Continuous Pyrolysis

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Abstract: The aim of recycling plastic in this project is to lessen high rate of plastic pollution and to remove waste plastic which is difficult to reuse. These efforts help preserve resources and redirect landfill-bound plastics.We here eliminate the single-use plastic by Pyrolyzing it to crude oil which can be used for domestic purposes. To take part in the reduction of pollution crisis, believing that small initiatives make a big difference.

It is process of repurposing discarded plastics into usable and valuable items via recycling. This saves resources and keeps plastic out of landfills and seas, where it would otherwise end up. Plastics are long-lasting, low-weight, and low-cost. Various items may be easily made from them, they have a wide range of applications. Over 100million metric tonnes of plastic are produced yearly across world. Millions of packages and items are made from 200 billion pounds of new plastic, which is thermoformed, foamed, laminated, etc. Therefore, plastics reuse, recovery, recycling are critical.

This initiative has potential to open up a wide range of possibilities in city. Waste plastic can be controlled, new ideas developed, and source of fuel for nation discovered via this method.

Keywords: Pyrolysis, GI tube, Flash point, Fire point.

I. INTRODUCTION

By repurposing plastic bottles in this initiative, we want to decrease plastic pollution but also eliminate trash bottles that can't be recycled. Conservation and recycling are both benefited by this practise.We here eliminate the single-use plastic by Pyrolyzing it to crude oil which can be used for domestic purposes. To take part in the reduction of pollution crisis, believing that small initiatives make a big difference.

It is process of repurposing discarded plastics into usable and valuable items via recycling. This saves resources and keeps plastic out of landfills and seas, where it would otherwise end up. Plastics are long-lasting, low-weight, and low-cost. Various items may be easily made from them, and they have a wide range of applications. Over 100million metric tonnes of plastic is produced yearly across the world. Millions of packages and items are made from 200 billion pounds of new plastic, which is thermoformed, foamed, laminated, etc. Therefore, plastics reuse, recovery, and recycling are critical.

These plastics which end up in landfills and oceans can be converted to their original form as crude oil to eliminate the risk of pollution. To do so cracking of long carbon chains (C6-C24) as oils, wax or coal which can be used as fuel at various places as alternate energy source. This process of cracking long carbon chains is known as pyrolysis.

To take part in reduction of the pollution crisis, believing that small initiative makes a big difference. As per my idea I have designed a pyrolysis machine unlike the machine present in today's market, this machine has a direct and continuous feed mechanism giving an uninterrupted yield of oil. Also the whole machine is monitored by single computer. Making it easier to operate and also besides automation in operation the automation in safety of the operator and the safe emmisions to the environment is prioritized.

The end product i.e. Crude oil which can be condensed at different phase, to get the different products like diesel, gasoline, wax, coal and methane- (which can be used as heating source for the heating chamber, hence not letting greenhouse gas in the air). These products can be used in industries, or produce electricity out of it.

II. LITERATURE SURVEY

V L Mangesh (2017). Examining current literature on plastic recycling and its use in diesel engines is goal of research presented in this paper. This study examines procedure of turning waste plastics in diesel engine liquid hydrocarbon fuels. As world's need for plastics grows, so does dilemma of how to properly dispose of and recycle debris. In order to make diesel engines work more efficiently, one solution is to turn waste plastic in flammable hydrocarbon liquid. Continuing study on conversion of waste plastic into combustible pyrolysis oil as an alternative fuel for diesel engines has been undertaken by researchers. nvestigation of chemical structure of waste plastic pyrolysis compared to diesel oil is topic of an existing literature.

Different catalysts for catalytic pyrolysis of waste plastics are also discussed in this research. Waste plastic pyrolysis oil may be reduced in unsaturated hydrocarbon bonds using this process, which would increase combustion of diesel engines as an alternative fuel.

Devy.K. Ratnasari, Mohamad A.Nahil, Paul T. Williams. (2017). High-density polyethylene has been pyrolyzed and then catalysedutilising solid acid catalysts to create gasoline-range hydrocarbon oil (C8–C12). There were two stages of catalyst layering in this process, with goal of increasing conversion of waste plastic to gasoline-range hydrocarbon products from mesoporous catalyst. Several MCM-41 to zeolite ZSM-5 catalyst ratios was studied using mesoporous MCM-41, microporous ZSM-5 as first two catalysts. MCM-41 with zeolite ZSM-5 also were employed as a comparison for each other. Utilizing a 1:1 MCM-41: ZSM-5 ratio in staged pyrolysis catalysis method, a significant yield of oil product (83.15 weight percent) was achieved from high density polyethylene using staged catalysis (83.15% weight percent). C2 (mostly ethene), C3 (primarily propene), and C4 (primarily butene and butadiene) gases were primary products. A large percentage of gasoline-range hydrocarbons (97.72 wt. percent) made oil product strongly aromatic (95.85 wt. percent oil). Catalyzed pyrolysis of waste plastic samples from diverse industrial sectors was also explored utilising a 1:1 ratio of MCM-41: zeolite ZSM-5 for the pyrolysis–catalysis process. Real-world examples included agricultural waste plastics, building reconstruction plastics, food packing waste plastics. Findings demonstrated that high concentrations of gasoline range hydrocarbons may be generated to create effective conversions of real-world trash plastics.

IoannisKalargaris, Guohong Tian, Sai Gu. (2017). Chemical recycling offers a promising solution to growing issue of plastic waste generation and disposal.

When plastics are burned, they are broken down and turned in higher-quality oil, which may be used in internal combustion engines to provide power and heat. Diesel engines may benefit from employing oils generated from pyrolysis at various temperatures, according to current study. Characteristics of generated oils were compared to those of diesel fuel and found to be comparable. Combustion, performance, and emission properties of plastic pyrolysis oils have been compared to those of mineral diesel in a four-cylinder direct injection diesel engine. At greater loads, pyrolysis oils gave engine a superior performance.

Heat transfer and ignition delay were both improved when oil was synthesised at lower pyrolysis temperatures than those used in tests. However, emission levels were lower with this oil than with oil generated at a higher temperature.

M. Z. H. Khan, M. Sultana, M. R. Al-Mamun, M. R. Hasan. (2016).WPPO (waste plastic pyrolysis oil) was described in detail and compared to normal diesel by authors. A self-designed stainless-steel laboratory reactor was used to pyrolyze high density polyethylene (HDPE) to yield usable fuel products. A two- to three-hour pyrolysis of HDPE at 330–490°C yielded solid residue, liquid fuel oil, volatile hydrocarbons. One notable feature of this fuel was its higher calorific value and higher kinematic viscosity (at 40°C) than normal petroleum diesel fuel. Other notable attributes were its density of 0.75gm/cc, sulphur content of 0.25 (weight percent), carbon residue of 0.5% (weight percent).

Shafferina Dayana AnuarSharuddin, Faisal Abnisa, Wan MohdAshri Wan Daud, Mohamed KheireddineAroua. (2016). Wide range of uses for plastics has led to a growth in worldwide plastic manufacturing throughout years. Buildup of plastic garbage in landfills has taken up a lot of space, which has exacerbated the environmental crisis. Plastics, which are derived from petroleum, have seen their use as a nonrenewable fossil fuel decline due to an increase in global demand. Recycling and energy recovery methods are two options for dealing with plastic trash.

Recyclability was hampered by high labour costs, water pollution that lowered process sustainability, despite method's advantages. Scientists are now focusing on energy recovery approach to make up for excessive energy use. P lastic waste converting to energy was established via intensive study and technological development.

This is because plastic manufacture relied heavily on petroleum, and so pyrolysis process could be used to recover plastics to liquid oils with calorific values equivalent to commercial fuels. P yrolysis process for each kind of plastic and primary process factors that impacted result, such as oil, gaseous, and char, were discussed in this study. Temperature, reactor type, residence time, pressure, catalysts, fluidizing gas type, and flow rate were among most important factors examined in this work. In addition, this research presented a variety of ways to increase amount of liquid oil produced from each plastic.

III. DESIGN AND CALCULATION

• Design calculation for Pyrolysis reactor

Material used for Pyrolysis reactor = Mild steel
Inner diameter of Pyrolysis reactor (d) = 185 mm
Height of Pyrolysis reactor (h) = 500 mm
Volume of Pyrolysis reactor = $\pi \times r^2 \times h$ in mm^3
$v= \pi \times 92.5^2 \times 500$
v= 13440126.07 mm^3 = 13440 m^3
Internal design pressure P= 2 bar
Maximum Principal Stress theory: -
A failure occurs when highest primary stress surpasses yield point stress, according to this hypothesis. These are maximum values for radial and circumferential stresses:

• Design of condenser

Material used for condenser – mild steel
Diameter of condenser – 45 mm
Inner diameter – 25 mm
Thickness of condenser – 2 mm
Height of condenser – 510 mm
Volume of condenser – $\pi \times r^2 \times h$ in mm^3
$v= \pi \times 12.5^2 \times 510$
v= 250345.66 mm^3 = 250.3 m^3

• Dimensions for condensing pipe

Outer Dia. of pipe – 10 mm
Inner Dia. of pipe – 9 mm
Material for pipe – mild steel

• Design of Stand

Height of stand = 150 mm
Support tube diameter = 10 mm
Frame Dimention = L * B = 650 * 300 mm
By using mild steel rod
σ = F
A [From D.D.H.B. Equation 7.2]
247= F /78.539
F= 19399 N/mm^2
$A= \pi/4 \times d^2$
$\pi/4 \times 10^2$

A= 78.539mm^2
Hence design is required with stand force safe = 16.5×9.81
= 161.805 N
Design of collecting jar
Diameter of collecting jar- 150 mm
Material of collecting jar- Plastic
Thickness of collecting jar- 2 mm
Height of collecting jar- 95 mm
Volume of collecting jar = $\pi \times r^2 \times h$ in mm^3
= π×752 ×95
= 1678788.5 mm^3

IV. METHODOLOGY

Pyrolysis process is carried out in a closed container in lack of oxygen to avoid combustion procedure, the plastic is heated at high temperatures (up to 550°C). This causes the long carbon chains (>C80) to crack down to smaller carbon chains (6C-24C) as oils. This superheated oil vaporizes, and this vaporized oil containing carbon particles and other impurities are removed by centrifugal filtration. The filtered vapors are condensed at different phases to get the purified form of various oils.

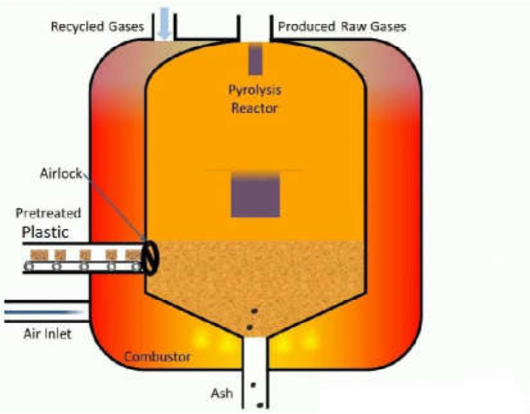

Fig.1 Pyrolysis Process

Initially the raw material (sorted plastic waste) is shredded to small paces and passed through spiral conveyer at 200 c to remove the moisture content, as it creates unwanted pressure and impurity in the pyroly5lS Chamber. The output from the shredder is again shorted in automated shorting machine to its possible pure form.Here the temperature is achieved at the spiral conveyer by induction heating as it is efficient and thoroughly heats the conveyor. Also the resorting is precisely done by image processing and blowing out the other type by identifying the default.

The continues feeder mechanism plays an important role in the whole contraption as it maintainsa continuous feed without letting in air to maintain the process in the absence of air. It initially contains a spiral conveyor which pumps in feed by squeezing it in, and at the end it contains a preheater which makes the feed still compressed by removing the air present, finally a nozzle helping to maintain the feed pressure. This whole mechanism works synchronously, this is placed at the top of the combustion chamber providing a pure feed. The feed mechanism i5 operated such that it provides material only when there is *a* requirement in the chamber as not to overload the pyrolysis chamber. This enables a good yield at greater efficiency.

The pyrolysis chamber is a cylindrical container (30 liters capacity), this shape is chosen as to provide a uniform heating. The chamber contains a feed mechanism, Safety valve, temperature sensor, oil vapor outlet and residue outlet at base, the whole chamber is enclosed in a furnace. The furnace is initially powered by LPG and a blower, the LPG is controlled by an actuator as per inner temperature. Then when the pyrolysis is initialized the end gas i.e. methane is pumped into the furnace and the LPG supply is reduced. The emissions are taken care by a catalyst and a safe exhaust is let out. Hence here we reduce the use of external source of energy.

The crude oil distillation is the final phase of the whole process,where the various oils are separated to its purest forms. The already produced oil vapours are used for the distillation process so as to increase the efficiency of the yield. Initially the oil vapour contains impurities like coal dust,which is removed by centrifugal filtration and the dust is removed. Then it goes in a fractional distillation column where it gets distilled at different temperatures,again an external reflex is done to precise the purity of end product.The extracted vapours are condensed and stored in storage tanks via accumulators to maintain the pressure.Then at last the methane gas which is difficult to store and is a green house gas is pumped into the furnace

For the condensation of the vapours a cooling tower is used as they are efficient and can produce the required temperature. The flow of cooled water by the tower is controlled by the computer ensuring that the desired temperature is achieved.

Here to begin the idea into reality,the contraption is built in small scale platform where the prototype capacity is 30 liters. The machine is estimated to convert 1ton of plastic in 6 hours. And 1 ton of plastic into 50 liters of oil, and rest to cool and gas.

Continuous Feed Mechanism

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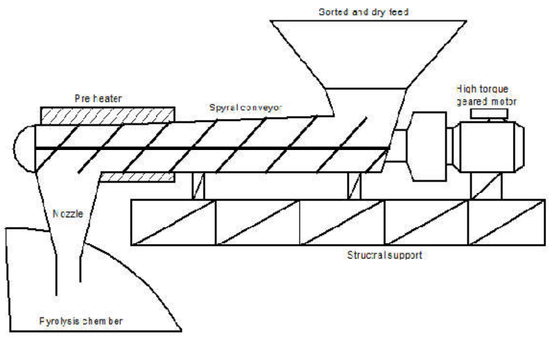

Fig.2 Continuous Feed Mechanism

Pyrolysis Chamber

The pyrolysis chamber is a cylindrical container (30 liters capacity), this shape is chosen as to provide a uniform heating. The chamber contains a feed mechanism, safety valve, temperature sensor, oil vapor outlet and residue outlet at base, the whole chamber is enclosed in a furnace. The furnace is initially powered by LPG and a blower, the LPG is controlled by an actuator as per inner temperature. Then when the pyrolysis is initialized the end gas i.e. methane is pumped into the furnace and the LPG supply is reduced. The emissions are taken care by a catalyst and a safe exhaust is let out. Hence here we reduce the use of external source of energy.

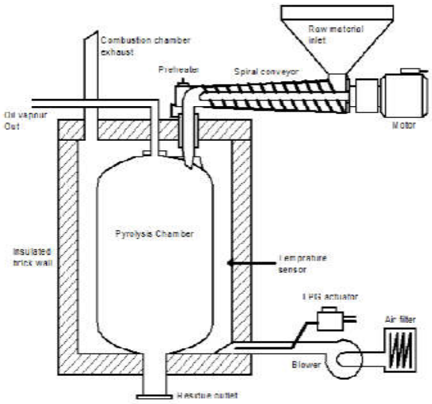

Fig.3 Pyrolysis Chamber Assembly

V. FABRICATION OF DIFFERENT PARTS OF EQUIPMENT

A metal structure is fabricated by cutting, bending, assemblating metal components. Machinery, components, structures are made from a variety of raw materials in this process. typically, a fabrication business bids on a work and constructs product after it has been accepted. Welding, cutting, shaping, and machining are just a few of the high-value operations used in large fabrication facilities.Drawings with accurate measurements & specifications are often first step in process of metal manufacturing. Contractors, OEMs, and VARs hire fabrication shops. Structural frames for buildings and heavy machinery, staircases, and handrails are among most common types of projects.

Machining Operation: -

1. Cutting

2. Arc Welding

3. Drilling

4. Gas Welding

5. Painting

Cutting

Cutting is act of separating or opening a physical item into two or more parts by using an intensively focused force.

Knives and saws are typical cutting tools, as are scalpels, microtomes in medicine and research. As long as hardness of cutting object exceeds that of thing being cut, any suitably sharp object may be used to cut. When utilised with sufficient power, when it comes to cutting, even liquids may be employed (see water jet cutter). Cutting has always been at core of manufacturing process. It is possible to categorise techniques used to process metals by physical phenomena they use. Inaccuracy, expense and impact on material may all be attributed to a particular process. Laser cutting, for example, is less suitable for materials with high reflectivity, such as aluminum because heat may degrade quality of heat-treated alloys.

Arc welding

To weld two pieces of metal together, an arc welder uses electricity to heat metal to melting point, and molten metals cool to form a strong bond. A welding power source is used to produce an electric arc between a metal stick ("filament") and base material to melt metals at contact point. Both direct (DC) and alternating (AC) current may be used, and electrodes can either be consumable or not.

Shielding gas, mist, or slag are often used to keep welding area safe. Manual, semi-automatic, or completely automated arc welding procedures are all possible. Arc welding, first used in shipbuilding in late 1800s, rose to commercial prominence during World War -II

Drilling

Drilling creates circle cross-sectional hole in solid materials by using a drill bit. Typically, a drill bit is multi-point rotary cutting device. The bit is pressed against the workpiece and rotated at rates of hundreds and thousands of rpms. Chips (swarf) are chopped away from hole as it is drilled as a result of this. Although bit is often turned during rock drilling, a circular cutting motion is seldom used to create hole. A drill bit is then hammered into hole with a series of rapid, brief motions. Using a top-hammer drill or a bottom-hammer drill, hammering motion is accomplished in either location (down-the-hole drill, DTH). Drifter drills are used for horizontal drilling.

Gas Welding

Metals may be weld or cut with aid of fuel gases with oxygen when they are used in oxy-fuel welding and oxy-fuel cutting operations. Oxygen-acetylene welding was invented in 1903 by two French engineers, Edmond Fouche and Charles Picard. It is possible to enhance flame temperature in a room by using pure oxygen instead of air, which allows for localised melting of workpiece material (such as steel). An oxyhydrogen and acetylene/oxygen flame burns at 3,073 K (2,800 °C; 5,072 °F), a propane/oxygen flame burns at 2,526 K (2,253 °C; 4,087°F), and a propane/air flame burns at 2,250 K (1,980 °C; 3,590 °F), while a propane/oxygen flame burns at 2,526 K (2,253 °C; 4,087°F).

Painting

Painting is the process of applying color, pigment, or another material to solid surface (support base). It is possible to add medium to the foundation using a variety of implements such as brushes as well as similar tools such as knife, sponge, or air brush.

Fabrication of Stand

Stand is used for giving support to the condenser to hold it on the position. This stand is of circular type due to shape of condenser being circular. Three columns are connected to the ring and the load is on two flat plates welded to the ring in the cross shape. As per the design, marking has done on each column. As per the marking, column is cut by cutting machine. Then welding is done between column and ring.

Fig.4 Stand

Assembly of cylinder with condenser and reactor.

Assembly of copper tube with condenser and reactor consist of copper tube of 10mm diameter and thickness of 1mm. One end of copper tube is welded to the closer of the reactor, the other end is inserted in the condenser. Two holes are made on condenser one on the top and one at the bottom side of the condenser. The tube is made into helical shape to put in condenser for condensation purpose.

The opening of the copper tube is at the bottom hole of the condenser through which the condensed oil is collected into the collecting jar.

Fig.5 GI tube attached to reactor closer

Fig.6 GI tube attached to the condenser.

Assembly of all components

After assembling all the parts of equipment final assembly is placed on the ground and is shown in below figure.

Fig.7 Assembly of allcomponents

VI. EXPENDITURE FOR THE PROJECT

The details of expenses incurred in developing the pyrolysis reactor as shown in table

Table 1 Bill of Material

Name of components	Material used	No. of Components	Cost of each components	Total cost (Rupees)
Reactor	Aluminium	1	1000	1000
Condenser	Stainless Steel	1	480	480
Copper Tube	Copper	1	800	800
Condenser Stand	Mild steel	1	500	500
Pressure Gauge	-	1	500	500
Fabrication Charges	-	-	-	1700
Gas filling charge	-	-	-	440
Painting	-	-	-	200
Transportation Cost	-	-	-	520
Miscellaneous Cost	-	-	-	300
Total	-	-	-	5540/-

VII. RESULTS

By melting 1 Kg of waste plastic in the pyrolysis reactor 500ml of plastic fuel is obtained. When plastic is melted in an open, it creates 3 kilogrammes of CO2, while when it is converted to fuel and melted, CO2 emissions are reduced by 80%, making it an ecologically benign process.

Table 2 : - Comparison between obtained pyrolysis oil and diesel

Parameter	Unit	Pyrolysis oil	Diesel
Flash point	^{0}C	42	50
Fire Point	^{0}C	46	56
viscosity	cSt	5.56	3.80
density	Kg/m^3	780	850

VIII. CONCLUSION

Plastic alternatives are quite tough to come by. Plastic's use and waste are both rising on a daily basis. Waste plastics are being used, a manufacturing plan is being drawn up, its viability has been examined as part of this project's investigation. Solid waste management will likely look for new methods to collect waste plastic as usage of material grows.

This initiative has potential to open up a wide range of possibilities in city. Waste plastic can be controlled, new ideas developed, and source of fuel for nation discovered via this method.

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