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Plastic to oil

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ABSTRACT: *The hazards of plastic waste is well known to us. The conversion of oil from plastic has dual benefits. First of all the oil produced can be used as a fuel for domestic purposes and also in vehicles and industries when further refined. Secondly the various types of pollution caused due to waste plastics can be minimised. Plastic in the first place is manufactured from natural gas specifically from ethane which is a constituent of natural gas. Therefore the waste plastic can be converted back into it. For the process of conversion a machine can be used which will heat the plastic to a temperature so that it melts and does not burns.*

Keywords: *ethane, fuel, natural gas, oil, plastic.*

I. INTRODUCTION

Every year humans produce nearly 280 million tons of plastic, and much of that plastic ends up in the environment, harming marine life and other ecosystems. The chemical bonds that makes plastic so durable makes it equally resistant to natural processes of degradation. Since plastics are non-biodegradable in nature, it is very difficult to eliminate the waste plastics from nature. Since 1950s 1 billion tonnes of plastic have been discarded and may persist for hundreds or even thousands of years.Expenditure incurred on disposal of plastic waste throughout the world is around US$ 2 billion every year. Even for a small country like Honk Kong spends about US$ 14 million a year on the exercise [1]. The majority of the plastic waste ends up in landfills, and becomes a carbon sink where it may take up to 1000 years to decompose and potentially leak pollutants into the soil and water. Also the plastic wastes are dumped in the oceans threatening the health and safety of marine life. The uncontrolled incineration of plastic produces polychlorinated dibenzo-p-dioxins, a carcinogen.

So, converting the waste plastic into crude oil will have two benefits. First of all, the hazards caused due to plastic waste can be reduced and secondly, we will be able to obtain some amount of oil from it, which can be further purified to be used as a fuel in different areas such as domestic fuel, fuel for automobiles and industries etc. Thereby, our dependency on fossil fuels will reduce to a certain extent.

Production of Plastics

The production of plastic begins with a distillation process in an oil refinery. The distillation process involves the separation of heavy crude oil into lighter groups called fractions. Each fraction is a mixture of hydrocarbon chains (chemical compounds made up of carbon and hydrogen), which differ in terms of the size and structure of their molecules. One of these fractions naphtha, is the crucial element for the production of plastics. Plastics are also produced from natural gas.

Production of Naphtha

Naphtha is an intermediate hydrocarbon liquid stream derived from the refining of crude oil. It is the lightest liquid distillate product of crude distillation consisting of C5 to C10 hydrocarbons boiling in the 100 to 310°F range. It is produced from the atmospheric distillation of crude oil and from many secondary processing units in the refinery. Unlike other petroleum fuels such as kerosene, diesel, or fuel oil, naphtha is not a direct petroleum fuel but is used as a feedstock for the manufacture of plastics. The first unit process in a petroleum refinery is the crude oil distillation unit. The overhead liquid distillate from that unit is called virgin or straight-run naphtha and that distillate is the largest source of naphtha in most petroleum refineries. The naphtha is a mixture of very many different hydrocarbon compounds. It has an initial boiling point of about 35 °C and a final boiling point of about 200 °C, and it contains paraffin, naphthene (cyclic paraffins) and aromatic hydrocarbons ranging from those containing 4 carbon atoms to those containing about 10 or 11 carbon atoms.

The virgin naphtha is often further distilled into two streams:

a virgin light naphtha with an IFP of about 30 °C and a FBP of about 145 °C containing most (but not all) of the hydrocarbons with 6 or less carbon atoms. A virgin heavy naphtha containing most (but not all) of the hydrocarbons with more than 6 carbon atoms. The heavy naphtha has an IFP of about 140 °C and a FBP of about 205 °C. [2]

It is the virgin heavy naphtha that is usually processed in a catalytic reformer because the light naphtha has molecules with 6 or less carbon atoms which, when reformed, tend to crack into butane and lower molecular weight hydrocarbons which are not useful as high-octane gasoline blending components. Also, the virgin light naphtha molecules with 6 carbon atoms tend to form aromatics which are high-octane components but which are undesirable because they are carcinogens (most particularly benzene) and governmental environmental regulations in a many countries limit the amount of aromatics that gasoline may contain.

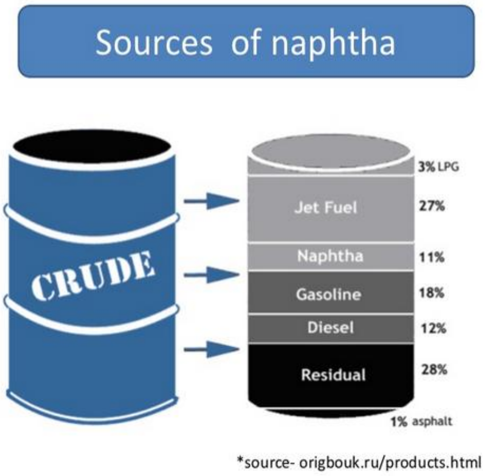

Figure 1: Sources of Naphtha

2.2 Process of converting natural gas and naphtha into plastics

Natural gas is taken from offshore oil and gas fields. Crude oil and natural gas are refined into ethane, propane, hundreds of other petrochemical products. Methane, the main constituent of Natural gas is removed from it. Ethane and propane are separated and purified. Then the ethane and propane are heated into steam mix which produces ethylene, propylene, hydrogen and other byproducts. Catalyst is combined with ethylene or propylene in a reactor, resulting in "fluff," a powdered material (polymer) resembling laundry detergent. Fluff is then combined with additives in a continuous blender. Polymer is fed to an extruder where it is melted. Now Melted plastic is cooled and fed to a pelletizer that cuts the product into small plastic pellets.

Conversion of plastic into oil

Depolymerization

This process is used for the reduction of complex organic materials into light crude oil. It mimics the natural geological processes thought to be involved in the production of fossil fuels. Under pressure and heat, long chain polymers of hydrogen, oxygen and carbon decompose into short chain petroleum hydrocarbons with maximum length of around 18 carbons.The feedstock material is first ground into small chunks, and mixed with water if it is especially dry. It is then fed into a pressure vesselreaction chamber where it is heated at constant volume to around 250 °C. Similar to a pressure cooker (except at much higher pressure), steam naturally raises the pressure to 600 psi (4 MPa) (near the point of saturated water). These conditions are held for approximately 15 minutes to fully heat the mixture, after which the pressure is rapidly released to boil off most of the water. The result is a mix of crude hydrocarbons and solid minerals. The minerals are removed, and the hydrocarbons are sent to a second-stage reactor where they are heated to 500 °C, further breaking down the longer hydrocarbon chains. The hydrocarbons are then sorted by fractional distillation, in a process similar to conventional oil refining.

Pyrolytic Conversion

Common features of these systems include:

Some level of pretreatment: this could be as minor as size reduction or as involved as cleaning and moisture removal.

Conversion: pyrolytic processes are used to convert the plastic to a gas.

Distillation: the gas is converted to liquid form
Acid removal process: removal of acids that form in the breakdown of some scrap plastics. These acids require removal because they can be corrosive to the PTF systems as well as the engines that will consume the fuel.
Separation/refining/final blending: the final steps required to make this product consumer ready can either be done on site or in some other plant.
The total yield of fuel oil is 50-65% [3].
The problem for this process is the pyrolysis equipment's corrosion incurred by PVC in mixed plastic wastes. [4].
However, the temperature caused by pyrolysis is higher and all the reactive time is longer than the other methods. The octane number of gasoline gained is relatively low and the pour point of diesel oil is high. More paraffin is produced in the process of pyrolysis. Although this process is simple and convenient, the converting rate and yield is still lower. The other problem for this process is the pyrolysis equipment's corrosion incurred by PVC in mixed plastic wastes. Therefore it is strongly recommended to establish a reasonable sorting system and apply an efficient technique to eliminate the toxic emissions and highly corrosive hydrochloric acid that is formed. Since the total yield of the fuel oil with pyrolysis is still lower and the quality of oil is not satisfied as gasoline and diesel oil, the upgrade by catalytic cracking for the crude products gained with pyrolysis can be used.

Stages of Conversion

Indirect heating of waste plastics

The feedstock would be placed in a specially designed cartridge. Now the air should be heated with a light industrial burner and recirculated around the cartridge, transforming the plastic feedstock from a solid to a liquid to a gas.

Gasification and movement

Using a combination of temperature and vacuum (or negative pressure), the gases are to be pulled from the cartridge into a central condensing system.

Condensing gases into oil

In the condensing system, the gases are to be cooled and condensed into synthetic crude oil. Waste impurities are then removed from the stream.

Final transfer and storage of oil

The crude oil product which leaves the condensing system should enter into a coalescing and settling process and eventually transferred to an exterior storage tank.

II. CONCLUSION

Plastics are a major threat to modern society and environment. Over 14 million tons of plastics are dumped into the oceans annually, which kills about lakhs of species of oceanic life. Though people has awoken to this threat and created degradable bioplastics, there is still no conclusive effort done to repair the damage already caused.

By converting plastics to fuel, we solve two issues, one of the large plastic seas, and the other of the fuel shortage. This dual benefit, though will exist only as long as the waste plastics last, but will surely provide a strong platform for us to build on a sustainable, clean and green future. By taking into account the financial benefits of such a project, it would be a great boon to our economy.

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