Implementing Sensors in the conversion of plastic into fuel

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Abstract - *In the present scenario, waste management has become a serious issue due to rapid urbanization, economical activities and increase in human population. Insufficient collection and inappropriate disposal of solid wastes represents a source of water, land and air pollution, and pose risks to human health and the environment. In the municipal Waste, plastics occupy a major part .The usage of plastic is increased rapidly in our day to day life. So it is necessary to recycle the plastics in an effective manner. So we adopt the process called pyrolysis. Pyrolysis of waste is the state-of-the art process providing destructive decomposition of waste materials in the absence of oxygen. The proposed paper deals with solving the problem of plastics by pyrolysis with the help of sensor technology. It is alternative to "conventional" waste disposal.*

Key Words: conventional, pyrolysis, environment, plastic, urbanization, disposal, destructive.

1. INTRODUCTION

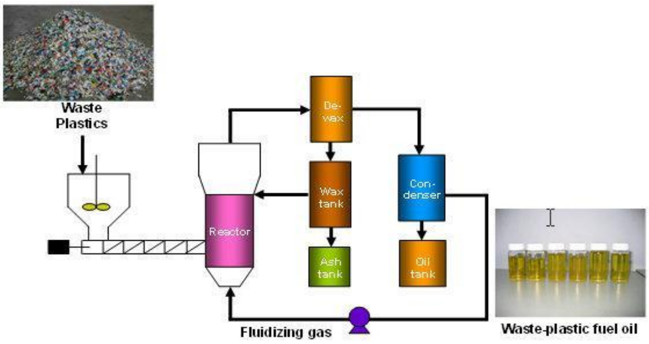
We find considerable growth in use of plastic everywhere due to various beneficial properties of plastics, such as: (i)Extreme versatility and ability to be tailored to meet very specific technical needs, (ii)Lighter weight than competing materials, reducing fuel consumption during transportation, (iii)Extreme durability, (iv)Resistance to chemicals, water and impact, (v)Better safety and hygiene properties for food packaging,(vi) Excellent thermal and electrical insulation properties (vii) Relatively inexpensive to produce.

However, plastics waste creates lot of nuisances and degrade environment in a big way. Recycling of plastics is desirable because it avoids their accumulation in landfills. While plastics constitute only about 8 percent by weight or 20 percent by volume of municipal solid waste, their low density and slowness to decompose makes them a visible pollutant of public concern. It is evident that the success of recycling is limited by the development of successful strategies for collection and separation. Recycling of scrap plastics by manufacturers has been highly successful and has proven economical, but recovering discarded plastics from consumers is more difficult.

Recycling and re-utilization of waste plastics have several advantages. Recycling and re-utilization of waste plastics lead to a reduction of the use of virgin materials and of the use of energy, thus also a reduction of carbon dioxide emissions. Economically, in some cases, plastics recycling may be profitable. However, a number of factors can complicate the practice of plastics recycling, such as the collection of the plastics waste, separation of different types of plastics, cleaning of the waste and possible pollution of the plastics. A further complicating factor is the low-value nature of most of the products that can be manufactured from recycled plastics. Reusing plastic is preferable to recycling as it uses less energy and fewer resources.

1.1 Pyrolysis process

Pyrolysis is the heating of an organic material, such as biomass in the absence of oxygen. Because no oxygen is present the material does not combust but the chemical compounds (i.e. cellulose, hemicelluloses and lignin) that make up that material thermally decompose into combustible gases and charcoal. Most of these combustible gases can be condensed into combustible liquid, called pyrolysis oil (bio-oil), though there are some permanent gases (CO_2, CO, H_2, light hydrocarbons). Thus pyrolysis of biomass produces three products: one liquid, bio-oil, one solid, bio-char and one gaseous (syngas). The proportion of these products depends on several factors including the composition of the feedstock and process parameters. However, all things being equal, the yield of bio-oil is optimized when the pyrolysis temperature is around 500 degree C and the heating rate is high (i.e. 1000 degree C/s) i.e. *Fast pyrolysis* conditions. Under these conditions bio-oil yields of 60-70 wt% of can be achieved from a typical biomass feedstock, with 15-25 wt% yields of bio-char. The remaining 10-15 wt% is syngas. Processes that use slower heating rates are called *slow pyrolysis* and bio-char is usually the major product of such processes. The pyrolysis process can be self-sustained, as combustion of the syngas and a portion of bio-oil or bio-char can provide all the necessary energy to drive the reaction.



Process of Pyrolysis of Waste Plastics Technology

2. PROPOSED METHOD USING SENSORS

2.1 COMPONENTS NEEDED

- Waste Plastic
- Temperature Sensor
- Pressure Sensor
- Humidity Sensor
- GI pipes
- Coiled Condenser
- Steel Reactor
- Condensate Collector

2.1.1 Waste plastic

Waste Plastic Pyrolysis can convert petroleum based waste streams such as plastics into quality fuels, carbons. Given below is the list of suitable plastic raw materials for pyrolysis:

- Mixed plastic (HDPE, LDPE, PE, PP, Nylon, Teflon, PS, ABS, FRP etc.)
- Mixed waste plastic from waste paper mill
- Multi Layered Plastic

2.1.2 Thermocouple or Temperature sensor

A Thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created. The voltage can then be interpreted using thermocouple to calculate the temperature.

Thermocouples are typically selected because of their low cost, high temperature limits, wide temperature ranges, and durable nature.500◦C was established as the optimal temperature for plastic waste pyrolysis, in terms of both conversion and quality of the pyrolysis liquids. Reaction time in the range 15–30 min is enough to achieve total conversion of the waste. As pyrolysis temperature is raised, gas yields significantly increase to the detriment of liquid yields.460 ◦ C is the lower temperature at which total conversion is achieved but the liquids are extremely viscous(semi solid at room temperature) and difficult to handle.

2.1.3 Pressure sensor

A pressure sensor is a device which senses pressure and converts it into an analog electric signal whose magnitude depends upon the pressure applied. Since they convert pressure into an electrical signal, they are also termed as pressure transducers.

Need for Pressure Sensors

Pressure sensors are used to monitor gases and their partial pressures in industrial units so that the large chemical reactions take place in precisely controlled environmental conditions. In oil industry, sensors detail with the depth that the oil rig has reached while exploring. In differential pressure measurement, pressures of two distinct positions are compared. For example, pressure difference calculated by measuring it at different floors of a tall building will give us differential pressure. Differential pressure measurements, typically taken in pound per square inch differential (psid), are applied when high amount of pressure is to be measured. These types of measurements are used for feed pressure monitoring purposes where the pressure with which the fluid is flowing in a medium is monitored, so that homogeneity in the flow can be maintained. Differential pressure measurements find an important application in monitoring filters in various types of purification systems. They take the reference of the normal pressure with which the filters clean the fluid. Whenever the filters face the problem of clogging due to contaminants, these pressure sensors give a reading relative to the normal pressure. This helps in keeping the filter clean and operational.

2.1.4 Humidity sensor

Humidity is the amount of water vapor in the given substance (usually a gas). It is an important parameter in a variety of fields, including room air humidity in patient monitoring and exhibit perseveration in museums, meteorological observations, soil humidity in agriculture, and process control in the industrial applications. Humidity can be measured as the absolute humidity (ratio of water vapor to the volume of substance), relative (compared to the saturated moisture level) or dew point (temperature and pressure at which the observed gas starts to turn into liquid). Most common humidity sensors are based capacitive, resistive, and thermal conductivity measurement techniques.

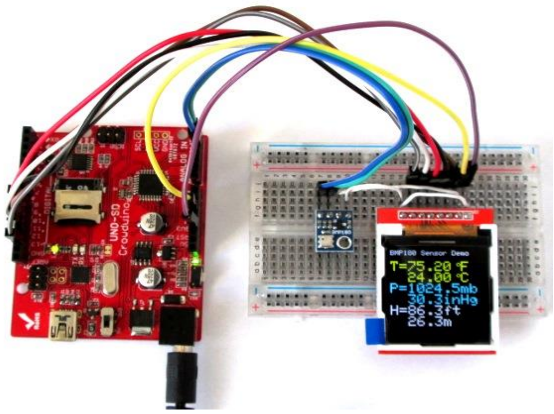


Fig-2: Sample Temperature,Pressure and Humity Sensor

2.1.5 Galvanized Iron Pipes

Galvanized Iron (GI) Pipes are manufactured using mild steel strips of Low Carbon Steel Coils. Galvanization (or galvanizing as it is most commonly called in that industry) is the process of applying a protective zinc coating to steel or iron, to prevent rusting. The most common method is hot-dip galvanizing, in which parts are submerged in a bath of molten zinc.

The GI Pipes are generally used for distribution of treated or raw water in rural or urban areas. These pipes are cheaper, light weight and easy to handle.

2.1.6 Coiled Condenser

Condenser is used for converting the plastic vapours in to the Polyfuel. Coiled condenser is used for this experiment in which copper coil is inserted in to the water bath of carbon steel.

Fig-3: Copper tube coiled condenser

Criteria for choosing copper condenser coil than aluminum:

- Copper is superior in strength to aluminum
- Copper is more reliable than aluminum
- Copper is more durable than aluminum
- Copper is easier to maintain than aluminum
- Copper provides better heat transfer characteristics than aluminum
- Aluminum coils damage easier than copper coils
- Aluminum coils are more difficult to clean than copper coils.

2.1.7 Steel reactor

Steel Reactor is the container user in this process which should sustain the heat and should not allow the oxygen inside the container. If the container allows the oxygen then the plastic inside the container will start to burn.

Fig-4: Steel Reactor in a heating source

2.1.8 Collector

After condensation process the obtained liquid fuel is collected in beaker used as a condensate collector. This collector size or volume depended upon volume of production. Here only little amount of plastic is used so the fuel obtained is also lesser.

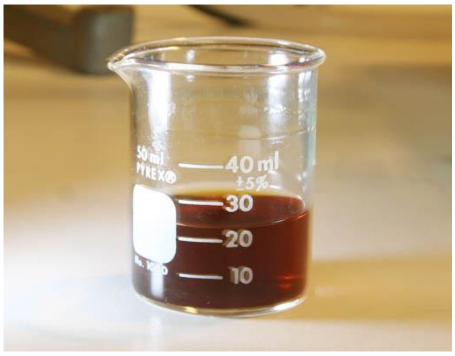


Fig-5: Sample Beaker (Condensate collector)

3. CONVERSION PROCESS

The closed mild steel reactor is used in this process. The size may vary based on the amount of waste plastics. The provision for passing the generated vapors from the reactor to the condenser is made by welding the half inch diameter GI pipe with top cover of the reactor. The provision for to mount the sensor on the top of the reactor should me made so that the temperature, pressure and the humidity can be monitored and maintained. Once the steel reactor is heated, the plastic produces vapor on certain temperature. The escape of vapors from the reactor to the condenser was made by the GI pipe. The vapours then turned into liquid which is here a fuel collected and stored. The process performed here is called condensation.

Condensation process

Condensation is the change of the physical state of matter from gas phase into liquid phase and is the reverse of evaporation. The word most often refers to the water cycle. It can also be defined as the change in the state of water vapour to liquid water when in contact with a liquid or solid surface within the atmosphere.

Fig-6: Fuel and its usage

3.1 Residue

Finally some residue is obtained because of using all types of plastics. The residue is like a tar which can be used in road process. So there is no wastage arises here at the end of the process.

Fig-7: Tar (Residue) like substance

Results:

- Conversion of up to 100% of waste
- No Greenhouse and other harmful gas emission into the atmosphere
- No toxic waste to dispose of
- No dioxins in the off-gas and the solid residue
- Reduced public health risk
- Simultaneous treatment of various types of waste materials
- Reliable energy source, high energy output
- High conversion efficiency
- Carbon credits production
- Low capital and operation costs
- Low energy consumption (as compared to the alternative management scenarios).

4. CONCLUSION

Conversion of waste plastic into liquid fuel can solve the problem of plastic waste recycling and the shortage of liquid fuel in developing countries like India. Thermal degradation of plastic can be done easily with economic means. The yield of the product can be increased by varying the process parameters like temperature, pressure, catalyst amount etc. The fuel produced in this study was found the properties comparable to the regular diesel fuel used in automobiles. So it can be concluded that the "Polyfuel" may be an alternative fuel of the future. The residue produced can be used in road making process, As no waste generated during the process, it can be called as zero discharge process or green process which avoids the pollution

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