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A Review on Plastic Pyrolysis Process

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ABSTRACT: In the recent years demand of energy is increased which directly creates the demand of gasoline and diesel fuel, but the use of this fuel increase the pollution which effects on environment. This requirement creates the Researchers interest for alternatives to replace gasoline and diesel fuel. Pyrolysis is a thermo chemical decomposition of material in to liquid, gases and char (solid state) at controlled temperature in the absence of oxygen. In this paper we discussed pyrolysis process for the plastic.

KEYWORDS: Pyrolysis, Gasoline, Diesel Fuel, Thermo Chemical Decomposition.

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 are investigated to deliver the replacement of fossil fuel. The focused technologies are bio-ethanol, bio-diesel lipid derived bio-fuel, waste oil recycling, pyrolysis, gasification, dimethyl ether, and biogas. On the other hand, appropriate waste management strategy is another important aspect of sustainable development since waste problem is concerned in every city.

Pyrolysis is the process of heating organic material at high temperature in the absence of oxygen. Since no oxygen is present, the organic material does not combust. Pyrolysis of biomass produces three products namely liquid, gas and solid [3].

II. TYPES OF PYROLYSIS

There are three types of Pyrolysis Thermal Pyrolysis, Catalytic Pyrolysis and Hydrocracking, as shown in figure 1. In the Thermal Pyrolysis, the plastic waste is heated at high temperature. This type is divided into three type; Slow Pyrolysis (slow heating rate (0.1-1 °C/s), 35% yield of carbon black), Fast Pyrolysis (Heating rate (10-200 °C/s), 75% yield of pyro oil) and Flash pyrolysis (very high heating rate (> 1000 °C/s), 85% yield of gas)

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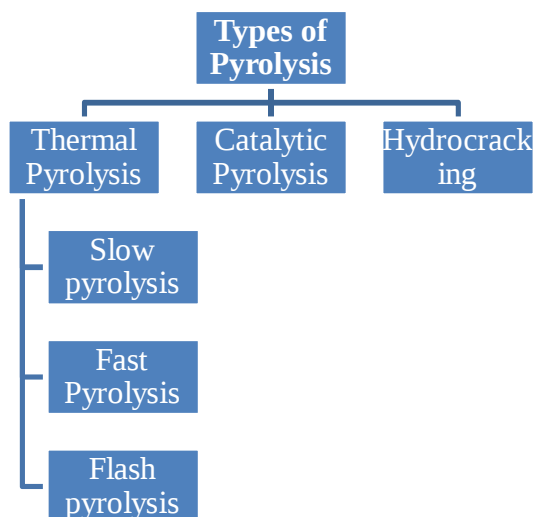


Figure 1 types of Pyrolysis

III. DISPOSAL METHODS OF WASTE PLASTICS & THEIR ADVANTAGES AND DISADVANTAGES

Following table 1 shows the different disposal methods of waste plastics and their advantages and disadvantages [2].
Table 1 Different Disposal Methods of Waste Plastics, their Advantages and Disadvantages [2]

Ocean Dumping		Sanitary Landfill	
Advantages	Disadvantages	Advantages	Disadvantages
Convenient	Ocean overburdened	Volume can increase with little addition of people	Completed landfill area can settle and requires maintenance
Inexpensive	Killing of plankton	Filled land can be reused for other community purpose	Require proper planning, design and operation
Source of nutrients, shelter and breeding.	Destruction of food sources		
Incineration		Open Dumping	
Advantages	Disadvantages	Advantages	Disadvantages
Require minimum land	Expensive to build and operate	Inexpensive	Health-hazard-insects, rodents etc.
Produce stable Odor-free residue	High energy required		Damage due to air pollution
Can be operated in any weather	Required skilled person		Ground water and run off pollution
Recycling			
Advantages	Disadvantages		
Provides the livable environment for the future	Expensive		
	Some wastes cannot be recycled		

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IV. LITERATURE SURVEY

Stella Bezergianni et al [1] presents the two-step (i.e. Upgrading of Plastic Waste via Pyrolysis and Pyrolysis Oil Hydro-treatment) process for converting waste plastics to diesel fuel has been experimentally tested and assessed with respect to final fuel yield quality. In the first step, the plastic waste pyrolysis was produced at the semi-continuous operating pyrolysis plant shown in figure 2. This first step contains two steps; Pyrolysis Oil Quality pyrolysis (oil produced included a wide boiling-point range of molecules that cover all transportation fuel standards) and Mid-Distillate Fraction Quality (the main fraction is the mid-distillate fraction (170–370 °C), accounting for 68.5 wt % of the total pyrolysis oil). In the second step i.e. Pyrolysis Oil Hydrotreatment is a key refinery process that enables heteroatom removal and saturation reactions, leading to a significant improvement in the quality of the treated fuels.

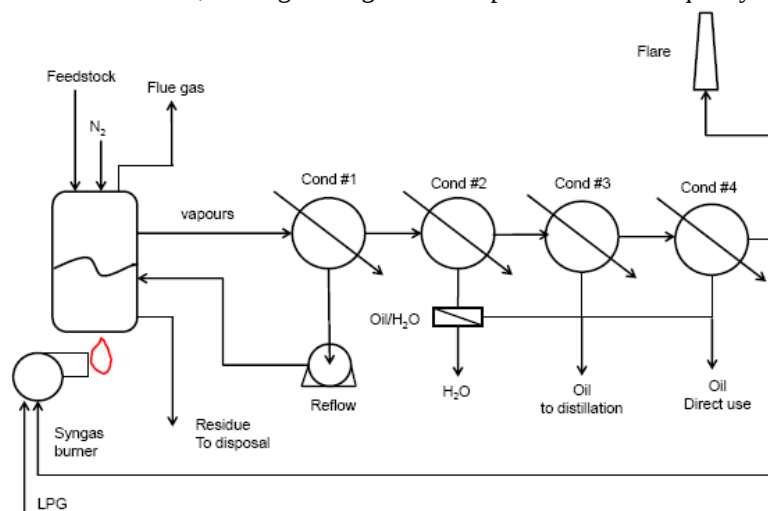


Figure 2 Mass and energy balance of the pyrolysis plant [1].

M. F. Ali et al. [4] reported that the high yields of liquid fuels in the boiling range 100°C–480°C and gases were obtained along with a small amount of heavy oils and insoluble material such as gums and coke. The results obtained on the co-processing of polypropylene with coal and petroleum residues are very encouraging as this method appears to be quite feasible to convert plastic materials into liquefied coal products and to upgrade the petroleum residues and waste plastics. N. Miskolczi et al [5] investigated the pyrolysis of real waste plastics (high-density polyethylene and polypropylene) in a pilot scale horizontal tube reactor at 520 °C temperature in the presence and absence of ZSM-5 catalyst. It was found that the yields of gases, gasoline and light oil could be increased in the presence of catalyst. They also concluded that the plastic wastes could be converted into gasoline and light oil with yields of 20–48% and 17–36% respectively depending on the used parameters.

F. Murphy et al .[6]from the recent literature, it is evident that the process of converting waste plastic to reusable oil is a current research topic, preparation of blends of diesel with varying proportions of waste plastic oil produced from the thermal pyrolysis and the analysis of viscosity and density of these blends is presented. The feasibility of the waste plastic oils derived from PVC plastics as an alternate fuel for transportation is also checked by conducting performance test on a single cylinder Kirlosker diesel engine equipped with electrical loading at 50% of the engine maximum load i.e., at 3.7 kW.

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V. MAIN OIL COMPOSITION FROM THE PYROLYSIS OF PLASTICS

Table 2 shows the main oil composition from the pyrolysis of plastics [7].

Polyethylene terephthalate (PET) [8]	Polyvinyl chloride (PVC) [8]	High-density polyethylene (HDPE)[9]	Polypropylene (PP) [9]	Low-density polyethylene (LDPE)[10]	Polystyrene (PS) [11]
1-Propanone	Azulene	1-Methylcyclopentene	2-Methyl-1-Pentene	Benzene	Benzene
Benzoic acid	Naphthalene, 1-methyl-	3-Methylcyclopentene	3-Methylcyclopentene	Toluene	Toluene
Biphenyl	Biphenyl	1-Hexene	1-Heptene	Xylene	Ethylbenzene
Diphenylmethane	Naphthalene, 1-ethyl-	Cyclohexene	1-Octene	Dimethylbenzene	Xylene
4-Ethylbenzoic acid	Naphthalene, 1-(2-propenyl)-	1-Heptene	C4-C13 hydrocarbon	Trimethylbenzene	Styrene
4-Vinylbenzoic acid	Naphthalene, 1,6-dimethyl-	1-Octene	Over C14 hydrocarbon	Indane	Cumene
Fluorene	Naphthalene, 2,7-dimethyl-	1-Nonene	Benzene	Methylindenes	Propylbenzene
Benzophenone	Naphthalene, 1,7-dimethyl-	1-Decene	Toluene	Naphthalene	2-Ethyltoluene
4-Acetylbenzoic acid	Naphthalene, 1,4-dimethyl-	1-Undecene	Xylene	Methylnaphthalenes	Naphthalene
Anthracene	9H-Fluorene	1-Tridecene	Ethylbenzene	Ethyl-naphthalene	Diphenylmethane
Biphenyl-4-carboxylic acid	Naphthalene, 1,6,7-trimethyl-	C4-C13 hydrocarbon	Indene	Dimethylnaphthalene	Anthracene
1-Butanone	Naphthalene, 1-(2-propenyl)-	Over C14 hydrocarbon	Biphenyl	Acenaphthylene	1,2-Diphenylethane
m-Terphenyl	Phenanthrene, 1-methyl	Benzene		Acenaphthene	2,2-Diphenylpropane
	Fluoranthene, 2-methyl-	Toluene		Trimethylnaphthalenes	1,3-Diphenylpropane
	1H-Indene, 2,3-dihydro-5-methyl	Xylene		Fluorene	Phenylnaphthalene
	Naphthalene, 2-phenyl-			Tetramethylnaphthalene	Diphenylbenzene
					Triphenylbenzene

VI. CONCLUSION

The global plastic production increased over years due to the vast applications of plastics in many sectors. The continuous demand of plastics caused the plastic wastes accumulation in the landfill consumed a lot of spaces that

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contributed to the environmental problem. This paper reviewed the pyrolysis process in the literature survey, its types also Disposal methods of waste plastics & their advantages and disadvantages.

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