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Conversion of Plastic Wastes into Hydrocarbon Fuels

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Abstract: The present rate of economic growth is unstable without fossil fuel crude oil, natural gas, coal. So the mankind has to rely on the renewable energy resources like biomass, hydropower, geothermal energy, wind energy, solar energy, nuclear energy, etc. On the other hand, sustainable waste management is the important for sustainable development. Plastic wastes are one of the fastest grown materials because of its application and low cost. Plastic is the term refers to the synthetic or non-synthetic amorphous solids like polyethylene, polystyrene, polyvinyl chloride and phenol formaldehyde. These are the materials which are widely used to make industrial products. Due to raise in increase in plastic waste causes serious effects in environment and has a great impact on social conditions. But, this can be controlled by recycling of plastic wastes. The solution for recycling of non-recyclable plastic into liquid hydrocarbons is degradation. This can be done by pyrolysis and liquid hydrocarbon fuels can be obtained like petrol, diesel, kerosene, etc. Conversion of plastic waste into fossil fuel will reduce the dependence on the fossil fuels. This process can ensure 100% eco-friendly and nothing is left behind the environment

Keywords: Polymer degradation, Catalytic cracking, Waste Plastic Disposal, fossil fuels- petrol, diesel.1.

1. INTRODUCTION

As a brief introduction to plastics, it can be said that Plastic is the term which refers to a wide range of synthetic or semi-synthetic organic amorphous solid materials which are typically of high molecular mass.

It is a relatively cheap, durable and versatile material, however due to this, the huge amount of plastic waste that resulted from the dramatic increase in plastic production gives rise to serious environmental concerns, as plastic does not degrade. If this problem is not addressed properly, it will lead to accumulation of humorous amount of waste plastics

As Waste plastics are one of the most promising resources for fuel production because of its high heat of combustion and due to the increasing availability in local communities.

Plastic waste recycling can provide an opportunity to collect and dispose of plastic waste in the most environmental friendly way and it can be converted into a resource. Thus the recycling of plastic wastes can be carried by the various methods like pyrolysis, pelletizing, pre-treatment, gasification.

2. OBJECTIVES

The main objective of this paper is to convert waste plastic into valuable hydrocarbon fuel with the help of zeolite catalyst at elevated temperatures in the absence of oxygen and avoid the accumulation of humorous amount of waste plastics.

3. PRINCIPLES INVOLVED

All plastics are polymers mostly containing carbon and hydrogen and few other elements like chlorine, nitrogen, etc. Polymers are made up of small molecules, called monomers, which combine together and form large molecules, called **polymers**. When this long chain of polymers breaks at certain points, or when lower molecular weight fractions are formed, this is termed as **degradation of polymers**.

This is reverse of **polymerisation or de-polymerisation**. If such breaking of long polymeric chain or scissions of bonds occur randomly, it is called **'Random Depolymerisation**. Here the polymer degrades to lower molecular fragments. In the process of conversion of waste plastics into fuels, random depolymerisation is carried out in a specially designed reactor in the absence of oxygen and in the presence of coal and certain catalytic additives.

The maximum reaction temperature is 350°C. There is otal conversion of waste plastics into value-added fuel products.

4. TOXICITY OF PLASTIC WASTES

- Due to the huge amount of plastic waste that resulted from the dramatic increase in polymer production gives rise to serious environmental concerns, as plastic does not degrade and also it has adversely impacted on social condition.
- Plastic wastes **increases pollution** in environment
- Plastic wastes increases the **green house gas**

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- Due to disposal of plastic wastes in the landfills the heavy metals from these wastes precipitation in the soil occurs
- The plants absorbs the heavy metal which is deposited in the soil by plastic wastes
- Then the plants are consumed by the animals and humans.
- Such that the heavy metals from the plastic wastes causes cancer and death to both humans and animals

5. RECYCLING OF PLASTICS WASTES THROUGH ENVIRONMENTALLY SOUND MANNER

Recycling of plastics should be carried in such a manner to minimize the pollution during the process and as a result to enhance the efficiency of the process and conserve the energy. Basically there are 4 different ways of recycling of plastics:

1. Primary Recycling – Conversion of waste plastics into products having performance level comparable to that of original products made from virgin plastics.

2. Secondary Recycling – Conversion of waste plastics into products having less demanding performance requirements than the original material.

3. Tertiary Recycling – The process of producing chemicals / fuels / similar products from waste plastics.

4. Quaternary Recycling – The process of recovering energy from waste plastics by incineration.

Purpose of plastic wastes conversion into fuel

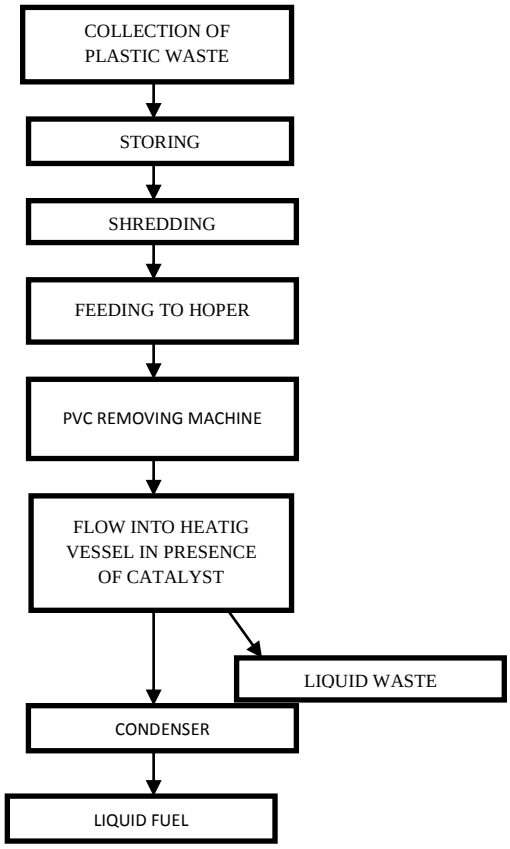
- Promote resource conservation by obtaining fuel from waste plastics.
- Upgrade the properties of wastes as fuel for transportation, storage, feeding to a boiler, calorific value, smooth combustion and qualities of flue gas and ash.
- Reduce green house gas by using waste plastics for the cleaner fuel production and supporting biomass utilization.

5.1Conversion technologies available:

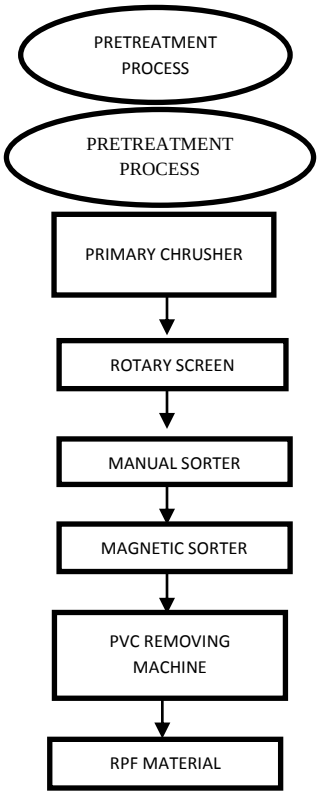
• Under controlled reaction conditions, plastic materials undergo random De-polymerisation and is converted into three products:

a) Solid Fuel – Coke
b) Liquid Fuel – Combination of Gasoline, Kerosene, Diesel and Lube Oil.
c) Gaseous Fuel – LPG range gas.
**flue gas quality and ash from fuel products should be examined.
*plastics containing Cl, N, S and Al composite are to be avoided

5.2 The process includes following steps



5.3 Schematic diagram of pre-treatment process



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After pre-treatment, a suitable mixture of paper and plastics are further processed in a secondary crusher and sorting process (conveyor and magnetic separator) and the resulting mixture is **pelletized** to produce solid fuel. The resulting solid fuel is cooled in an air-cooling system to prevent natural ignition during storage and it is further stored for shipping.

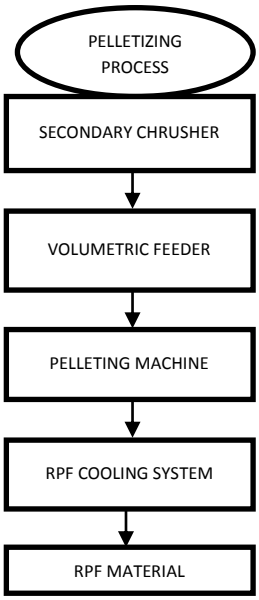


Figure 5.4Schematic diagram of a pelletizing process

6. SOLID FUEL PRODUCTION

Production method

The solid fuel production process usually involves two steps, pre-treatment and pellet Production:

Pre-treatment includes coarse shredding and removal of non-combustible materials.

Pellet production comprises secondary shredding and pelletization (<200°C).

The **pre-treatment** process includes crushing and sorting for the removal of unsuitable materials from incoming wastes.

RPF material

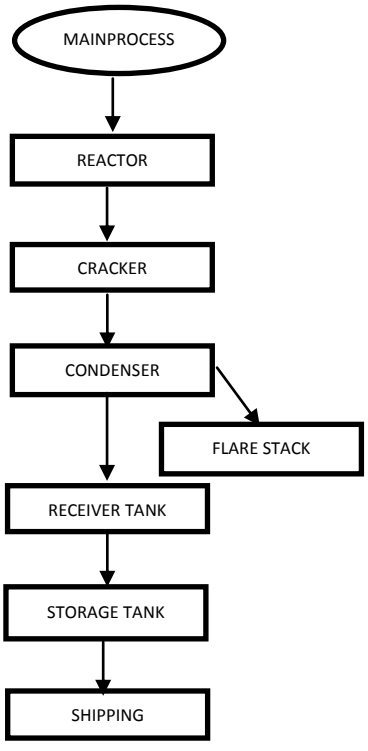
Figure 6 Pelletizing machine

6. Liquid Fuel Production

Production method:

The production method for the conversion of plastics to liquid fuel is based on the pyrolysis of the plastics and the condensation of the resulting hydrocarbons. Pyrolysis refers to the thermal decomposition of the matter under an inert gas like nitrogen. For the production process of liquid fuel, the plastics that are suitable for the conversion are introduced into a reactor where they will decompose at 450 to 550 C. Depending on the pyrolysis conditions and the type of plastic used, carbonous matter gradually develops as a deposit on the inner surface of the reactor. After pyrolysis, this deposit should be removed from the reactor in order to maintain the heat conduction efficiency of the reactor.

6.1 Schematic diagram of a production plant of plastics-derived fuel of pyrolysis process.



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The evaporated oil is further cracked with a catalyst. The boiling point of the produced oil is controlled by the operation conditions of the reactor, the cracker and the condenser. In some cases, distillation equipment is installed to perform fractional distillation to meet the user's requirements.

After the resulting hydrocarbons are distilled from the reactor, some hydrocarbons with high boiling points such as diesel, kerosene and Gasoline are condensed in a water-cooled condenser. The liquid hydrocarbons are then collected in a storage tank through a receiver tank. Gaseous hydrocarbons such as methane, ethane, Propylene and butanes cannot be condensed and are therefore incinerated in a flare stack. This flare stack is required when the volume of exhaust gasemitted from the reactor is expected to be large.

7. GASEOUS FUEL PRODUCTION

Production method

The gasification process includes a series of steps such as pre-treatment, gasification, gas cleaning and storage.

Polyethylene and polypropylene thermally decompose at temperatures up to about 700 °C and under an inert atmosphere to form a mixture of gaseous hydrocarbons, methane, ethane, ethylene, propane, propylene, and various isomers of butane and butane.

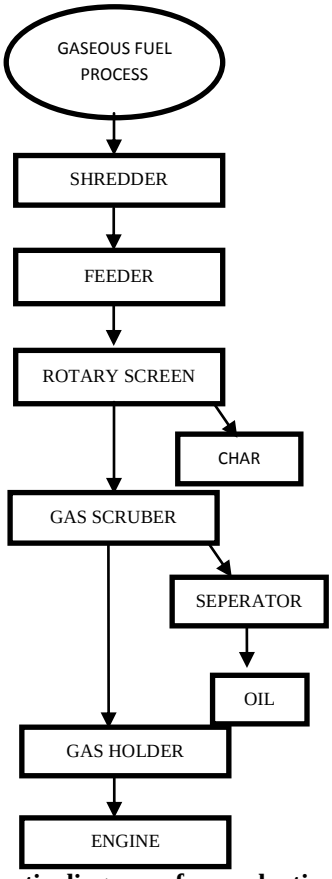

Figure 7.1 Schematic diagram of a production plant of plastics-derived gaseous fuel

8. BENEFITS OF CONVERSIONWASTE PLASTICS INTO FUEL

- As plastics are an extreme versatility and ability to be tailored to meet very specific technical needs, it avoids issues like regarding to the environmental, health and economic issues.
- It avoids the risk outcomes from landfills and incinerators of the plastic wastes.
- Having excellent thermal and electrical insulation properties it can easily subject to any process like py`rolysis, pelletizing, etc and gets converted into useful products.
- Relatively inexpensive to produce.

Advantages

- Reduces pollution helps in waste plastic degradation.
- Cheaper and quality fuel.
- Perfect solution for waste plastic, rubber, tyre management.
- Raw material readily available

9. ENVIRONMENTAL RELATED PROBLEM DURING THOSE PROCESSES

- The odour of volatile organics has been experienced in the processing area due to some leakages or lack of proper sealing.
- Absolute conversion of liquid-vapour was not possible into liquid; some portion of gas (about 20%) is connected to the generator. However, the process will be improved in full-scale plant. PVC plastics waste is not used and if used, it was less than 1%.
- In case PVC is used, the chlorine can be converted into hydrochloric acid as a by-product.
- The charcoal (charcoal is formed due to tapping of tarry waste) generated during the process has been analyzed and contain heavy metals, poly aromatic hydrocarbon (PAH) which appears to be hazardous in nature.
- The source of metals in charcoal could be due to the presence of and due to multilayer and laminated plastics

10. CONCLUSION

The optimal solution for converting non – recyclable plastic into liquid hydrocarbon is degradation of polymer and this could be carried out by catalytic degradation of waste plastic into fuel range hydrocarbon i.e. petrol, diesel and kerosene etc. and the occurrences of plastic waste is drastically reduced. Conversion of waste plastic into fuel will reduce dependence on fossil fuels and this process is 100Additives in plastics and due to multilayer and laminated plastics. Thus, we can easily reduce pollution which is induced by plastic wastes with the help of the pyrolysis, pelletizing process and we can make a **clean, zero plastic waste environment**

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