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Design And Fabrication Of Pyrolytic Conversion System

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Abstract: Heating plays a vital role in science, engineering, mining, and space, where heating can be achieved via electrical, induction, infrared, or microwave radiation. For fast switching and continuous applications, hotplate or Peltier elements can be employed. However, due to bulkiness, they are ineffective for portable applications or operation at remote locations. Miniaturization of heaters reduces power consumption and bulkiness, enhances the thermal response, and integrates with several sensors or microfluidic chips.

The microheater has a thickness of ~ 100 nm to ~ 100 μm and offers a temperature range up to 1900°C with precise control. In recent years, due to the escalating demand for flexible electronics, thin-film microheaters have emerged as an imperative research area. This review provides an overview of recent advancements in microheater as well as analyses different microheater designs, materials, fabrication, and temperature control.

I. INTRODUCTION

The process is really simple; it is similar to how alcohol is made. If you heatplastic waste in non-oxygen environment, it will melt, but will not burn. Afterit has melted, it will start to boil and evaporate, you just need to put those vapors through a cooling pipe and when cooled the vapors will condense to aliquid and some of the vapors with shorter hydrocarbon lengths will remain asa gas. The exit of the cooling pipe is then going through a bubbler containingwater to capture the last liquid forms of fuel and leave only gas that is then burned. If the cooling of the cooling tube is sufficient, there will be no fuel inthe bubbler, but if not, the water will capture all the remaining fuel that will float above the water and can be poured off the water. On the bottom of the cooling tube is a steel reservoir that collects all the liquid and it has a release valve on the bottom so that the liquid fuel can be poured out.

This device works on electricity (3 phase), it has six nichrome coils as heating elements and consumes a total of 6kW (1kW each coil). The coils are turned on and offby three solid state relays, one for each phase, the relays are controlled by a digital thermostat with a temperature sensor just a bit below the lid, so that thevapor temperature can be monitored. You need to heat the plastic slowly to about 350 degrees and just wait till it does the magic. Our device has a capacity of 50 liters and can hold about 30 kg of shredded plastic. The process takes about 4 hours, but it can be shortened considerably by tweaking the design a bit. As said, this makes a liquid fuel that can be used as multifuel, that means it can be used on diesel engines and also on gasoline engines, but we still need to test it will work on gasoline. It works for diesel engines just fine, that has already been tested.

There is a difference in what plastic you use, if you use polyethylene (plastic cans, plastic foil, and all kind of flexible non break plastics) you will get out liquid fuel that will solidify as it cools into paraffin, it is still good for diesel engines as long as you use a heated fuel tank, because it needs to be heated just about at 30 degrees Celsius to be liquid and transparent. If you don't want that, you can put the paraffin through the device for one more time and you will chop those hydrocarbons even smaller and half of the paraffin will turn to liquid fuel and other half will remain a paraffin, but much denser and will melt at higher temperatures, this is the stuff you can make candles out of and it does not smell at all when burned, maybe a bit like candles. But if you use polypropylene (computer monitor cases, printer cases, other plastics that break easily), you get out only liquid fuel, no paraffin at all. All you need is just filter the fuel out of solids and you good to go and put it in your gas tank. We have made the analysis and it is almost the perfect diesel fraction. It has no acids or alkaline in it, like fuel from tires does.

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The unit in the pictures can convert about 60 kg of plastic into 60 liters of fuel in one day. Other methods of heating the reactor can be employed, electricity is just easier to work with and control. Some Japanese companies manufacture such devices, but their prices for this size unit is more than 100 000$, our home- made device cost us 900$ max. We use aluminum oxide bricks to insulate the heat, they are light as foam and can be easily cut in any shape, but any kind of insulator can be used. The bricks make the highest costs for this device. It can also be made using liquid fuel burners to heat the reactor, this will enable to make the device self-sustainable by usingabout 10-15% of the produced fuel along with the produced gas.

II. LITERATURE SURVEY

All around the globe companies and individuals are starting to produce fuel from wasteplastic. As only 8% of waste plastic is recycled in the U.S., 15% in Western Europe, andmuch less in developing countries, this reuse of plastic could potentially keep enormousamounts of plastic out of landfills and out of the oceans. Over 500 billion pounds of newplastic is manufactured each year and roughly 33% of that is single use and thrown away.As so little plastic is recycled, we need to reframe plastic waste as an underused resourcevs landfill destined. If all plastic waste made it into the landfill, it would surely be minedin the future, but currently all plastic waste does not make it into our landfills. The UnitedNations estimates plastic accounts for four-fifths of the accumulated garbage in the world's oceans. We need to stop polluting our oceans with plastic before it is too late, and start collecting all plastics suitable for this new fairly simple technology. The technology is not overly complicated, plastics are shredded and then heated in an oxygen-free chamber (known as pyrolysis) to about 400 degrees Celsius. As the plasticsboil, gas is separated out and often reused to fuel the machine itself. Thefuel is then distilled and filtered. Because the entire process takes place inside a vacuumand the plastic is melted - not burned, minimal to no resultant toxins are released into the air, For this technology, the type of plastic you convert to fuel is important. If you burn purehydrocarbons, such as polyethylene (PE) and polypropylene (PP), you will produce a fuelthat burns fairly clean. But burn PVC, and large amounts of chlorinewill corrode the reactor and pollute the environment. Burning PETE releases oxygen into the oxygen deprived chamber thereby slowing the processing, and PETE recycles efficiently at recycling centers, so it is best to recycle PETE traditionally. HDPE (jugs) and LDPE (bags and films) are basically polyethylene so usable as fuel as well, just slightly more polluting as a thicker heavier fuel is created. But additional processing canturn even HDPE into a clean diesel.

III.METHODOLOGY

The process is really simple; it is similar to how alcohol is made. If you heat plastic wastein non-oxygen environment, it will melt, but will not burn. After it has melted, it will startto boil and evaporate, you just need to put those vapors through a cooling pipe and when cooled the vapors will condense to a liquid and some of the vapors with shorter hydrocarbonlengthswillremain as agas. Theexit ofthecooling pipe is thengoingthrougha bubbler containing water to capture the last liquid forms of fuel and leave onlygas that isthen burned. If the cooling of the cooling tube is sufficient, there will be no fuel in the bubbler, but if not, the water will capture all the remaining fuel that will floatabove the water and can be poured off the water. On the bottom of the cooling tube is asteel reservoirthat collects all the liquid and it has a release valve on the bottom so that the liquid fuel canbe poured out. This device works on electricity (1 phase), it has nichromecoils as heatingelements and consumes a total of 1 kW. The coils are turned on and off by three solid staterelays, one for each phase, the relays are controlled by a digital thermostat with atemperature sensor just a bit below the lid, so that the vapor temperature can be monitored.You need to heat the plastic slowly to about 310 degreesand just wait till it does the magic.The device has a capacity of 5 liters and can hold about3 kg of shredded plastic. The process takes about 2 hours, but it can be shortened considerably by tweaking the design abit. As I said, this makes a liquid fuel that can be used as multifuel, that means it can be used on diesel engines and also on gasoline engines, but we still need to test it will work on gasoline. It works for diesel engines justfine, that has already been tested. There is a difference in what plastic you use, if you usepolyethylene (plastic cans, plastic foil, and all kind of flexible non break plastics) you will get out liquid fuel that will solidify as it cools into paraffin, it is still good for dieselengines as long as you use a heated fuel tank, because it needs to be heated just about at30 degrees Celsius to be liquid and transparent.If you don't want that, you can put the paraffin through the device for one more time and you will chop those hydrocarbons even smaller and half of the paraffin will turn to liquid fuel and other half will remain aparaffin, but much denser and will melt at higher temperatures, this is the stuff you can make candles out of and it does not smell at all when burned, maybe a bit like candles. But if you use polypropylene (computer monitor cases, printer cases, otherplastics that break easily), you get out only liquid fuel, no paraffin at all. All you need isjust filter the fuel out of solids and you good to go and put it in your gas tank. We have made the analysis and it is almost the perfect diesel fraction. It has no acids or alkaline in it, like fuel from tires does. Other methods of heating the reactor can be employed, electricity is just easier to work with and control. Some Japanese companies manufacturesuch devices, but their prices for this size unit is more than 100 000$, our home-made device cost us 900$ max. We use aluminum oxide bricks to insulate the heat,they are light as foam and can be easily cut in any shape,

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but any kind of insulator can be used. The bricks make the highest costs for this device. It can also be made using liquid fuel burners to heat the reactor, this will enable to make the device self-sustainable by usingabout 10-15% of the produced fuel along with the produced gas. A small farm canuse a device this size and make fuel for itself by converting plastic waste to fuel, farms have verymuch plastic waste and it is a big problem, at least in my country. Our next goal is to makethe same thing possible using biomass, every farm could then use old leaves, wet grass, saw dust and all kind of biomass and gasify it into tar like substance that can then be put through the pyrolysis device and turned into biodiesel. The followingfigure shows actual model of converting fuel from waste plastic.

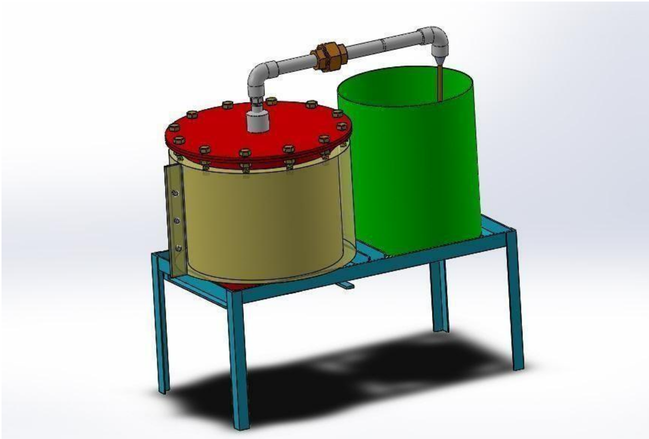

Fig. 3D modelling of the system

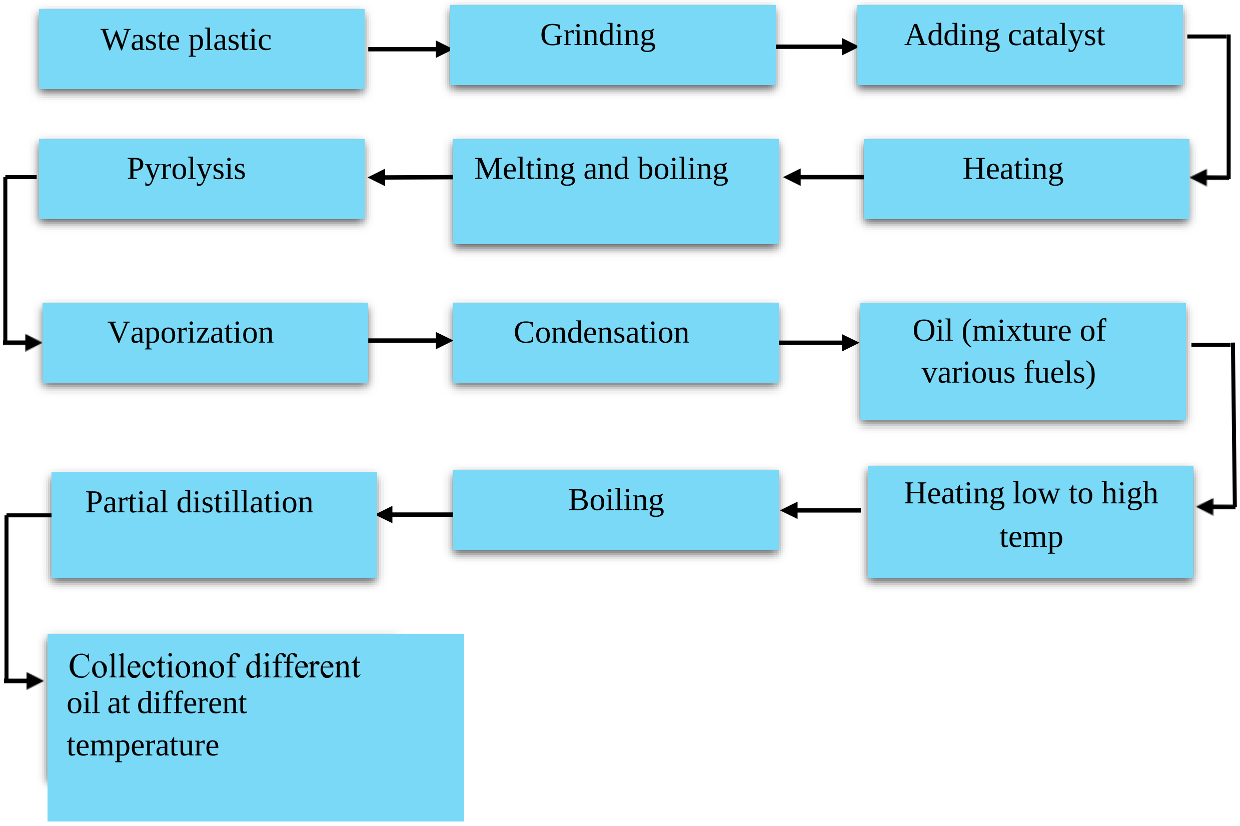

Fig. Block diagram of system

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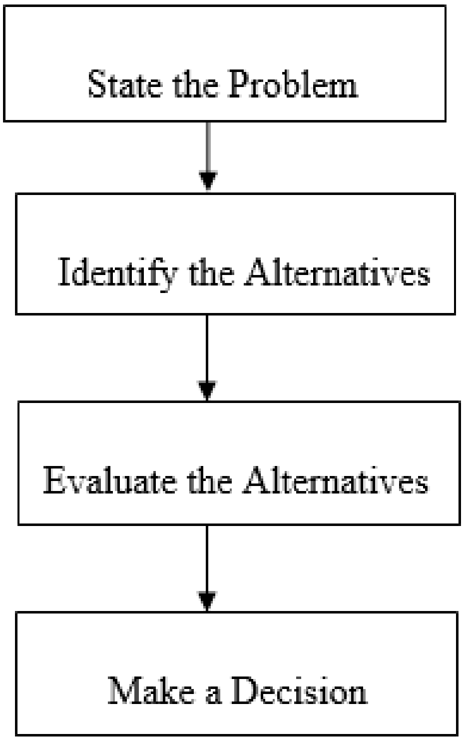
Copper Heat Exchanger:

Copper Heat Exchangers tubes normally supplied in round and straight lengthannealed and half hard temper. The copper tubes shaped by are metal industries have the stiff tolerances but also have the most dependable dimensions throughout tube length. The tube surface is clean both inside and outside with no caustic stains. Copper Heat Exchangers are used condensation of vapours and cooling to liquids. Condensers are made by fusing number of round coils in a vessel. Coils are made in different diameters tubes of different bores. Copper tubes artificial to special requirements as to dimensional coppertubes produced are metal industries suitable to transfer heat in a wide variety operating condition and to refuse to accept decay for longest period of time possible under the harshest operating circumstances. Due to simple construction, they are low price and easy to clean on the shell side. Their thermal efficiency approximates that of a true counter current type exchanger.

IV. DECISION MAKING PROCESS

No methodology is available for material and method selection except decision makingin multi attribute environment. Material selection is vital and crucial activity in any industry nowadays. This substantially reduces the risk of wrong material or method selection.



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SOLID MODELING:

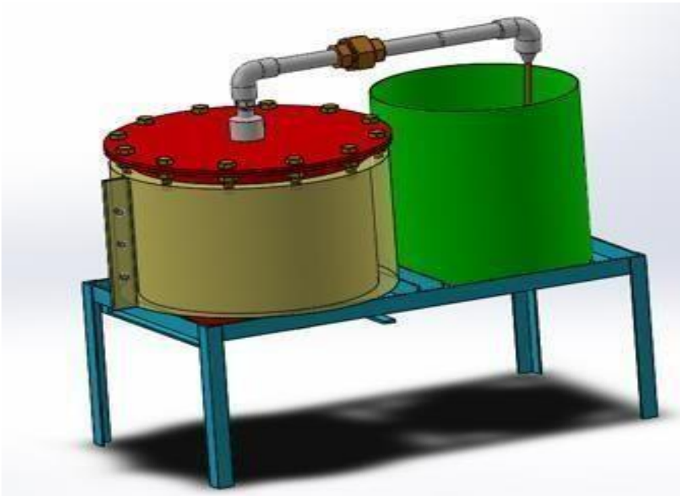

Fig. Isometric front view

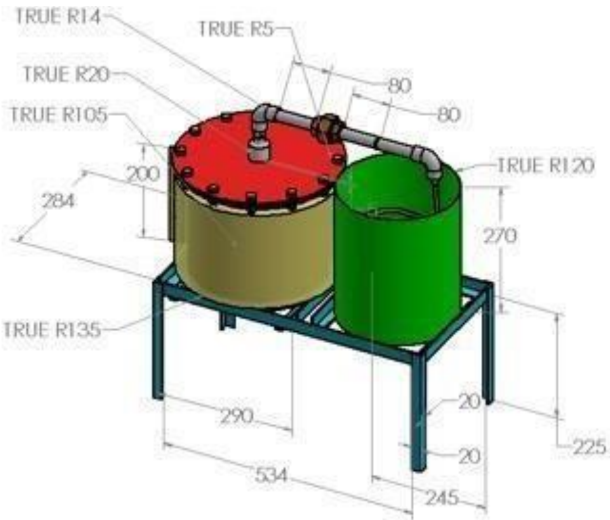

Fig. Cut section view

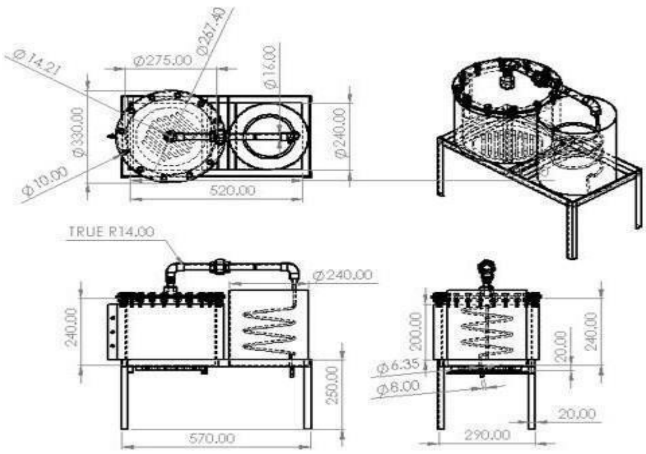

Fig. drafting

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V. DESIGN & CALCULATION

Mild Steel C-45:

- Easily available in all sections.
- Welding ability
- Machinability
- Cutting ability
- Cheapest in all other metals.

Assumption: FOS – 2

$\sigma_t = \sigma_b$ = 540/FOS = 270 N/mm^2σ_s = 0.5 $\sigma_t$$\sigma_s$ = 0.5 x 270

σ_s = 135 N/mm^2

Design of heating chamber:

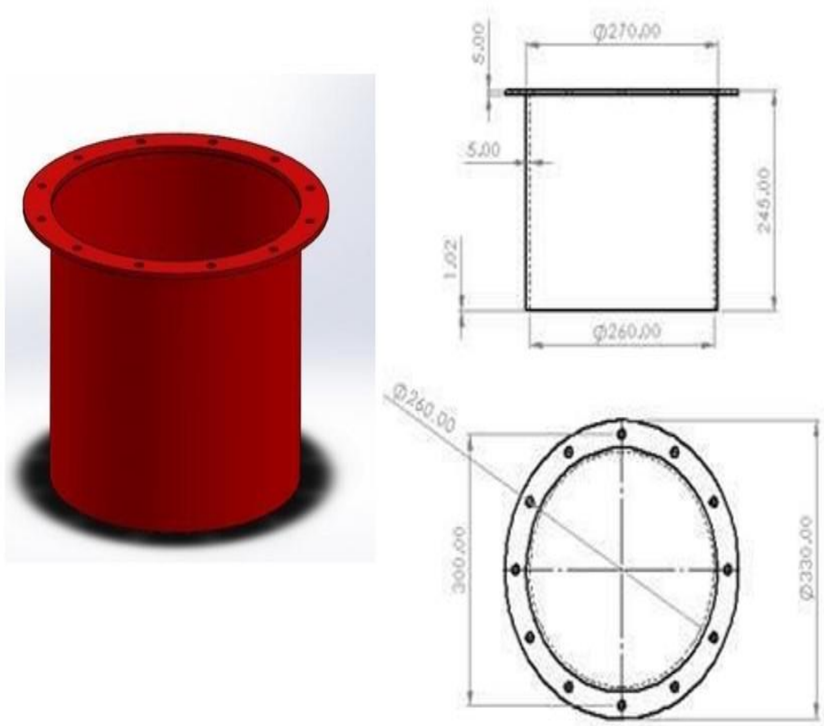

Fig. 6.1 Heating chamber

P: design pressure, MPa

C: corrosion allowance, mm

D_1: inside diameter of the vessel, mm D_2: outside diameter ofthe vessel, mmR_1: inside radius of the vessel, mm R_2: outside radius of the vessel, mm S: maximum allowable stress, N/mm^2 E: Joint efficiency, %

T: required the thickness, mm

The pipe used for heating chamber is 150 mm inner diameter and 156 mmouter diameter

So, we will check for its failure

Material for shell selected = C45 = 0.45 % carbon.Design pressure p_i = 4 bar = 0.4 N/mm^2

Material C45 – 0.45 % carbon FOS for pressure vessel, take = 4Now,

$\sigma_t = \sigma_b$ = 540/ FOS = 135 N/mm^2.

Joint efficiency of fillet welding ήT: 80% Thickness of shell obtained from formulas:

Based on theory of Thin cylinders with modificationst = ( ) ÷ (2 ή) t = (0.4 260) ÷ (2 135 0.8)

t = (104) ÷ (216)

t = 0.481 mm

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VI. CONCLUSION & FUTURE SCOPE

Conclusion:

Based on the reviewed paper for the performance and emissions of waste plastic pyrolysis oil, it is concluded that the waste plastic. Pyrolysis oil represents a good alternative fuel for diesel and therefore must be taken into consideration in the future for transport purpose, boiler, power generation and combustion chamber. The Pyrolysis process studied is efficient, clean and very effective means of removing the debris that we have left behind over the last several decades. By converting plastic to fuel, we solve two issues, one of the large plastic seas and other of the fuel shortage. This dual benefit, though will exist as long as plastic waste and plastic last, but will surely provide a strong platform for us to build on sustainable, clean green future. By taking into account the financial benefits of such a project, it would be great boon to our economy.

Future Scope:

- The ministry of science and technology has stated that the Indian Institute of Petroleum is exploring the economic viability of conversion of waste plastic into petroleum product technology in order to refine the technology, so that it may be available to the public for future use.
- The statement issued by the press information bureau states that the Council for Scientific and Industrial Research (CSIR) have developed a technology for conversion of waste plastic into petroleum product after nearly a decade long experimental research.

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