene , and PE (Polyethylene). In some cases, plastics were copolymerized with other materials such as waste motor oil ,With regard to fast pyrolysis of PE, pyrolysis of LDPE (Low-density polyethylene) , HDPE (High-density polyethylene) etc.[1] 67 percent of plastic are of type HDPE and LDPE. Plastic waste management involves reduce, reuse & recycle. Recycling methods can be classified as primary recycling, secondary recycling and tertiary recycling. Primary recycling is a physical method. Remoulding is an example of this process. not more than 20 percent of plastic waste can be recycled by this process. It cannot recycle multilayer plastic waste. Secondary recycling is also a physical method. Tertiary method is a chemical method to recycling plastic waste. pyrolysis is one of the suggested method. Chemicals and fuels are the by-product of chemical recycling.

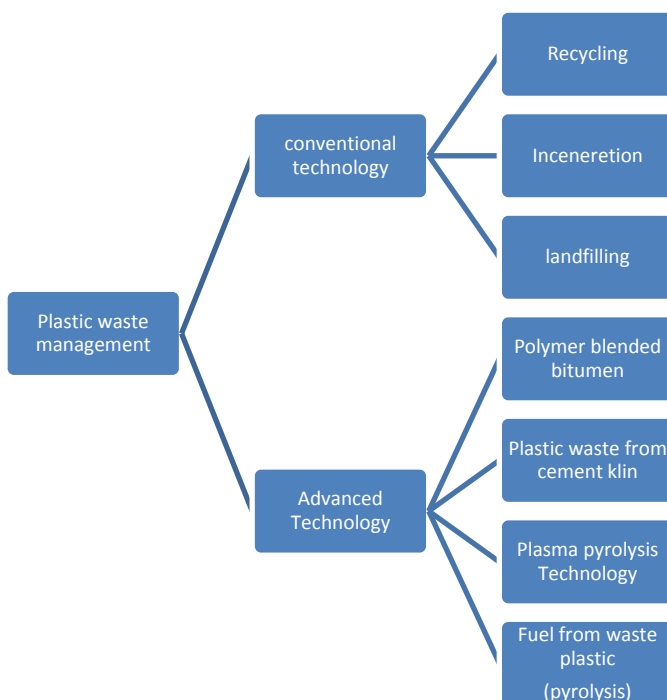


Fig . 1

## II. PLASTIC WASTE MANAGEMENT OF VARIOUS COUNTRIES :-

In past centuries, sanitary land filling was extensively used for disposal of solid waste. During early 2000, the largest amount of plastic wastes is disposed of by land filling (65–70%), and incineration (20–25%). Recycling is only about 10%. These values vary from country to country. In Japan, in the early 1980s, approximately 45% of municipal Solid Waste was buried in sanitary land filled, incineration was 50%, and the other 5% was recycled. In the USA, more than 15% of the total MSW was incinerated in 1990; only about 1% of post-consumer plastics were recycled. In India, during 1998 around 60% of plastic wastes generated were recycled. In Europe 2006 marks a milestone as the first year when recovery and disposal rates of used plastic were equal. The recovery rate of post-consumer end of life plastics now stands at 50% and disposal stands at 50%. The recycling rate for post -consumer plastics has increased to 19.7% up from 18% in 2005 and energy recovery has increased to 30.3% up from 29% in 2005. Of the 11.5 million tonnes recovered 4.5 million tonnes were recycled as material and feedstock and 7.0 million tonnes were recovered as energy. The overall material recycling rate of post-consumer plastics in 2006 was 19.7%, with mechanical recycling at 19.1% (up 2.5% point over 2005) and feedstock recycling at 0.6% (down 1% from 2005). The energy recovery rate was up by 1.5% from 2005 to 30.3%, reflecting the stricter legislation on landfill in several Member States. [2] This shows that there is an increase in awareness towards solid waste management over the globe. It is accepted that more stress is to be given over the recycling and recovery of energy from plastic waste.

## III. PYROLYSIS:-

Thermal cracking or Pyrolysis, involves the degradation of the polymeric materials by heating in the absence of oxygen. The process is usually conducted at different temperatures. The By-product generated out of the process depends on the quality of the plastic waste but also on technology used. The extent and the nature of these reactions depend both on the reaction temperature and also on the residence of the products in the reaction zone, an aspect that is primarily affected by the reactor design. However, the thermal degradation of polymers to low molecular weight materials requires high temperatures and has a major drawback in that a very broad product range is obtained [2]. It has advantages such as generation of fuel oil, Volume of waste is significantly reduced and reduction in environment problems.

## IV. TEST RESULTS STUDIED BY DIFFERENT AUTHOR:

### 4.1(Muhammad Ali Uzair et al) [3]

#### A. Effect of Catalyst

The kaolin clay treated with 3M HCl was used as catalyst lead to highest liquid yield and least liquid yield was recorded without using a catalyst, For 3M HCl treated clay, reaction started at 400°C, but reaction completed at 500° C. For 1M HCl treated clay, reaction started at 420°C and completed above 500°C, while reaction started at about 400°C and completed at 470°C for 5M HCl treated clay. The results of the experiments have been reflected in the Table 1.

TABLE-1  
YIELD OBTAINED BY CATALYTIC PYROLYSIS OF POLYPROPYLENE

|                            | 1M HCL treated clay | 3M HCL treated clay | 5M HCL treated clay | No Catalyst |
|----------------------------|---------------------|---------------------|---------------------|-------------|
| <b>Liquid Yield (gram)</b> | 12.8500             | 14.3800             | 12.2100             | 11.0900     |
| <b>Gas Yield (gram)</b>    | 5.4100              | 4.7300              | 7.0700              | 5.800       |
| <b>Residue (gram)</b>      | 1.7400              | 0.8900              | 0.7200              | 3.1100      |
| <b>% Liquid Conversion</b> | 64.25 %             | 71.9 %              | 61.05 %             | 55.45 %     |

#### B. Effect of Temperature on Product Distribution in Thermal Pyrolysis:

Three fractions namely low and high viscous liquid, no condensable gases and solid residue were obtained as products of thermal pyrolysis. The liquid fraction obtained at 400°C was less viscous. As temperature increased to maximum 500°C for thermal pyrolysis, liquid yield converted to more viscous form. At high temperature, less liquid yield and more gas yield was due to formation of more non-condensable volatile fractions as a result of severe cracking. Product distribution at different temperatures is summarized in Fig. 2

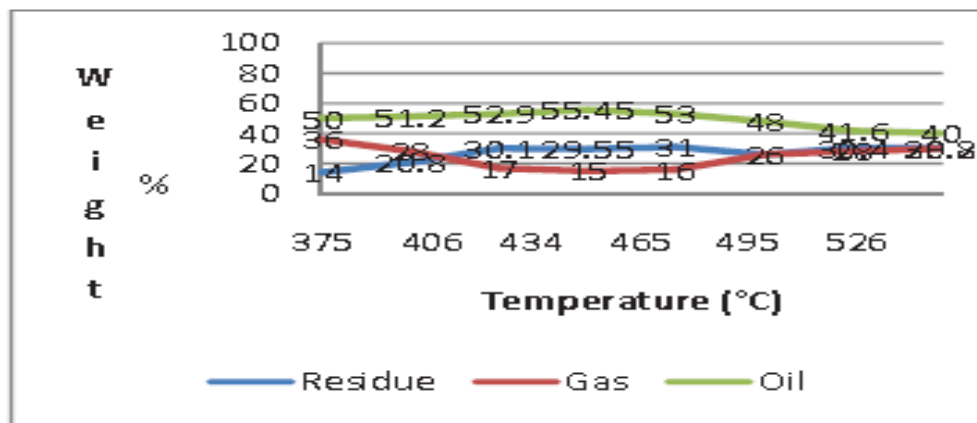


Fig.2. EFFECT OF TEMPERATURE ON PRODUCT DISTRIBUTION OF POLYPROPYLENE

4.2 [Vijaykumar B. Chanashetty et al] [4]

#### A. Effect of Temperature on LDPE

Effect of temperature on the yield of fuel oil from LDPE: 1 kg. LDPE was cracked at the different temperatures and reaction time. The initial temperature before the start of heating was found to be 31°C.

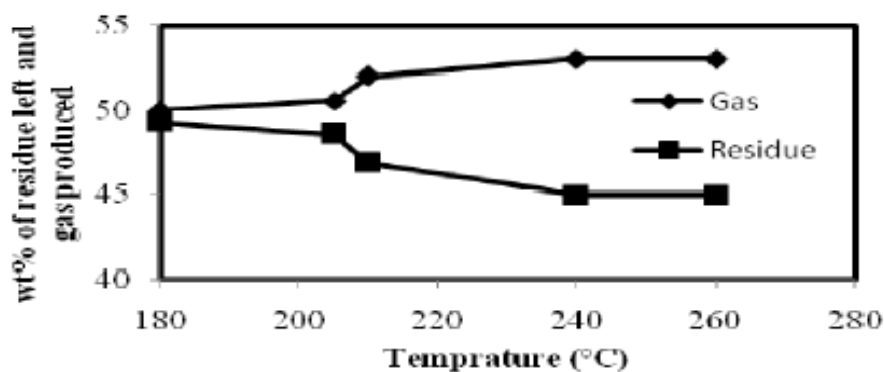


Fig.3 EFFECT OF TEMPERATURE ON THE RESIDUE LEFT AND GAS PRODUCED FOR LDPE

Fig.3. represents the production of gases at different temperatures and residue obtained at that temperature. Here, it was found that at the 180°C, they are just started to separate from each other and after that at 205°C the residue is reduced to 48.5% and gaseous product is increased to 50.5%. At 210°C residue is 46.8% and gaseous product is about 52%. Finally at the temperature 250 we find the residue 44.9% and gaseous product is 53 %

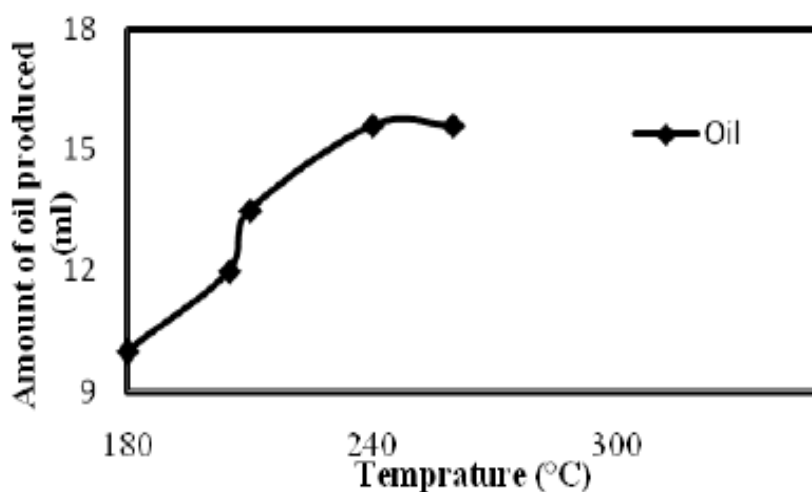


Fig 3.1 EFFECT OF TEMPERATURE ON THE AMOUNT OF OIL PRODUCES FROM LDPE

Fig. 3.1 shows that the amount of crude oil produced with respect to temperature. With increases of the temperature the amount of oil produced is increasing up to 15ml. No further increase in amount of crude oil is recorded after further increase in temperature.

#### B. Effect of Temperature on Fuel from HDPE

1Kg. of HDPE was cracked at different temperatures. After the completion of reaction at different temperature levels, the residue left along with the amount of oil produced was collected. The initial temperature before cracking was found to be 31°C. Fig.3.2 shows the effect of temperature on the amount of oil produced from HDPE. Initially the amount of oil production increases as the temperature increases, the graph is a straight line at various points as shown. The amount of oil produced raises up to 185 ml and remains constant with further increase in temperature, which indicates the consumption of the raw materials (plastics).

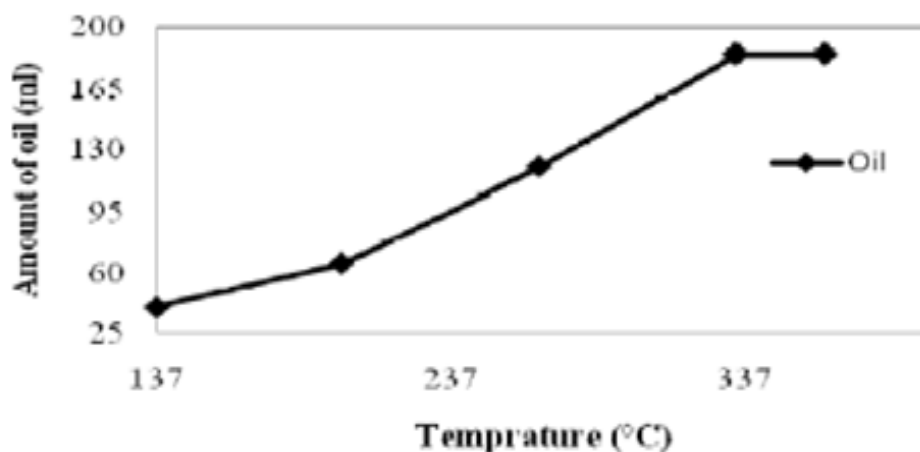


Fig 3.2 EFFECT OF TEMPERATURE ON THE PRODUCTION OF CRUDE OIL FROM HDPE

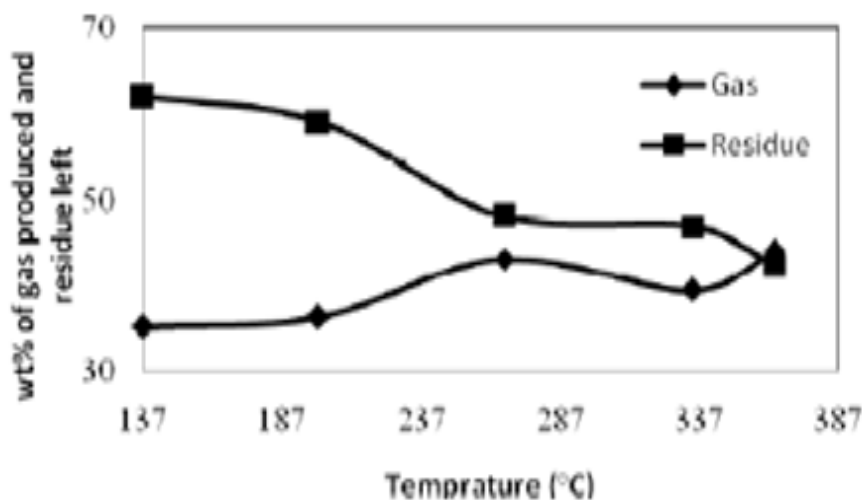


FIG. 3.3 EFFECT OF TEMPERATURE ON THE DISTRIBUTION OF RESIDUE LEFT AND GAS PRODUCED

At a temperature of 137°C the percentage of gas produced and residue left were measured to be 35% and 62% respectively. As temperature is increasing, the value of the gas produced is increasing because the plastic is cracked more at higher temperature while the residue left was decreasing. As the temperature is increasing the amount of residue is close to zero.

#### V. CONCLUSION

It is found that the quantity and quality of product yield by pyrolysis is greatly affected by the composition of plastic waste, the temperature range and the nature of catalyst used. It is possible that quantity and quality of fuel obtained as result of pyrolysis can be improved by experimenting taking different mix of plastic waste and catalyst. Blending of waste plastic oil with conventional fuel such as diesel can enhance the quality of oil. Thus recycling waste plastic by pyrolysis can give sustainable solution in terms of generating alternative energy source without environment degradation.

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