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EXPERIMENTAL INVESTIGATION OF PLASTIC FUEL ON IC ENGINE

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ABSTRACT

Plastic is an indispensable part of our daily life. Its production and consumption has been rising very rapidly due to its wide range of application. Due to its non biodegradable nature it cannot be easily disposed off. So, nowadays new technology is being used to treat the waste plastic. One of such process is pyrolysis. This paper describes non catalytic pyrolysis and catalytic cracking of plastic wastes into useful gasoline range hydrocarbons. Under the pyrolytic and cracking conditions the plastic wastes can be decomposed into three fractions: gas, liquid and solid residue. Here the main consideration is the recovery of liquid products which are composed of higher boiling point hydrocarbons. The waste plastics consisting of high density polyethylene (HDPE) was pyrolyzed in this study. Pyrolysis appears to be a technique that is able to reduce a bulky, high polluting industrial waste while producing energy and/or valuable chemical compounds. The pyrolysis of plastic wastes produces a whole spectrum of hydrocarbons including paraffins, olefins, naphthalenes and aromatics. By catalytic cracking more aromatics and naphthene in the range of C6-C8 which are valuable gasoline range hydrocarbons can be produced. Different catalysts like Silica Alumina, Modernite and Activated Carbon were used for catalytic cracking. The catalysts were used in different ratios with feed to find out the optimum range at which maximum yield occurs. The liquid product yield is about 60% in all the cases. In thermal pyrolysis, the product obtained gets solidified but in catalytic cracking good liquid product can be obtained which can be used as fuel. This application is further combined with technologies of municipal plastic wastes collection, classification and pretreatment at front end and product purification and testing at back end to determine the properties of the various products obtained.

Keywords: pyrolysis, HDPE, naphthalene,

I. NTRODUCTION

Today's use of plastic is majorly increases and that plastic are non-biodegradable in nature, the life plastic in environment for long period which affects environment. In India, plastic waste accounts to be about ten thousand tons per day of generated municipal solid waste [1]. As there are no effective solution and recycling process for the plastic waste generated, then it use in construction side for landfill because of their non-biodegradable nature and causes environmental problems like air, soil and ground water pollution as well as loss of marine biodiversity. In India thermoplastic type plastic mostly use in household appliances which includes polyethylene terephthalate, high density polyethylene (HDPE), polyvinyl chloride, low density polyethylene (LPDE), polypropylene and polystyrene. According to classification plastic, the HDPE is the major components and generally used for making carry bags, plastic bottles and milk and food containers etc [2]. Formation liquid fuel from the waste plastic gives the some percent reliability to plastic waste management. Formation liquid fuel from waste plastic by use of pyrolysis method. The word pyrolysis from the Greek i,e pyro mean "fire" and lysys "decomposition". Pyrolysis technology is thermal degradation process in the absence of oxygen. Plastic waste is treated in a cylindrical vessel (Reactor) at temperature of 300ºC – 350ºC [1]. Pyrolysis of HDPE has been studied by Kumar et al. and Ammar et al. [2,3] Studies on pyrolysis of LDPE were done by Sarker et al. and Ademiluyi et al. [4,5]. Obali et al. and Nishino et al. [6,7] used Polypropylene material for pyrolysis without using catalyst. Different catalysts also have been studied in pyrolysis process for enhancing yield of product by Tiwari et al.[8,9].

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II. METHODOLOGY

1) Study on formation of plastic.
2) Study on various type plastic.
3) Pyrolysis technology.
4) Design component for pyrolysis process.
5) Chemical analysis.
6) Performance analysis.
7) Evaluation of result.

Procedure

- **Collection of the waste plastic materials-**

The waste plastics used by me for the process consisted mainly of HDPE products in the form of used plastic disposable glasses. A person was allotted for collecting the material. He collected the glasses that were used by students during the time of semester examination and the various functions taking place in our college.

Figure 1: Stirring during the melting process

Figure 2: Absorption of gases in water bath

- The material was then directly taken for the melting process. For this purpose a cylindrical stainless steel vessel of 27.2 cm diameter and 30 cm height was used. The weight of the vessel was 1395g. The vessel was put on an electrical domestic heater and a temperature of around 150°C was maintained for melting. Total time taken for single batch of reaction was around 15 minutes.
- Continuous stirring was done during the process to avoid sticking of the plastic materials to the bottom of the vessel and for better distribution of heat. Here the gases are completely absorbed. According to literature the gases coming from the process are in the range of LPG and HCl gases [1]. But we were unable to collect the gases. During the stirring process, the lid of the vessel was opened intermittently. Then some of the gases escaped to the atmosphere. The molten plastic in liquid form was cooled to room temperature to obtain the solid form. Then the material was broken into small sizes in the range of 10mm-30mm. These pellets were ready for the pyrolysis process.
- The process involves heating the plastic in an oxygen free (air tight) environment and condensing the vapours formed. Since there is no oxygen the plastic would not burn but just melt. After further heating the molten plastic gets converted into vapours. The vapours may then be passed through condenser to condense the vapours again into liquid. The condensed liquid is nothing but fuel such as diesel, petrol and some amount of paraffin. The fuel may not be so pure.

III. RESULTS AND DISCUSSION

The experiments on pyrolysis were conducted by using HDPE as the raw material. Both thermalcracking and catalytic cracking was done. The plastic was cracked thermally at various temperature ranges of 575ºC, 600ºC, 625ºC, and 650ºC. The products obtained were of different composition and the product yield was different for different temperatures.

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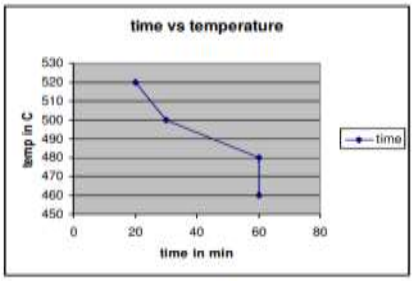
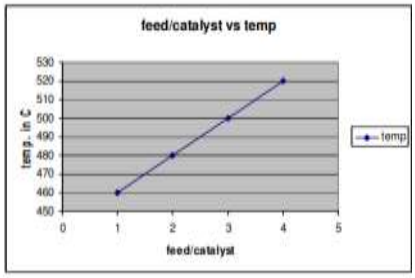
Figure 3: Solidified liquid product

The different trends of the product obtained and its relation with time, temperature, amount of catalyst used is shown below.The liquid product was very much combustible and its specific gravity varied in the range of gasoline and diesel oil. Thus it can be inferred to be of gasoline range fuel.





IV. CONCLUSION

In case of thermal cracking the process yielded good amount of product. But the onlyproblem was that it solidified completely after sometime. This may be because it was subjected to excess temperature. It was observed in this case that for first few minutes, good quality of product was evolved, but suddenly after a certain time impure product was obtained. This led to the solidifying of the product. When the plastic was catalytically cracked by using Silica Alumina as the catalyst, it gave quite good quantity and quality of liquid fuel. The highest yield was obtained when the feed to catalyst ratio was 3:1. At this condition, it required a temperature of about 550°C and 15 minutes time. The liquid product obtained had a specific gravity of 0.7787 which is quite good and falls in the range of gasoline fuel. From the graph plotted for, it can be observed that as the feed to catalyst ratio increases, the time of reaction decreases but the temperature required is more.

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