ORIGINAL RESEARCH PAPER

Engineering

PLASTIC WASTE TO FUEL GENERATION

KEY WORDS:

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ABSTRACT

Plastics have woven their way into our daily lives and now pose a tremendous threat to the environment. Over a 100 million tonnes of plastics are produced annually worldwide, and the used products have become a common feature at overflowing bins and landfills. Though work has been done to make futuristic biodegradable plastics, there have not been many conclusive steps towards cleaning up the existing problem. Here, the process of converting waste plastic into value added fuels is explained as a viable solution for recycling of plastics. Thus two universal problems such as problems of waste plastic and problems of fuel shortage are being tackled simultaneously. In this study, plastic wastes (low density polyethylene) were used for the pyrolysis to get fuel oil that has the same physical properties as the fuels like petrol, diesel etc. Pyrolysis runs without oxygen and in high temperature of about 300°C which is why a reactor was fabricated to provide the required temperature for the reaction. The waste plastics are subjected to depolymerisation, pyrolysis, thermal cracking and distillation to obtain different value added fuels such as petrol, kerosene, and diesel, lube oil etc. Converting waste plastics into fuel hold great promise for both the environmental and economic scenarios. Thus, the process of converting plastics to fuel has now turned the problems into an opportunity to make wealth from waste.

1.INTRODUCTION

In the recent years it is quite common to find in newspapers and publications that plastics are turning out to be a menace. Days are not so far when earth will be completely covered with plastics and humans will be living over it. All the reasoning and arguments for and against plastics finally land up on the fact that plastics are nonbiodegradable in nature. The disposal and decomposition of plastics has been an issue which has caused a number of research works to be carried out in this regard. Currently the disposal methods employed are land filling, mechanical recycling, biological recycling, thermal recycling, and chemical recycling. Of these methods, chemical recycling is a research field which is gaining much interest recently, as it turns out to be that the products formed in this method are highly advantageous.

Plastic is one such commodity that has been so extensively used and is sometimes referred to as one of the greatest innovations of the millennium. There are a numerous ways in which plastic is and will continue to be used. The plastic has achieved such an extensive market due to fact that it is lightweight, cheap, flexible, reusable, do not rust or rot, and so forth.

2.LITERATURE REVIEW

In order to have a proper background study on technologies available for conversion of waste plastics to fuel, literature survey is carried out to know its various applied method throughout the globe, they are summarized below. The study was conducted by Tiwari et al. (2009) 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. This process mainly consists of four units

(1) reacting vessel or reaction chamber
(2) condensation unit
(3) receiving unit
(4) distillation unit.

The study was carried out by NikolettBorsodiet et al. (2011) on Pyrolysis of clear and contaminated waste plastics in a tubular reactor, applying 500°C temperature. Y-zeolite catalyst was applied to reduce the contaminant level in the products and the effect of pre-treatment of raw materials was also studied. Thermal degradation of contaminated plastic wastes resulted in higher yields of volatile products than the Pyrolysis of pre-treated or original raw material. The study was carried out by Deshpande et al. (2012) on thermal degradation of waste plastic into fuel range hydrocarbon i.e. petrol, diesel and kerosene etc. Thermal cracking is a process in which waste plastic were 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. The study was conducted by Moinuddin 2012 reviewed on thermal cracking and fractional distillation process conducted with single types of HDPE waste plastic to get jet grade fuel production. This process can convert all HDPE waste plastic to different grade fuels and specially jet grade fuel. After reviewing these various literatures, we can see that different forms of Pyrolysis processes have been employed for the conversion of plastic wastes to efficient fuels and also successfully tested as well.

3.BRIEF CONCEPT LINING OF THE PROJECT

The process is really simple, it is similar to how alcohol is made. If you heat plastic waste in non oxygen environment, it will melt, but will not burn. After it has melted, it will start to boil and evaporate, you just need to put those vapors through a cooling pipe and when cooled the vapors will condense to a liquid and some of the vapors with shorter hydrocarbon lengths will remain as a gas. The exit of the cooling pipe is then going through a bubbler containing water to capture the last liquid forms of fuel and leave only gas that is then burned. If the cooling of the cooling tube is sufficient, there will be no fuel in the bubbler, but if not, the water will capture all the remaining fuel that will float above the water and can be poured off the water. On the bottom of the cooling tube is a steel reservoir that collects all the liquid and it has a release valve on the bottom so that the liquid fuel can be poured out.

Liquid fuel obtained can be used as multifuel, that means it can be used on diesel engines and also on gasoline engines, but we still need to test it will work on gasoline. It works for diesel engines just fine, that has already been tested. There is a difference in what plastic you use, if you use polyethylene (plastic cans, plastic foil, and all kind of flexible non break plastics) you will get out liquid fuel that will solidify as it cools into paraffin, it is still good for diesel engines as long as you use a heated fuel tank, because it needs to be heated just about at 30 degrees celsius to be liquid and transparent. If you don't want that, you can put the paraffin through the device for one more time and you will chop those hydrocarbons even smaller and half of the paraffin will turn to liquid fuel and other half will remain a paraffin, but much denser and will melt at higher temperatures, this is the stuff you can make candles out of and it does not smell at all when burned, maybe a bit like candles. But if you use polypropylene (computer monitor cases, printer cases, other plastics that break easily), you get out only liquid fuel, no paraffin at all. All you need is just filter the fuel out of solids and you good to go and put it in your gas tank. We have made the analysis and it is almost the perfect diesel fraction. It has no acids or alkalines in it, like fuel from tires does. Other methods of heating the reactor can be employed, electricity is just easier to work with and control. Some Japanese companies manufacture such devices, but their prices for this size unit is more than 100 000$, our home made device cost us 900$ max. We use aluminum oxide bricks to insulate the heat, they are light as foam and can be easily cut in any shape, but any kind of insulator can be used. The bricks make the highest costs for this device. It can also be made using liquid fuel burners to heat the reactor, this will enable to make the device self sustainable by using about 10-15% of the produced fuel along with the produced gas. A small farm can use a device this size and make fuel for itself by converting plastic waste to fuel.

4.CONCEPT USED

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4.1.PYROLYSIS

Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements pyro "fire" and lysis "separating".

Pyrolysis is a type of thermolysis, and is most commonly observed in organic materials exposed to high temperatures. It is one of the processes involved in charring wood, starting at 200–300 °C (390–570 °F). It also occurs in fires where solid fuels are burning or when vegetation comes into contact with lava in volcanic eruptions. In general, pyrolysis of organic substances produces gas and liquid products and leaves a solid residue richer in carbon content, char. Extreme pyrolysis, which leaves mostly carbon as the residue, is called carbonization.

The process is used heavily in the chemical industry, for example, to produce charcoal, activated carbon, methanol, and other chemicals from wood, to convert ethylene dichloride into vinyl chloride to make PVC, to produce coke from coal, to convert biomass into syngas and biochar, to turn waste plastics back into usable oil, or waste into safely disposable substances, and for transforming medium-weight hydrocarbons from oil into lighter ones like gasoline. These specialized uses of pyrolysis may be called various names, such as dry distillation, destructive distillation, or cracking. Pyrolysis is also used in the creation of nanoparticles, zirconia and oxides utilizing an ultrasonic nozzle in a process called ultrasonic spray pyrolysis (USP).

Pyrolysis also plays an important role in several cooking procedures, such as baking, frying, grilling, and caramelizing. It is a tool of chemical analysis, for example, in mass spectrometry and in carbon-14 dating. Indeed, many important chemical substances, such as phosphorus and sulfuric acid, were first obtained by this process. Pyrolysis has been assumed to take place during catagenesis, the conversion of buried organic matter to fossil fuels. It is also the basis of pyrography. In their embalming process, the ancient Egyptians used a mixture of substances, including methanol, which they obtained from the pyrolysis of wood.

Pyrolysis differs from other processes like combustion and hydrolysis in that it usually does not involve reactions with oxygen, water, or any other reagents. In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs.

The term has also been applied to the decomposition of organic material in the presence of superheated water or steam (hydrous pyrolysis), for example, in the steam cracking of oil.

LAYOUT OF WORKING MODEL

5. BENEFITS OF PLASTIC FUEL CONVERSION

While the U.S. does not have a landfill crisis, numerous mandates to increase diversion, or a particular collective ethic to find as much value in our waste streams as possible, the U.S. does have many of the same market dynamics that have made these systems a success abroad. And, North American technology manufacturers are offering a model of commercialization that utilizes these market advantages. Those positive market conditions are a consideration when evaluating optimal facility locations. First, close proximity to a collection or generation point for non-recycled scrap plastics (access to supply) is important. And if needed, proximity to a refinery (demand for product) should be considered. In many cases, systems producing a product needing additional treatment need not be located near a refinery, however the logistics for transporting the product to the refinery should be considered when factoring in production costs.

Two of the companies that have systems abroad have been actively seeking potential sites for systems in the U.S. These companies have had discussions with state and local governments about tax and business incentives, which can also be a compelling factor when deciding where to locate a facility. While these systems are not eligible to receive recycling grants or tax credits, there a number of other economic incentive programs that these systems may be eligible for, including job creation tax credits and potential eligibility for U.S. Department of Agriculture grants if the facility is built in a rural location.

While the U.S. generally lacks some of the economic, environmental, and policy drivers that have encouraged investment in commercialization abroad, it is important to consider the likely factors that could ultimately spur investment in North America. Some of those likely factors include: rising fuel costs; growing investment in "green" or "clean" technologies and, in particular, investment in alternative fuel production; as well as the pressure to increase the recovery of plastics.

6.FUTURE SCOPE

Of course, it would be the best if there were widespread environmentally friendly plastics in use, but in the meantime, recycling existing plastics into fuel would keep the plastics out of our waterways. This process is also excellent for difficult to recycle PP and PE plastics like bottle caps, appliance plastics, nursery planters and dirty plastics such as meat wrappings. This process is not suitable for PVC or polystyrene (styrofoam). This technology could also reduce carting issues, as companies that deal with plastic waste could build mini-burners on location.

The electricity required in the process can be obtained by the use of solar panels.It will serve a long term goal in a country like India.

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