Research Journal of Recent Sciences ISSN 2277-2502
Vol. **1(3),** 63-67, March **(2012)** *Res.J.Recent Sci.*

Petro-Chemical Feed stock from Plastic Waste

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Available online at: www.isca.in
(Received 15th Februry 2012, revised 19th Februry 2012, accepted 22nd Februry 2012)

Abstract

This process involves thermal degradation of waste plastic into fuel range hydrocarbon i.e. petrol, diesel and kerosene etc. A thermal cracking 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. This process mainly consists of four units i. reacting vessel or reaction chamber ii. condensation unit iii. receiving unit iv. distillation unit. More specifically the degradation of waste plastic except polyvinyl chloride (PVC) and polyethylene terephthalate (PET), respectively, was studied in a semi-batch reactor. Also the effect of temperature variation was studied on the formation of liquid hydrocarbons. The best results were obtained when the temperature was constant at 400°c and after this temperature the somewhat liquid conversion decreases and gas conversion is increased. Furthermore alternate method for disposal of waste plastic is also studied. And the results of this process are found to be better than other alternate methods which are used for the disposal of waste plastic.

Keywords: *Polymer degradation, thermal cracking, waste plastic disposal.*

Introduction

Advantages of Plastic Waste? The disposal of municipal and industrial waste is now recognized to be a major environmental problem in world. The conventional solution of land filling is becoming too expensive and of questionable desirability for many localities. The destruction of wastes by incineration is becoming more prevalent, but this practice is too expensive and often generates problems with unacceptable emissions. A third alternative would be true recycling, that is, to convert the waste material into products that can be reused. If a reasonably economical process can be used, some cost recovery from the products would also be possible, and the net cost of disposal might be significantly reduced. Of the possible technologies for the conversion of waste to useful products, one that has attracted some study and development effort is thermal pyrolysis[1].

Safe disposal of plastics waste is a serious concern all over the world. Plastic waste management is done by reduce consumption, recycling, using bio-degradable plastics, land filling, incineration, plasma pyrolysis and energy recovery[1]. One can reduce the use of thin plastic bags and use the thicker plastic bags in his daily life. This will reduce the consumption of plastics. Plastic waste is recycled 5-6 times however; it has been observed that the recycled plastic does not possess the same mechanical properties as that of virgin polymer[2].

It loses its lustier as well as the recycled plastic releases certain chemicals therefore cannot be used for keeping food items. There are bio-degradable plastics in the market however; the decomposition process of biodegradable plastics is slow. The quantity such plastics is less in the market. Land filling is another way of managing the plastic waste. The requirement of large size land for land filling makes this process costly [3].

Used Low density polyethylene from household and industries are recognized to be a major environmental problem. There are several methods for disposal of municipal and industrial LDPE wastes, i.e. landfill, incineration, true material recycling, and chemical recovery. Landfill treatment and incineration destruction are quite expensive and may raise problems with unacceptable emissions [2].

Disadvantages of Plastic Bags: Plastic bags may be cheap and easy to use, but they're unhealthy for the planet. It is very dangerous for plant and animal life. Plastic bags are not renewable, which means they cannot be easily recycled like paper bags. They are made of petrochemicals, which is what makes them non-renewable and a risk to the health of the planet. They last for hundreds of years, all the while doing damage to natural habitats and killing animals that mistake them for food. The more plastic bags people use, the greater the chances of environmental damage[4]. If not carefully disposed of, plastic bags can be devastating to animal life. The Mauriceville Council reports that over 100,000 whales, turtles and birds die every year as a result of plastic in their environment. Infants and young children have died as a result of playing with plastic bags. Commission receives about 25 reports of plastic bag-related infant death. Because of the thin, airtight material, infants can easily block their mouths and nostrils with the plastic bag and suffocate. Solution of this all problem by most efficient techniques is cracking

Material and Methods

For practical purpose here used the Disposable waste plastic. The name doesn't mean that plastic is dispose earlier it require more time and land also and it cannot be recycled easily for managing this waste we just tried to convert it to the petrochemical feed stock by thermal cracking. Thickness of plastic is 16 micron. (figure no.3 shows the disposable glass).

Experimental Setup: Apparatus requirement: The main apparatus required are: Batch reactor, Diameter = 4.0cm, Reactor length = 40cm, Insulation= Borosilicate pipe, Asbestos thread, POP Etc, Thermocouple = 22 cm and 6 cm, Condenser and Receiver, Water pump. Also 50ml conical flask, measuring cylinder (50ml, 100ml) is required and other apparatus for determining various properties such as density (density bottle, weighing machine), viscosity (C-type viscometer) and ASTM distillation apparatus are required.

Component: It essentially consists of component given bellow: Reactor with Heating arrangement, Three necked flask, Condenser, Cooling system, Energy regulator

Setup: Reactor is place vertically on table with one of the temperature sensor inserted at the middle of the reactor and other is at the top with the help of two top outlet of reactor. Join first condenser with gas outlet of the reactor then connect it with three necked flask, second condenser joint to the other end of three neck flask, for collecting the heavy fraction which is not condense in first condenser. Other end is closed with stopper, cooling system is maintain at 5 to 6°c all system is make airtight for avoiding the oxidation of plastic feed. (figure no. 1 shows setup of the reactor).

Process: Fig. no. 1 shows the setup of the process.

Add measure weight of the west plastic in reactor and close reactor in such a way that there should not be any air gap. Then start the cooling system first for avoiding any damage to the condensing system, then start heating at suitable energy supply such as (30, 40,50, Etc.) Is maintaining constant. After some time (5-10min) temperature is rises gradually from at 40 min a temperature is reach up to the cracking temperature (285^0C) of the plastic west. At that time the product vapors is form and it will get condense inside the condenser which will maintain at 5-6°C. The gases which will not be condense in condenser first which is passes through the second condenser. Here heavier fraction(C_5-C_{10}) is get condense and other non condensable gases such as methane, ethane, propane, butane is leave to atmosphere this gases are highly explosive in nature so that's why we can also trap that gases, and then after continues time period(5min) condensate is captured. The temperature is rise up to 400 to 550°C and maintains it constant till the process is end, then removes the liquid product and measured it; residue is collected at the bottom of reactor and measured it. Then from this we calculate the yield of product. For identification of product we use the ASTM distilation proses from that we calculate the boilling rang of the product

Figure-1
Setup of Process

Start of Process: Befor starting the reactor first start the colling syste becouse it may cause the damage to the condensation system. Then switch on the power supply to the energy meter and adjust the energy meter to the required amount.

Shut Down of The Setup: At ending of process first switch off the reactor then after 15min stop the the cooling system,due to that the gases which is come out of reactor which get condence. And due to hot gases it may have chancess to damage our condensation system.

Precaution: Start the cooling system before starting the reactor,it may cause the damege to the condensation system. Switch off the reactor first then after 15min stop cooling system. Conferm all the system is air tight.

Explanation: This graph shows the behavior of reactor along the temperature and it is observed that the reactor remains constant at particular temperature for the period of three hours with ±10˚c difference in temperature.

Results and Discussion

The result shows the variation of Conversion of the product with different temperature of the reactor.

Temprature Profile Of Reactor:

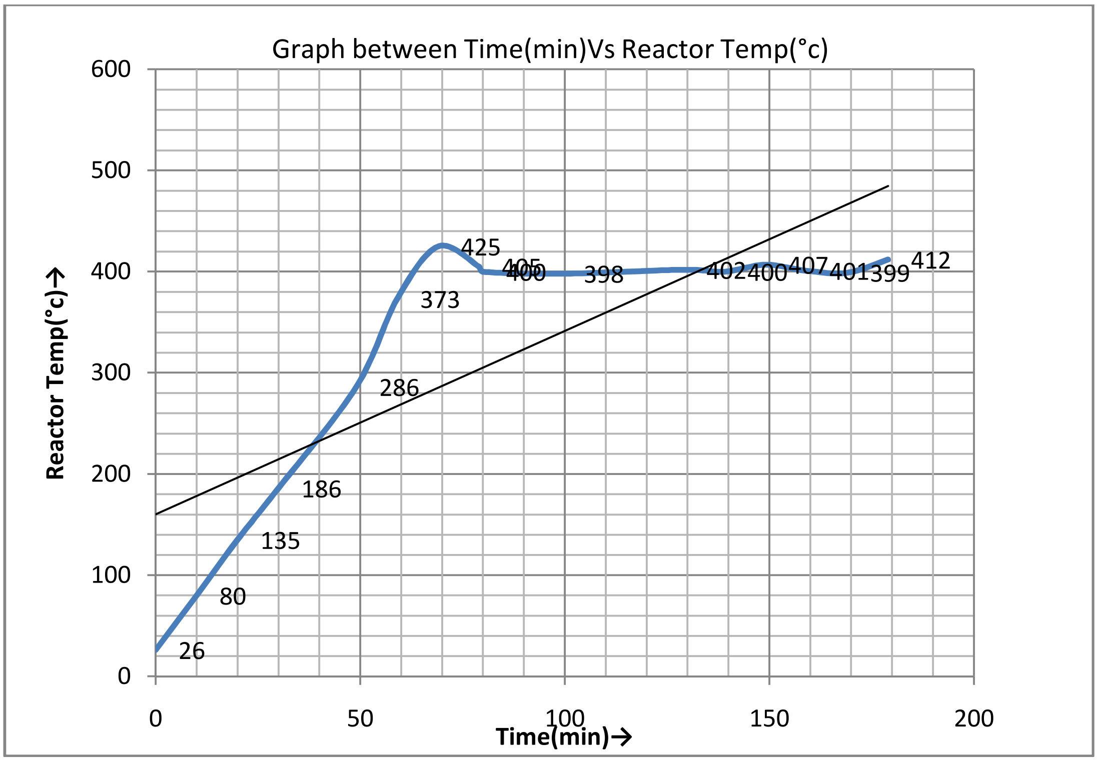


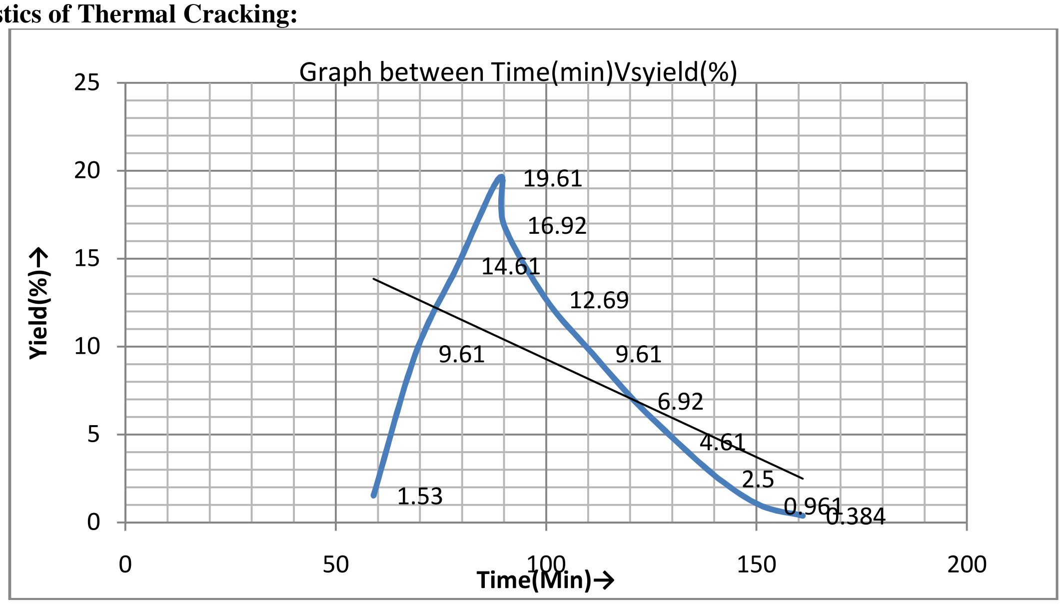
Figure-2
Graph between Time (min) Vs Reactor Temp (°c)

Table 1

Sr. No.	Temperature Rang	Product Conversion (%)			Total Conversion (%)	Viscosity Of Oil Product in cst At 32^0c	Specific Gravity Of Sample Liquid (gm/ml)
		Petroleum Oil (%)	Gas (%)	Solid Residue (%)			
1	500	66.49	14.11	5.28	85.88	1.2487	0.8338
2	400	76.16	14.05	4.89	95.1	1.4152	0.7738
3	350	Nil	Nil	Nil	Nil	Increased	Nil
4	550	72.30	14.93	6.38	93.61	1.4152	0.8318

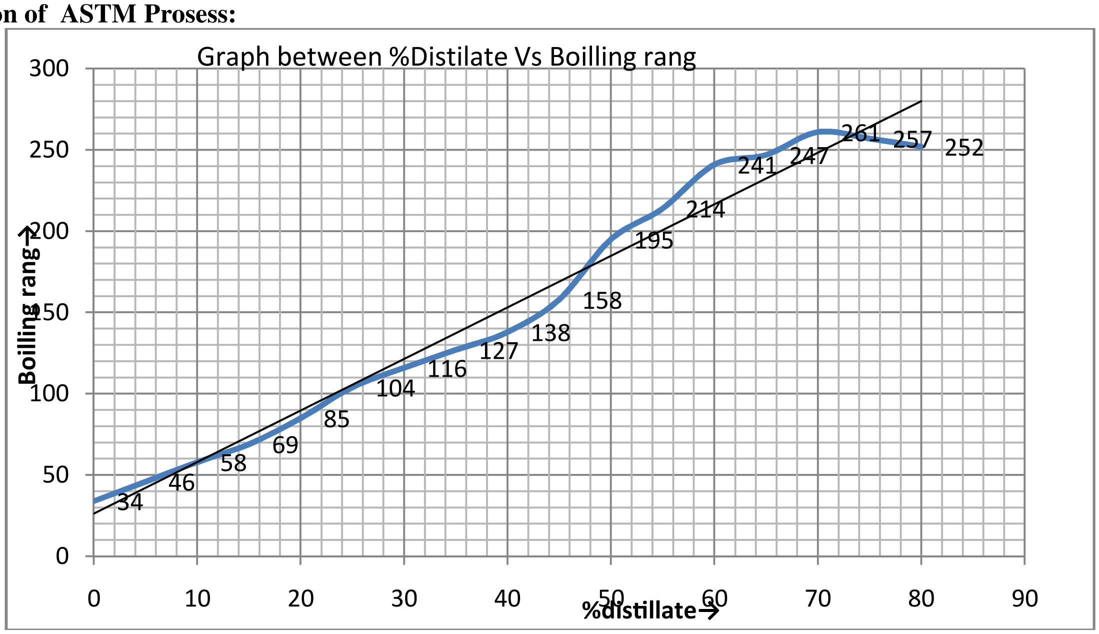
Fire Point: Fire point of Row oil is at 34°c it means that the vapors of raw oil are burned at very low temperature. Table shows the % conversion of the plastic waste, as the temperature of the reactor is increased above the 400^0C then the gaseous yield of the product is increased and viscosity of the product is decreased. In case of the 400^0C the liquid yield of the product gives optimum result, bellow that temperature the gaseous conversion is decreases and due to wax formation viscosity of the liquid product is goes on increase. So table shows the variation of the conversion as we said at higher temperature the gaseous conversion is increased, but it is depends upon the polymer conditions under which it is treated. If polymer is at its original condition then this condition is satisfy, but polymer has achieve its property of thermosetting then in that condition due to the closely packed bonding of the polymer it required more temperature for the cracking, that's why in table 1 at 550^0C the liquid conversion of the product not that much effected and also viscosity of the product is remains constant.

Characterestics of Thermal Cracking:



Graph-1
Graph Between Times (Min) Vs Liquid Conversion (%)

Representation of ASTM Prosess:

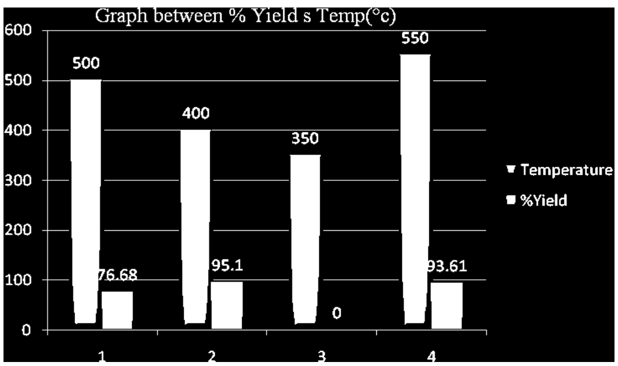


Graph-2
Graph between %Distillate Vs Boilling rang

Graph-1 shows the fluctuation in yield (%) with respect to time.Initialy the yield of product is increases with respect to time at one time it reach up to the maximum lavel.Then after that it get gradualy decreased at the end it will reach up to zero,Hear the process is stop.

Graph-2 shows the variation in boilling rang with %distillate from graph it is clear that the boilling ranges of the componunt which is preasent in crud.from graph we can identifay the compoun from there boilling rang i.e. (34-180°C gasoline,180-260°C ckerosen, 260-308^{0}C deasel). Hear we get up to 50% of gasoline and other is kerosen and deasel.

Representation of %Yield:



Graph-3
Graph showing variation in conversion

Graph shows the variation in yield with respect to temperature. In first run the temperature is mentain at 500°C in that we get 76.68% yield in that we get some what less yield due to the thermoseting product is add to the plastic feed.In second run the temperature is maintain at 400°C in that temperature we get maximum yield at that temperature.In thired run temperature is maintain at 350°C in that temperature we did not get product at perticular time that's why we need to be stop. But while analysis it is found that at lowar temperature than 400^{0}C the time required for the convertion is more and it gives the waxi product. In fourth run temperature require ment is more than expected lavel it will reach up to the 550°C due to the puerly thermoseting product is used in this run, due to this property of polymer temparature require ment is increased with not that much effect on yield and viscosity of product.

Conclusion

Real disposable plastic waste has been thermally cracked in reactor at 400-500^{0}C for 2 or 3 hr. Reaction temperature 400°C is very active to perform the thermal cracking in low residence time. At this temp petroleum fraction yields is improved in favor of reduction of char product yield. The liquid product is dominated by gasoline and kerosene compared to that of other temperature. In addition; carbon number distribution is shifted to lower values creating very light oil with distribution similar to that in gasoline fuel. Oil components distributed within boiling point range up to 34-285°C. The main aromatic hydrocarbons in the oils were gasoline, kerosene, diesel, naptha after A.S.T.M distillation in our experimental work the thermal cracking of polylacticacid were investigated. It was found, that the concentration of polylacticacid significantly affected both the quantity and quality of degradation products. It was also observed that the presence of the polylacticacid in the raw material increased the reaction rate. With increasing concentration of polystyrene in raw materials, the concentration of aromatics considerably increased, furthermore, the characteristic of products also changed notably (e.g. both the Research Octane Number and Motor Octane Number of the gasoline fractions were increased).

Acknowledgement

The authors gratefully acknowledge authorities of Jawaharlal Darda Institute of Engineering and Technology, Yavatmal for providing laboratory facilities

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