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Conversion of Plastic into Fuel by Pyrolysis Process

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ABSTRACT:The increased demand and high price for energy sources are driving efforts to convert organic compounds into useful hydrocarbon fuels. Although much of this work has focused on biomass, there are strong benefits to deriving fuels from waste plastic material. Waste plastic is abundant and its disposal creates large problems for the environment. Plastic does not break down in landfills, it is not easily recycled and degrades in quality during the recycling process, and it can produce waste ash, heavy metals, and potentially harmful gas emissions if incinerated at high temperatures. However, thermal processes can be used to convert plastics into hydrocarbon fuels such as gasoline, diesel, aviation / jet fuel, which have unlimited applications in airline industries, helicopter, heavy transportation, and electricity generation. The method and principal of the production / process will be discussed..

KEYWORDS:waste plastic recycling, pyrolysis, LDO

I. INTRODUCTION

Plastic waste is regarded as a potentially cheap source of chemicals and energy. Lots of us have encountered a variety of products that use plastic materials today. As a result of the increasing level of private consumption of these plastic materials huge amount of wastes are discharged to the environment.

Plastic was invented by Alexander Parkes in 1860. Plastics have become a crucial part in today's world. Due to their light weight, durability, design flexibility, they are excessively used in industry as well as household and other fields. The demand for plastic is increasing day by day which now pose a tremendous threat to the environment. The study focus on the design and fabrication of machine to convert plastic into oil as an effort in finding environment-friendly means of waste recycling by means of pyrolysis. It is an alternative solution to increasing problem of waste disposal. Pyrolysis keeps running without oxygen and in high temperature of around 250°C for which reactor is manufactured to give the expected temperature to the response. Pyrolysis process becomes an option of waste-to-energy technology to deliver bio- fuel to replace fossil fuel. The advantage of the pyrolysis process is its ability to handle unsorted and dirty plastic. The pre-treatment of the material is easy. Plastic is needed to be sorted and dried. Pyrolysis is also nontoxic or non-environmental harmful emission unlike incineration. In this investigation, plastic waste (polypropylene) are utilized for pyrolysis to get fuel oil that has comparable physical properties as the energizes like petroleum, diesel and so on. Converting waste plastics into fuel hold great promise for both the environmental and economic scenarios.

II. LITERATURE REVIEW

S.L. Low, M.A. Connor and G.H. Covey: - The paper titled "Turning mixed plastic wastes into a useable liquid fuel", the abstract is presented here. As landfill and incineration become more expensive and less accepted, the 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 feedstocks.

Achyut K. Panda, R.K. Singh, D.K. Mishra (et al):-"Thermolysis of waste plastics to liquid fuel". In this research project he used wide range of old and new technologies for chemical recycling of waste plastic to liquid fuel.

Tiwari D.C., Ejaz Ahmad, Kumar Singh K.K 2009(et al):-wrote on catalytic cracking process in which waste plastic is melted and cracked in the absence of oxygen and at very high temperature, the resulting gases were

cooled by condensation and resulting crude oil was recovered. From this crude oil various products petrol, diesel and kerosene etc. can be obtained by distillation.

Antony Raja and AdvaitMurali (et al):-“Conversion of Plastic Wastes into Fuels”.He concluded that we can convert all types of waste plastic into hydrocarbon fuel at the temperature profile 350°C to 500°C through pyrolysis process.

Wenger Jorn.Investigated (et al):-The pyrolysis of waste plastics (HDPE and polypropylene) in a tubular reactor at 500 °C temperature in the presence and absence of Y-zeolite catalyst. It was found that the yields of gases, gasoline and light oil could be increased in the presence of catalyst.

Manish Chand Sharma, NeeleshSoni (et al):-Issued a paper in 2013 on “Production of alternative fuel from waste oil and comparison with fresh diesel”. This research paper compares the diesel obtained from pyrolysis of plastic oil with conventional diesel oil.

Yasha Shukla, Hemant Singh, ShiwangiSonkar and Deepak Kumar: - The paper titled “Design of Viable Machine to Convert Waste Plastic into Mixed Oil for Domestic Purpose” states in the abstract that the aim of the article is to provide a more efficient design of machine to convert waste plastic into mixed oil for domestic purpose

III. METHODOLOGY

3.1 Design

Pyrolysis is the thermal decomposition of materials at higher temperatures in the absence of oxygen (or an inert atmosphere).It is a chemical reaction process which involves molecular breakdown of larger molecules into smaller molecules in the presence of heat. It includes the difference in concoction arrangement and the procedure is irreversible. The word pyrolysis is begat from the Greek determined components pyro which signifies "fire" and lysis which signifies "isolating". The most common application of pyrolysis is applied to the treatment of organic materials. It is one of the processes involved in charring wood, starting at temperature range of 250oC–350°C. During pyrolysis of organic substances, it produces volatile products and leaves a solid residue which is rich in carbon, char. Extreme pyrolysis leaves mostly carbon as the residue which is called carbonization.

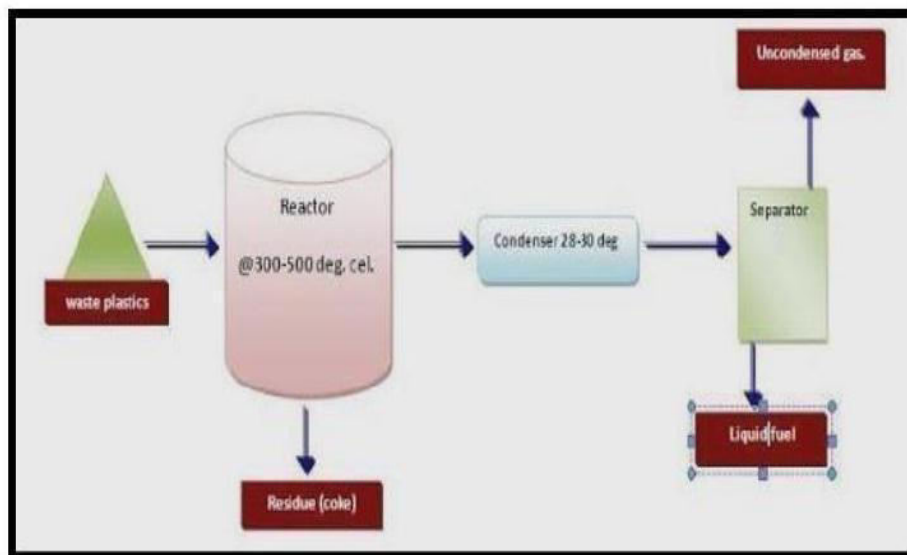


Figure 1: Process of Pyrolysis

3.2 Pyrolysis of Plastic

Production of fuel from waste plastic involves pyrolysis process. In this process, plastic is rapidly heated to 250o-350°C in a reactor in the absence of oxygen.The temperature required depends on the types of plastics used. Once the melting point is reached, the plastics melts and the vapour rise Vapor collected in the condensing unit. Water is used to condense the vapour. The condensed vapour is collected above the water due to the density difference of the oil and water. Finally, the oil is poured out of the condensing unit through the tap provided. The pyrolysis of plastic gives out the mixture of fuel, gases and solid char. Variation of the pyrolysis process, type of plastic used and the temperature will produce the varying percentage of these three products.

Table 1: Degradability Of Different Waste Materials

TYPESOFWASTE	TIMEFORDEGARDATION
OrganicWaste,likepaperetc,	1-3Weeks
Cotton Cloth	8-20Weeks
Wood	10-15Years
Tin, Aluminium ,etc,	100-500Years
PLASTICS	AMillionYears

IV. EXPERIMENTAL SETUP

A laboratory scale externally heated fixed bed pyrolysis batch reactor was used for production of oil from plastic. The schematic diagram of plastic pyrolysis setup is shown in figure. Basic instruments of the pyrolysis chamber are temperature controller, condenser, a heating coil, storage tank, valve, and gas exit line. The effective length and diameter of the glass made reactor are 38 cm and 15 cm, respectively. The reactor with polythene was heated electrically up 475°C with Ni- Cr wire electric heater. Then the gases produced from heating of plastic are passed toward condenser, where condensation of these gases occur and get oil from the plastic. Mainly there are two types of plastics: thermoplastics and thermosetting plastic. If enough heat is supplied, thermoplastics can be softened and melted repeatedly. On cooling, they are hardened, so that they can be made into new plastics products. Examples are polyethylene terephthalate, polystyrene, polyvinyl chloride, high- density polyethylene, low-density polyethylene, poly propylene etc. They are recyclable. Thermosets or thermosetting plastics can be melted and shaped only once.



Figure 2: Experimental Setup

There was no output at low temperature range and the process was carried out between the temperature ranges of 330°C to 490°C in the reactor for about two hours and forty minutes. The vapour products of pyrolysis were carried out through condenser. The condenser was cooled with ice water and condensed bio oil was collected into collector the non-condensed gas was flared to the atmosphere and the char was collected from the reactor after completion in of pyrolysis cycle. This figure shows the outcome of experiment, after the condensation process is done gases will beconverted into liquid form which is the main output of the project

V. FUEL SYNTHESIS PROCESS

Fuel Synthesis Process:

The system consists of an internally threaded pinion and one externally threaded lead screw which are engaged like nut and bolt arrangement. C-clamp is used to transfer the motion of lead screw.

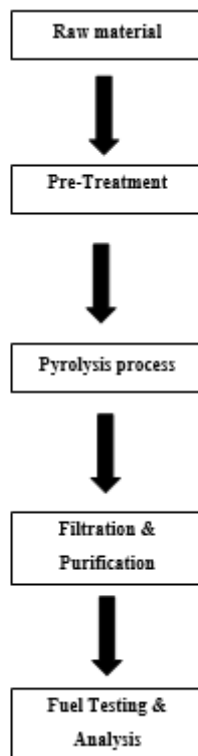


Fig.1: Fuel Synthesis Process

VI. 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.

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