A STUDY ON EXTRACTION OF FUEL FROM WASTE PLASTIC

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ABSTRACT

There has been an ever increasing global demand for energy in recent years. The demand especially from liquid fuels is very high and the limited resources of fuel production has created bottleneck leading to an energy crisis. This has led to exploring other resources for fuel production, one of which is plastic. Being a non-degradable source, plastics disposed off in the open environment as wastes pose a threat to the environment. Most of the waste plastics end up as landfills. It can instead be used as a source for making fuel. The work describes an attempt to use the waste plastic to synthesize potential fuel called 'Pyrolysis Oil' since the process used in order to obtain the oil is Pyrolysis. The obtained oil from different grades of waste plastics is analyzed so as to validate its use as fuel.The paper deals with extracting pyrolysis oil from waste polymers by fabricating an furnace to carry out pyrolysis.Solid waste is the useless, unwanted and discarded material resulting from day to day activities in the community. Solid waste management may be defined as the discipline associated with the control of generation, storage, collection, transfer, processing and disposal of solid waste. Solid Waste management is one of the vital issues in the contemporary urban environment, more particularly in developing countries. The one effective way of utilizing the the solid waste is to convert them into the fuels. Production of bio gas is a very effective way of utilizing the solid waste

Keyword: *Solid waste,pyrolysis,energy,environment*

INTRODUCTION

India is rapidly shifting from agricultural-based nation to industrial and services-oriented country. Solid waste management, a critical element towards sustainable metropolitan development, comprises segregation, storage, collection, relocation, processing, and disposal of solid waste to minimize its adverse impact on environment.Un managed solid waste becomes a factor for propagation of innumerable ailments. Solid waste refers to the refuse,the solid and semi solid waste matters of a community except the night soil. Solid waste contains organic as well as inorganic matters. Solid waste management includes the entire process of dealing with solid waste ,starting from the collection from the primary source to ultimately disposing off it hygienically, so that it may not be a nuisance or create any harmful effect on near by community. The solid waste management involves,management at waste generation level,storage at the source of generation,primary collection,street cleansing,temporary storage at locality level , regular and periodic transportation of this temporarily collected waste to disposing sites and treatment plants. Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, which generate thousands of tons of solid wastes daily. So solid waste is one of the major environmental problems of Indian mega cities. It involves activities associated with generation, storage, collection, transfer and transport,processing and disposal of solid wastes. But, in most cities, the Municipal Solid Waste Management(MSWM) system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. The management of MSWM requires proper infrastructure, maintenance and upgrade for all activities. This becomes increasingly expensive and complex due to the continuous and unplanned growth of urban centers. The difficulties in providing the desired level of public service in the urban centers are often attributed to the poor financial status of the managing municipal corporations. In the present study, an attempt has been made to provide a comprehensive review of MSWM for Indian cities to evaluate the current status and identify the problems of MSWM. The study also aims at

encouraging competent authorities/researchers to work towards the improvement of the present system through suggestions and recommendations.

Solid wastes may be defined as useless, unused, unwanted, or discarded material available in solid form. Semisolid food wastes and municipal sludge may also be included in municipal solid waste. The subject of solid wastes came to the national limelight after the passage of the solid waste disposal act of 1965. Today, solid waste is accepted as a major problem of our society. At this generation quantity, the average resident of an urban community is responsible for more than 1.8 kg of solid waste per day. This quantity does not include industrial, mining, agricultural, and animal wastes generated in the country each year. If these quantities are added, the solid waste production rate reaches 45kg per capita per day. To introduce the reader to the solid waste management field, an overview of municipal solid waste problems,sources,collection, resource recovery and disposal methods are presented in this paper. Greater emphasis has been given to the design and operation of municipal sanitary landfills, regulations governing land disposal, and leach-ate generation, containment and treatment methods.This project proposes the usage of domestic wastage in different formats by converting solid waste into bio gas and oil. Bio degradable material converted into bio gas and rest will be sent for fertilizer and plastic material converted into fuels by using pyroliser. Then remaining of metal will be sent for re usage.

EXTRACTION OF FUEL BY PYROLYSIS

Pyrolysis is the thermal decomposition of materials at elevated temperatures in an inert atmosphere.It involves a change of chemical composition and is irreversible.Solid biomass can be liquefied by pyrolysis thermo chemical technologies. Pyrolysis and gasification are related processes of heating with limited oxygen or without oxygen. Conditions for producing pyrolysis oil are more likely to include virtually no oxygen. Pyrolysis oil or other thermo chemically derived biomass liquids can be used directly as fuel, but also hold great promise as platform intermediates for production of high-value chemicals and materials.Fast pyrolysis is a thermal decomposition process that occurs at moderate temperatures with a high heat transfer rate to the biomass particles and a short hot vapor residence time in the reaction zone. Several reactor configurations have been shown to assure this condition and to achieve yields of liquid product as high as 75% based on the starting dry biomass weight . They include bubbling fluid beds, circulating and transported beds, cyclonic reactors, and ablative reactors.

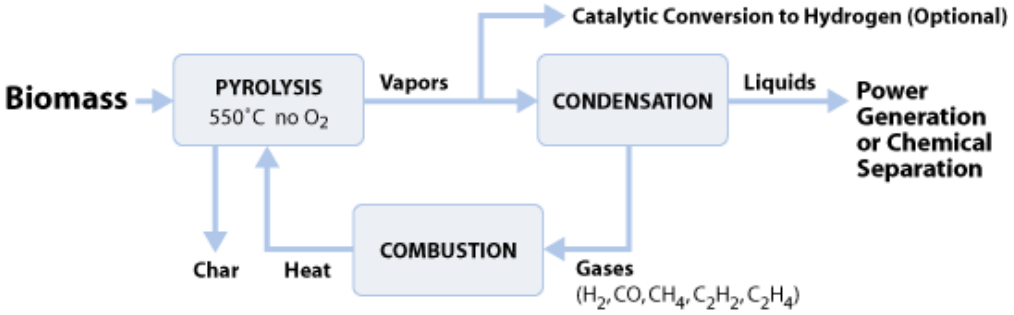

Fig.1: Bio-mass liquification

Fast pyrolysis of biomass produces a liquid product, pyrolysis oil or bio-oil that can be readily stored and transported. Pyrolysis oil is a renewable liquid fuel and can also be used for production of chemicals. Fast pyrolysis has now achieved a commercial success for production of chemicals and is being actively developed for producing liquid fuels. Pyrolysis oil has been successfully tested in engines, turbines and boilers, and been upgraded to high quality hydrocarbon fuels although at a presently unacceptable energetic and financial cost.Pyrolysis generally consists in heating the material above its decomposition temperature, breaking chemical bonds in its molecules. The fragments usually become smaller molecules, but may combine to produce residues with larger molecular mass, even amorphous covalent solids. In many settings, some amounts of oxygen, water, or other substances may be present, so that combustion, hydrolysis, or other chemical processes may occur besides pyrolysis proper. Sometimes those chemical are added intentionally, as in the burning of firewood, in the traditional manufacture of charcoal, and in the steam cracking of crude oil. Conversely, the starting material may be heated in a vacuum or in an inert atmosphere avoid adverse chemical reactions. Pyrolysis in a vacuum also lowers the boiling point of the byproducts, improving their recovery. When organic matter is heated at increasing temperatures in open containers, the following processes generally occur, in successive or overlapping stages.

WORKING METHODOLOGY

EXTRACTION OF FUEL FROM WASTE PLASTIC

WORKING:

With the rapid development of the world plastic industry, more and more plastic materials are used widely than before. As the increasing quantity application of plastic, it brings people convenience as well as serious pollution problems. At present, the waste plastics mainly are solved by landfill, burning and recycling. However, both of landfill and burning cause the secondary pollution, and the scope waste plastic recycling is very limited. For example, the waste plastics produced by household garbage and paper-making factory, which can not be recycled. With the increasing price of International crude oil, the waste plastic pyrolysis plant project report is closely watched by different countries in the world.Plastic pyrolysis plant adopts the latest pyrolysis technology, which can convert plastics waste into pyrolysis oil and combustible gas. And these end products have many applications. The pyrolysis oil from plastic waste not only can be used as fuel for iron factory, power plant, cement factory, restaurant, but also can be reprocessed into diesel by waste oil distillation equipment. The combustible gas can be used as fuel to heat the reactor, this will save energy for the whole plastic pyrolysis process.

For performance of the experiment, the material selected is first added to the heating chamber. The next step is placing the heat sealing gasket between the flanges and fastening the flanges using nut bolting. The fasteners are tightened so that the gasket properly seals the flanges. No air leakage is tolerated as this may result into combustion of the polymers being used. The empty water tank is filled with water before starting the test. The water is filled so that the major part of the coil is immersed under water. This helps to increase the effectiveness in heat exchange. After final inspection the electric supply to the furnace is switched on and the experiment begins. A stopwatch is used so as to keep a track of observations with respect to time. After switching on the apparatus, approximately 15 minutes later it is observed that furnace starts heating considerably. This can be said as the hot fumes are seen rising up from the little gaps in the frame and the heating chamber. Approximately 40 minutes after the start it is observed that milky fumes are obtained from the outlet. Also the heat sealing gasket is seen to emit some fumes as it heats up. However these observations last for a few minutes until the entire setup attains high temperature (400°C+). Using 1.5 kg of plastic in the experimentation 85 minutes after the start of the experiment it is observed that drops of oil start falling from the outlet. A funnel and a flask for oil collection are placed below the outlet.

Components of the set up

1. Reactor

A reactor is a mechanical device in which a chemical reaction of particular material should takes in the absence of oxygen. In our set up we took 1.5 meter long cylindrical type of material which is made up of cast iron and is about 0.25 mater of diameter having capacity of 3 kg of waste plastic handling. The one of the side of it is having a lid which can be opened and closed with the help of suitable pitch of thread. On the outer surface of it 4 coils are mounted in which two of its coil can heat up to 350 degrees and rest of two coils can bear temperature range of up to 1200 degrees. Those 4 coils are completely closed with another cast iron type of material over it. On the outer surface of it each coils one hole is made so that we can mount thermocouple in it and we can sense the heat with the help of electricity. But only problem we are facing in it is that heat was dissipating to outer environment surrounding of that reactor.

Specifications OF Reactor:

Diameter - 165mm

Length - 300mm

Thickness - 6mm

Fig-2: Showing the picture of reactor

The heating chamber is the most important component of the setup as it has to sustain the heat generated by the furnace and also be free of any leakage. The heating chamber basically consists of one cylindrical chamber. The outer diameter of chamber is 165mm, height is 300mm and thickness is 5mm. Heater coil is placed around the chamber for heating to produce oil. The temperature of 400 degree centigrade is maintained and the whole chamber is covered with glass wool to avoid the loss of heat. The plastic inside the chamber is undergone anaerobic reaction to produce oil.

Temperature indicator with its regulator

A temperature indicator is used to indicate temperature at which the our thermocouple is transferring heat to the coils. It can work with only one set point based on the requirements.The temperature regulator is the device which is used to decide whether temperature has to decrease or remain same or to increase. For increasing temperature we should turn the knob towards right, suppose if we set 50 degree then temperature will raise upto 50 degree and thereafter it will remain constant. In the same way if we need to decrease then we should turn it towards left side at a particular

degree centigrade.

Fig-3: Temperature indicator and regulator

Thermocouple

A thermocouple is a sensor used to measure the temperature. Thermocouples are consists of two wires made up of different materials. Those wires are welded together at one end, creating a junction. This junction is where the

temperature is measured. In our set up one thermocouple is used at one side of reactor to measure the temperature.A copper tube is a ring used in our set up which is mainly used to pass the flue gases which is produced in the reactor.

Fig-4: Thermocouple

It is also has a valve which we can open and close we need to keep close that valve for around 18 hours from stating of that process and once reactor will get completely filled up with flues then we can open that valve to release the flue gases. Once we release that valve flue gases will come out and it is allowed to pass through the water where it is condensed naturally. So here flue gases convert into liquid.

Heating coil

Ceramic Band Heater is made of an electrical resistance helical coil, which is inserted around a series of interlocking steatite bricks of 1100°c having physical and die electric strength and good thermal conductivity, covered with 4mm insulation and then wrapped in sheet metal. The resistance wire that converts electrical energy to thermal energy is a nickel-chromium alloy of 80% nickel normally termed as Ni-Chrome. The sheet metal is stainless steel (chrome – nickel) for temp up to 700°c.

Fig-5: Ceramic band heater

The diameter of the ceramic band heater is 165mm and length is about 150mm which covers the half of the length of heater. This heater can produce the constant heat of 400 degree centigrade which is required for the process.

Gasket Sheet

A gasket is a mechanical seal which fills the space between two or more mating surfaces, generally to prevent leakage from or into the joined objects while under compression.Gaskets allow for "less-than-perfect" mating surfaces on machine parts where they can fill irregularities. Gaskets are commonly produced by cutting from

sheet materials. Gaskets for specific applications, such as high pressure steam systems, may contain asbestos. However, due to health hazards associated with asbestos exposure, non-asbestos gasket materials are used when practical.It is usually desirable that the gasket be made from a material that is to some degree yielding such that it is able to deform and tightly fill the space it is designed for, including any slight irregularities. A few gaskets require an application of sealant directly to the gasket surface to function properly.

Fig-6: Gasket

Glass Wool

Glass wool is an insulating material made from fibres of glass arranged using a binder into a texture similar to wool. The process traps many small pockets of air between the glass, and these small air pockets result in high thermal insulation properties. Glass wool is produced in rolls or in slabs, with different thermal and mechanical properties. It may also be produced as a material that can be sprayed or applied in place, on the surface to be insulated.Gases possess poor thermal conduction properties compared to liquids and solids, and thus makes a good insulation material if they can be trapped in materials so that much of the heat that flows through the material, is forced to flow through the gas. In order to further augment the effectiveness of a gas (such as air) it may be disrupted into small cells which cannot effectively transfer heat by natural convection. Natural convection involves a larger bulk flow of gas driven by buoyancy and temperature differences, and it does not work well in small gas cells where there is little density difference to drive it, and the high surface area to volume ratios of the small cells retards bulk gas flow inside them by means of viscous drag. In order to accomplish formation of small gas cells in man-made thermal insulation, glass and polymer materials can be used to trap air in a foam-like structure. The same principle used in glass wool is used in other man-made insulators such as rock wool, Styrofoam, wet suit neoprene foam fabrics, and fabrics such as Gore-Tex and polar fleece. The air-trapping property is also the insulation principle used in nature in down feathers, and insulating hair such as natural wool.

Fig-7: Glass Wool

RESULTS AND DESCUSSION

The experiment is conducted on high density plastic as the raw material. Thermal cracking is carried out for extracting the fuel from the plastic. The plastic was thermally cracked at various temperature ranges from 300 °C to 400°C.

EXPERIMENTAL PROCEDURE

Collection of plastic materials

Fig-8: Showing the plastics used for experiment

The waste plastics used by us for this process consisted mainly HDPE and LDPE products in the form of used plastic disposal glass and disposal ice cream container. A person was allotted for collecting the material. He collected all the plastic which are needed for the experiment from house holds.

Preparation of HDPE & LDPE pellets

The material that was collected was subjected to cutting by using scissors manually. This was done to increase the surface area of contact of the material during the melting process. The material was then directly taken for the melting process.

Thermal pyrolysis

For this purpose a cylindrical mild steel reactor was used. The rector was covered by the band heater at the bottom of reactor. The heater is meant for maintaining the constant temperature through the process with the help of controllers like thermo couple. For the better distribution of heat and also particles are fed into the reactor often in order to fill the reactor completely with molten plastic products, otherwise the air may fill the gaps inside the reactor which may be cause hindrance for our process. The gases coming from the process are directed into the water bath. Here the gases are completely absorbed. The gases coming from the process are in the range of LPG and HCI gases, since it is a product of hydrocarbons.

Fig-9: Fuel obtained from experiment

The problem that we got at the beginning is leaking of gases through the plates at the top. To overcome the leakage two gaskets are added. After this we were able produce the fuel from the plastics which is a hydrocarbon and can be get converted into some other valuable fuels like petrol,diesel and kerosene by recycling.

ANALYSIS OF LIQUID PRODUCT

The liquid product we got was viscous liquid with an dark yellowish and mud mixed colour with an ab noxious odour and has properties like highly flammability and burned completely without any left over residue.

Table -1: Some properties of liquid product

Sl no.	Properties	Values
1	Density	702.5 kg/m^3
2	Viscosity	5.27 m.Poise
3	Flash point	22°C
4	Fire point	29°C
5	Calorific value	43796.02 KJ/kg

CONCLUSION

Waste plastics are the major problems for today's environment. Over 14 million tons of plastics are dumped into the oceans annually,killing about 1,000,000 species of oceanic life. In this regard the pyrolysis studies here presents an efficient, clean and very effective means of removing the debris that we have left behind over the last several decades. By converting plastics to fuel, we solve two issues, one of the large plastic waste, and another one is shortage of fuel. The dual benefit, it will surely provide a strong platform for us to build a clean and green future. By taking into account the financial benefits of such a project, it would be a great boon to our economy. So from the studies conducted we can conclude that the properties of the fuel obtained from plastics are similar to that of petrol and further studies on this field can yield better results.

The use of plastic pyrolysis oil in diesel engine in the aspect of technical and economical is compared and found that oil is able to replace the diesel oil.Though the plastic pyrolysis oil offers lower engine performance, the plastic waste amount is enormous and it needed to be process to reduce the environmental problems. Moreover, the engine can be modify follow the combustion condition of plastic pyrolysis oil. The waste plastic used in the process must be PE or PP or LDPE in order to protect the contamination of chlorine in the oil.

SCOPE OF FUTURE WORK

1. By making use of some additional equipment s such as a hopper,flare stack and designing good sort of reactor we can increase the capacity and also we can yield more amount of liquid fuel.

2. By the proper thermal cracking the oil which obtained can be tested for their properties and the can be mixed with diesel.

3. By making the system automatic such that the system itself reach and maintain a required temperature range for the process for particular kind of plastics so it does not need any human interference.

4. By using more number of condensers and also good capacity condensers we could get more amount of liquid product so that flue gases will not get wasted or escape from the system

5. We can improve economy by maintaining the technical parameter.

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