Waste Plastic Pyrolysis : An efficient way of Plastic Recycling

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Abstract: *Nowadays, There is a need to think about the major causes of pollution, one of which is crude oil, the plastic is used worldwide today. Plastic is found everywhere. Creation of plastics was a boon for low cost substitution to metal, being cheap is now causing environment problem. Plastic and polymer-carbon chains have long life and could be classified according to the uses. This has lead us to a point where waste plastics in the tons are causing various environmental hazards, not to mention the shame it bring to one's mind when he sees his own country littered with it. It is still on the places of landfills and oceans, which has become major concern of the world. There is a need to think of this issue as it's leading to impact environment seriously. There is ever increasing global demand for energy in recent years. A pyrolysis process provides an alternative energy source which reduces pollution and recycles waste plastics. In this study, pyrolysis of waste plastic is solution for the issue in the current world, disposal of waste plastic will also be minimized if applying pyrolysis process in different cites & make the environment clean. This paper deals with extracting pyrolysis oil/pyro fuel from waste plastic that is found in everyday life & by recycling to make out pyrolysis fuel & reduce carbon emission. This project leads to a meaningful contribution to Swatch Baharat Abhiyan & Paris climate deal.*

Keywords: **plastic waste, pyrolysis, pyro fuel, carbon emission**

1. INTRODUCTION

Removal of plastic waste is exceptionally enormous issue in developing nation like India. A huge number of Tons of Plastic waste is dumped ashore and a lot of waste plastic is arranged off into the ocean. These plastic squanders could be utilized for delivering fuel. Pyrolysis is a thermal splitting of plastic material at high temperatures without oxygen. Pyrolysis of plastic produce gas and fluid items which are known as pyro fuel or plastic pyrolysis oil and leave a strong buildup carbon dark. The venture is consequently chosen with a target of utilizing this non-disposal waste plastic as a source to fuel which after refining can be utilized as an alternative source of energy. currently the plastics end up at city landfills or waterways. Disposed of plastic items and bundling or packaging materials make up a developing of city waste. Consumption brought about on removal of plastic waste all through the world is around US$ 2 billion consistently. In any event, for a little nation like Honk Kong spends about US$ 14 million per year on the activity. The Global Environment Protection Agency [GEPA] gauges that constantly 2004 the measure of plastic discarded will be 65% more prominent than that in the 1990's. The reusing of the plastic is just around one percent of waste plastic in the flood of waste in creating nations when contrasted with a pace of reusing of aluminum which is about 40% and 20% for paper, while reusing rate in India is high up to 20% of waste plastic. Plastics have become basic materials of our regular day to day existences, and a considerable lot of their properties, for example, toughness, flexibility and light-weight, can be a huge factor in accomplishing manageable improvement. In any case, plastic applications likewise add to the developing measures of strong waste created, as plastic items are regularly utilized just a single time before removal. The removal issue isn't just specialized, yet it additionally has social, financial and even political viewpoints. This is the motivation behind why a few unique strategies have been investigated and applied for taking care of the issues related with polymer squander taking care of and removal.

2. LITERATURE SURVEY

C. Muhammad et, al. in their paper concluded that recycling of plastics into useful fuel will assure for both the environmental and economic circumstances. Thus, recycling of plastics to fuel has now turned the difficulties into opportunity to make assets from waste [2]. According to Central Pollution Control Board (CPCB), India produces around 18.7 million tons of plastic waste per year and out of this only 60% of collected plastic waste is re-cycled. This has lead to serious environmental conditions and their disposal problems. [4]. According to ministry of Environment and Forest, Creation of best from waste is recent scenario in our country. Recycling waste plastic into fuel could be one of that best solutions as plastic is durable, easily available and cheap. This will reduce problem of decomposition of plastic waste. [5] J. Hopewell et, al. has addressed that recycling provides opportunity to reduce usage of oil, CO emissions and the quantities of waste requiring dumping. With advancement in technologies and systems available for the collection of waste, their sorting and reprocessing of plastics has given new ways for recycling of plastic waste. Thus, combined measures of people, industry and government will divert the majority of plastic into useful production of oil. [6] Hayelom D B worked in order to introduce methods for conversion of recyclable plastic to fuel. With recycling it is possible to prevent waste accumulation and convert into useful materials or fuels. There are various methods such as Hydrogenation, Gasification, Chemical de-polymerization; Catalytic conversions and Thermal cracking can be used to convert waste plastic into gas or liquid fuels. [7] Aishwarya K N et, al in their work used microwave irradiation as tool for heating waste plastic, found to be effective heating method and can provide good efficiency for pyrolysis. Current method developed microwave for operating frequency of 2.45 GHz with varying energy outcome of 5 kW. The development of microwave reactor with provisions of quartz reactor, cold trap and condenser has made design attractive. In this work testing of pyrolyzed products (oils/waxes) carried out using advanced techniques like GCMS, FTIR and TGA also characterization carried out using methods like SEM and XRD. [8] C. Muhammad et, al. in their work used waste collected from electrical and electronic equipment (WEEE) for pyrolysis with inclusion of zeolite catalysts to produce useful oil. An observation with use of plastic waste from CRTs and refrigerators proves that oil produced was more than 80 wt%, and the gases consisted of hydrogen, methane and C2-C4 hydrocarbons. The waste collected from electrical and electronic equipment (WEEE) for pyrolysis produces oil containing styrene. [9] Young-Hwa Seo et, al. has predicted use of zeolite and non-zeolite type catalysts for degradation of waste high-density polyethylene (HDPE) by process of hydrocarbon analysis of oil products, and it is found to be precious to improve efficiency. In this work, batch reactor is used to identify the cracking efficiency of catalysts for oily products such as olefins, paraffins. [10] MC Sharma et, al. in their study compared three types of oils such as oil from plastic pyrolysis, engine oil and waste tire oil with various petroleum products and it is observed that it has same properties like diesel (fuel). [12] Recycling plastic waste to eco-friendly, recyclable and renewable polymers will reduce disposal problems of waste plastic and will lead to a greener environment with minimizing problems of global warming and improve the sustainability. Plastic waste recycling will complete loop and will provide norms for circular economy. Mechanical recycling is the shortest pathway to use the plastics waste again. [16] Use of plastic is increasing day by day and its disposal is one of the major problems faced by many countries. Thus, recycling this waste to produce fuel production will be most effective way because of its high heat of combustion. Plastic has some of the good characteristics such as it does not absorb much moisture and it has very low water content than biomass such as crops and kitchen wastes. The recycling methods of waste plastics into fuel have many parameters such as type of plastics to be targeted and the characteristics of other waste products that might be used in the process. With incorporating appropriate technologies will lead to effective conversion of plastic into fuel. [2]

3. METHOD AND MATERIAL

3.1 Method

The procedure of pyrolysis, used to convert plastic wastes like ldpe covers, pp covers, pet bottles, multilayer packaging, & different types of plastic into valuable products like pyro fuel, carbon black & gases. Nearly 100 tons of plastic waste is collected in single city [5]. This highest plastic waste is disposed which leads to landfills which further leads to land slide. By survey nearly 300 tons to 500 tons of plastic is disposed into land in single district [5]. By estimating 5000 tons to 6000 tons of plastic will be wasted from household sources in the state per year [5]. Waste plastics have been then washed & dried before pyrolysis to give maximum yielding. From above factors from municipal plastic waste have been used as raw material. The production method for the conversion of plastics to pyro fuel is based on the pyrolysis of the plastics and the condensation of the hydrocarbon gases resulting pyro fuel. For the production process of pyrolysis fuel, the plastics that are suitable for the conversion are put into a reactor where they will melt at 250 to 500°C. Depending on the pyrolysis conditions and the type of plastic used, carbon progressively develops as a deposit on the bottom surface of the glass reactor. After pyrolysis, this deposit should be removed & clean the reactor in order to maintain the heat conduction efficiency of the reactor [6].

3.2 Pyrolysis method

Pyrolysis is derived from the Greek word “pyro” means heat “lysis” mean separating. Pyrolysis is a warm air cracking of plastic at high temperatures. It is conducted out in the absenteeism of oxygen (vacuum). It involves the continuous change of chemical structure and physical phase of plastic, due to which its breaks into long & short chain . Pyrolysis is a type of thermal-separating, and is mostly observed in plastic when it exposed to high temperatures with absence of oxygen. It is one of the processes starts melting at 250–500°C. The gases then further take to condensed in condenser & convert the gases into fuel. Remaining gases can be reused to heat the reactor and run the genset to generate electricity. Raw materials used to generate pyrofuel -Waste plastic

The important sources of MPW plastics are nourishment covers, milk covers, water bottles, bundling froth, dispensable cups, plates, cutlery, CD and tape boxes. Cooler liners, distributing cups, electronic gear cases, seepage pipe, carbonated beverages bottles, plumbing pipes and guttering, flooring [5]. Modern plastic squanders are those emerging from the huge Plastics assembling, preparing and bundling industry. The modern waste plastic predominantly establishes plastics from development and obliteration organizations (for example polyvinylchloride funnels and fittings, tiles and sheets) electrical and gadgets enterprises (for example switch boxes, link sheaths, tape boxes, TV screens, and so forth.) and the car businesses save parts for autos, for example, fan sharp edges, seat covers, battery compartments and front flame broils) [5]. The vast majority of the mechanical plastic waste has moderately well physical qualities for example they are adequately spotless and liberated from pollution and are accessible in genuinely huge amounts [5]. About 8.8 million metric huge amounts of waste plastic is dumped in the seas consistently [13]. Mass centralizations of marine trash in high oceans 'sink' zones, for example, the tropical intermingling zone, are of specific concern. In whatever regions, 'piles' of arranged trash, including different plastics, ropes, angling nets, freight related squanders, for example, dunnage, beds, wires and plastic covers, drums and dispatching compartments can be seen spreading generally [13].The types of plastic can be classified according to the recyclable number that is mention in table 1.

Table No 1 Types of plastics

1 PETE	2 HDPE	PET-polyethylene terephthalate HDPE- high density polyethylene
3 PVC	4 LDPE	LDPE- low density polyethylene PVC- polyvinyl chloride
5 PP	6 PS	PS- polystyrene PP- polypropylene
7 OTHER		PF- phenol formaldehyde PU- poly urethane PVDC- polyvinylidene chloride

4. Design & material parameters

The experiment is carried out at high temperature hence system must withstand with high temperature. Pressure gauge and safety valves are installed at the reactor. The setup was intended to work at high temperatures and atmospheric pressure. The chamber of the exploratory device was a vertical glass round reactor. An I/C joint was connected to the reactor upper end this empowered controlled measures of gases to be aggregate during process. At the I/C joint condenser is appended After that condenser is connected to siphon to consolidated hot gases. Vessel of the reactor is attached to a heating mantle to warm the reactor. The process flowchart is shown in fig.1.

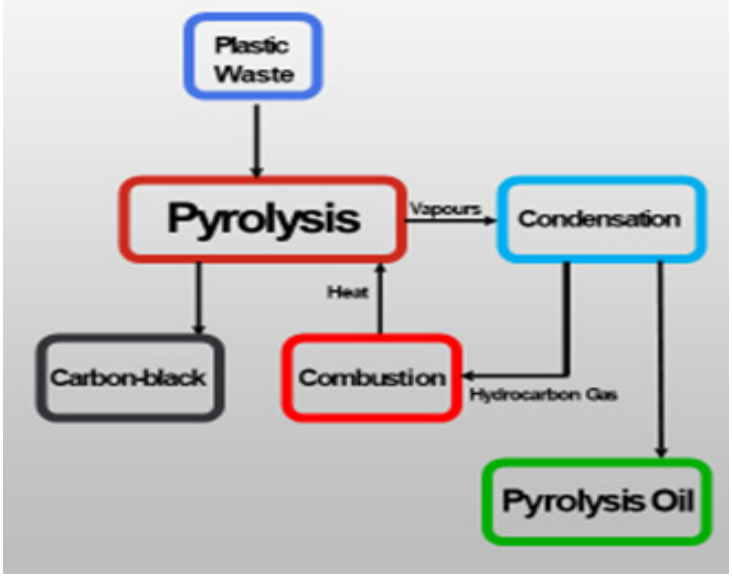

Figure. 1 flowchart of pyrolysis system

Desirable standard parameters for design & selection of pyrolysis system.

- Melting point of the plastic. Average temp(250-500*c).
- plastic with Lower Density
- More Moisture in plastic.

- High temperature Reactor
- More Heating rate input =V×I (220×0.5).
- Optimum Reactor size to get max oil yield. 250 ml borosilicate glass reactor used.
- Feed rate depends according to type of process Batch type =170gram Continuous type = commercial process
- Graham condenser is used (length 300mm).

5. Experimental study

The experimental setup is selected to pyrolysis the waste plastic is shown in figure no.2.It Consists of a heating mantle, Glass reactor, Condenser and a pump.the heating mantle is used to supply heat to the borosilicate glass reactor in the absence of catalyst and oxygen, which results into production of gases are 230ºc. The glass reactor consists of the waste plastic. This sort of waste comprises of acrylonitrile butadiene styrene, polypropylene, polystyrene, polyethylene, polycarbonate, and so forth.The heating mantle input is 220 v & 1 amp current. For getting ideal condition various parameters were changed in pyrolysis process. More catalyst loading could facilitate rate of catalytic cracking to form gaseous compounds. The gas produced consists of butane, ethane, hydrogen, and methane. the gases produced get contained into graham condenser & converted into pyro fuel. The condenser is attached to the pump at the bottom to provide gravity force. Cotton was placed at the exit which we can burn to check the experiment output.

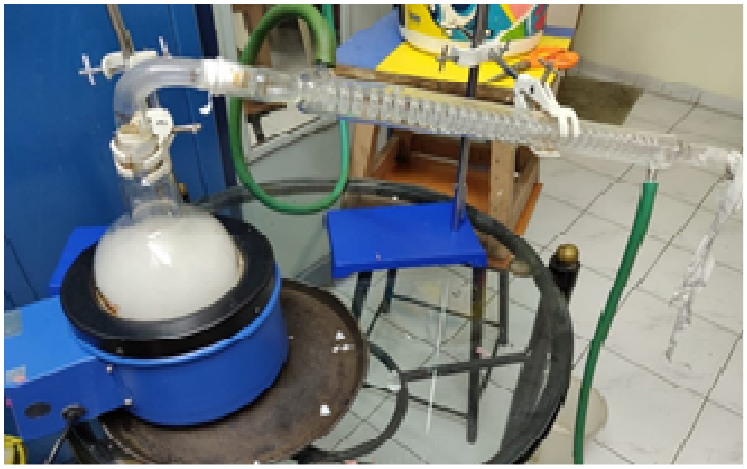

Figure. 2 pyrolysis prototype setup

6. RESULT & DISCUSSION

After the successful completion of experiment it was observed that the fuel produced by plastic pyrolysis is equivalent to conventional fuel. The uses pyro fuel give less carbon emission, equivalent gross calorific value, less Sulphur content. By the process of Pyrolysis, plastics can be converted into fuel along with few other products. These products are in particular Pyrolysis Oil, Gaseous blend and Carbon Black It is worth notice to tell that plastics plastics as well as plastics in which added substances were utilized can be blessed to receive structure similarly great oil [8]. Thermal and catalytic pyrolysis has has their own yield perspectives for various items. It has been discovered that can be selected warm pyrolysis for Liquid items and to synergist pyrolysis can be favored for Gaseous items [11] [15]. Pyro fuel competes with properties like specific gravity, fire point, calorific value, pour point of diesel & base crude. The fuels pull off

from the plastic waste progression are practically free from impurities such as less Sulphur content and carbon emission. Through the practice, vulnerabilities related to healthiness and welfare is increasing due to fewer emissions of carbon & healthy environment. The average efficiency of municipal waste plastic waste to fuel is 50%. Gases: 40%; pyro fuel: 45%, carbon black 15%. Efficiency=input/output (2) INPUT =150 G OUTPUT=75ml

Efficiency = 50%.

Table No 2 Result of plastic pyrolysis oil

Property	Result	Units	Method
Gross Calorific value	10266	(kcal/kg)	ASTM D4868-2017
Density@15*c	0.882	(kg/m3)	ISO 3675:2007
Kinematic viscosity @40*c	2.1	CST	ASTM D445-2017
Flash point*C	38	*C	ASTM D93(Procedure A)-2016A
Cetane number	51	-	
Fire point*C	44	*C	ASTM D93(Procedure A)-2016A
Carbon residue (%)	0.91%	(m/m)	ASTM D189-2014
Ash content	0.140%	(m/m)	ASTM D482-2013
Sulphur content (%)	497%	(mg/kg)	ASTM D4294-2016e1
Appearance	Brown viscous	-	NAKED EYES
Water content	1.30%	(v/v)	ASTM D95-2013
Pour point	<-13	*C	ASTM D-2017

7. CONCLUSION

Plastic is disposed everywhere is the major issue in the developing country. The uses of plastic are increasing everyday creating environmental and hazardous problems. Over oodles of tons of plastic is generated every day in India & it should be disposed of, as plastic take more than 300 years too degrade naturally. Though human created the waste from decade, now the time came to solve the issue & vanished the plastic that are in landfills. We can say that the fuel produced by the pyrolysis is cleaner than conventional fuels. For different grades of plastic, the yielding may vary accordingly to raw plastic & it comes at average of 50%. It is the one of the best recycling method for the waste plastic. The gaseous products produced by the pyrolysis of plastic have desirable composition and consist mainly of methane, butane and ethane. Unused gases can be feed to the system for heating purpose & hence increasing the overall efficiency. The fuel obtained from waste plastics provides solution for both the environment and economy. Pyrolysis of waste plastic is the best technology for the developing country like India to keep environment clean & green.

8. FUTURE SCOPE

The study shows that, there is ever increasing demand of conventional fuels in past few years due to increase in industries and growing population. The uses of plastic are also going increasing day by day & waste generation is going on swelling. So, the pyrolysis of waste plastic has a great future scope for developing country to create the wealth from waste. The implementation of pyrolysis plant can reduce carbon footprint from environment & keep it clean. The implementation of this project in different areas for society welfare and growth of our nation

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