



A REVIEW ON PERFORMANCE AND CHARACTERISTICS OF VCR ENGINE USING PYROLYSIS PLASTIC OIL BLEND WITH DIESEL

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ABSTRACT

Plastic waste is an ideal source of energy due to its high heating value and abundance in amount. These plastics could be converted into useful fuels through the pyrolysis process. Then the oil which is produced through the process is made to mix with the diesel or any other easily available fuel source with the ratio comfort to ignite in engine. This mix is utilized in the internal combustion engines to produce power and heat source. The pyrolysis oil produced by using the specifically Low Density Polyethylene. Performance of the engine such as the emission, brake efficiency and fuel efficiency are checked.

1. INTRODCUTION

Vijay et al., As years goes, the population rate keeps increasing in enormous amount. These people are much need in plastics to run up their life. Plastics plays a major role in every human in present day of scenario. Most of the things made easy through this plastics at an end but to look at the other end it makes a major tragedy to the human life and living beings in the world.^[1]

Suriya et al., This plastic is proven to be a non bio-degradable product. This is made of polymers which cant be degraded that easily. These things were been the major threat to the human in recent days. People were facing a term called global warming which is due to the

green house gases. This green house gases comprises of carbon monoxide and other oxides of nitrogen and sulphur. This is mainly emitted through burning the fuel and also plastics. Burning plastics and making them to dump to the land brings a pollution threat to the people.^[6]

And here is the solution to overcome the problem which is faced till. Plastics are made to melt and formed as a useful fuel used in the internal combustion engine and the performance are checked.^[3]

SindhaMydeen et al., Through this method of pyrolysis the plastics are not made to dump over the land and not making them infertile. Also no way of harming the human and other lives through the reduction in burning and pollution respectively.^[1]

2. LITERATURE SURVEY

2.1 PLASTIC

Suriya et al., Plastic is material consisting of any of a wide range of synthetic or semi synthetic organic compounds that are malleable and so can be molded into solid objects. Plasticity is ability of the material to deform it shape to a limit within which it can retain to its original shape respectively. Whereas in the case of moldable polymers the plasticity cannot be attained beyond a level of specific limit.^[6]



Many studies comparing plastic versus paper for shopping bags show that the plastic bags have less net environmental effect than paper bags, requiring less energy to produce, transport and recycle. Recycling of plastics give merely a higher amount of benefit than the paper bags. Most of the trash bags are made of the plastics. And plastics bags are bought for no cost amount from every shops with no taxes compared to paper bags.^[6]

2.2 TYPES OF PLASTICS

SindhyaMydeen et al.,

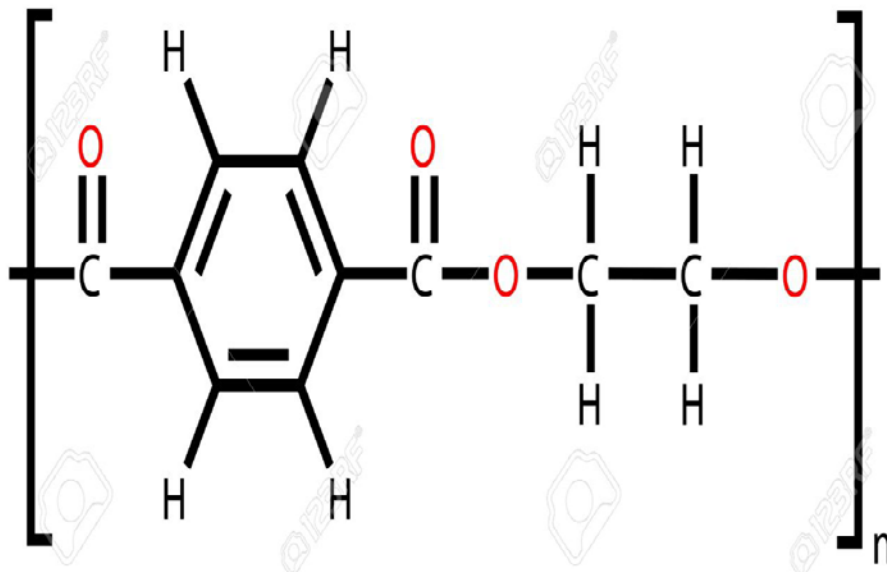
- Polyamides or Nylons
- Polycarbonate
- Polyester
- Polypropylene
- Polystyrene
- Polyurethanes
- Polyactide
- Polyvinyl chloride
- Polyvinylidene chloride

- Acrylonitrile butadiene
- Styrene
- Nylon
- Fiberglass
- Polyethylene
- ❖ High – density polyethylene
- ❖ Low – density polyethylene
- ❖ Polyethylene terephthalate^[2]

2.3.POLYETHYLENETERPHTHALATE

Vijay et al., Polyethylene terephthalate commonly abbreviated PET, PETE or the obsolete PETP or PET – P is the most common thermoplastic polymer resin of the polyester family and is used in fibres for clothing, containers for liquids and foods, thermoforming for manufacturing and in combination with glass fibre fir engineering resins.^[8]

- ❖ Chemical formula $-(C_{10}H_8O_4)_n$
- ❖ Density – 1.38 g/cm^3 (20°C)
- ❖ Melting point - $> 250^\circ\text{C}$
- ❖ Boiling point - $> 350^\circ\text{C}$
- ❖ Elastic limit – 50 – 150%^[2]



Vijay et al., Plastic bottles made from PET are widely used for soft drinks. For containing liquid like beer content in it, the PET has to be added with another layer of polyvinyl alcohol which reduces the permeability of oxygen. The majority of the world's PET production is for synthetic fibres, with bottle production accounting for about 30% of global demand.

Depending on its processing and thermal history, polyethylene terephthalate may exist

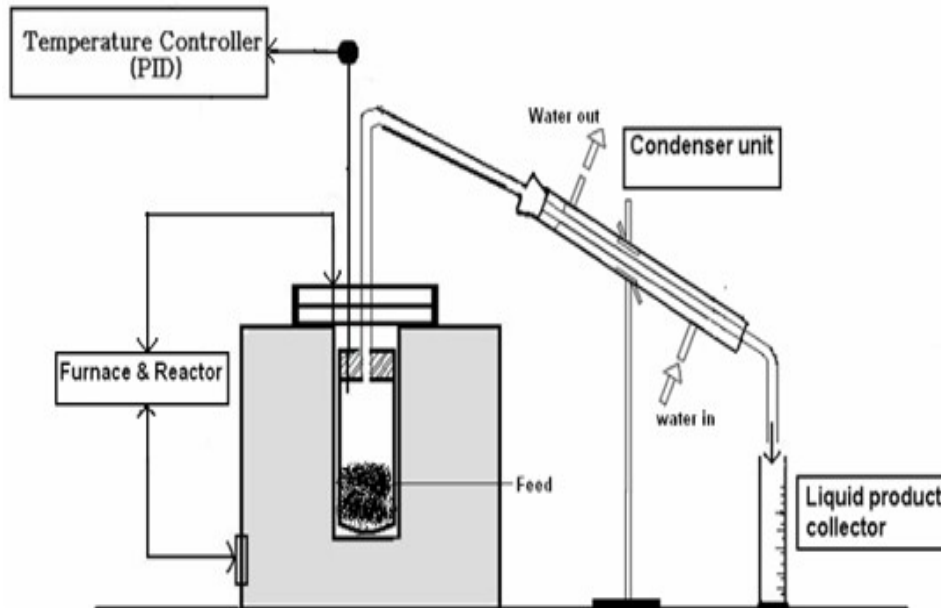
both as as amorphous and as a semi-crystalline polymer. The semi-crystalline material might appear transparent or opaque and white depending on its crystal structure and particle size.^[6]

3. METHODS USED

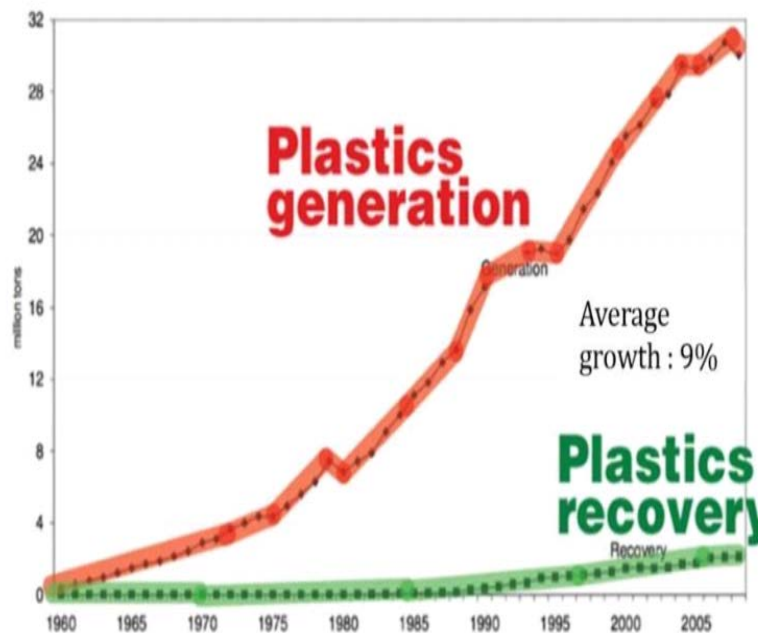
3.1 PYROLYSIS

Suriya et al., Pyro = heat, lysis = breakdown. At inert atmosphere the thermal

decomposition takes place for the plastics. It involves the change in chemical treated. Plastic pyrolysis is a chemical reaction. decomposition and is irreversible.^[5]



This reaction involves molecular breakdown of larger molecules into smaller molecules in presence of heat of about 400 to 500 degree celcius. Pyrolysis is also known as thermal cracking, thermolysis, depolymerization etc.,^[4]



Suriya et al., At any given temperature the molecule is in vibrating stage. This is called molecular vibration. The frequency at which molecules vibrates is directly proportional to the temperature of molecules. During pyrolysis the object's molecules are subjected to very high temperature leading to very high molecular vibrations. At these high molecular vibration, every molecule in the object is stretched and

shaken to such an extent that molecules starts breaking down into smaller molecules. This is called pyrolysis.^[4]

3.2 TYPES OF PYROLYSIS

Sindhmydeen et al.,

These three types of pyrolytic reactions are differentiated by the processing time.

- ❖ Slow pyrolysis

- ❖ Flash pyrolysis
- ❖ Fast pyrolysis^[8]

❖ 3.2.1 SLOW PYROLYSIS

- ❖ **Vijay et al.**, Slow pyrolysis is characterized by lengthy solids and gas residence times, low temperatures and slow biomass heating rates. In this mode, the heating temperatures ranges from 0.1 to 2 degree celcius per second and the prevailing temperatures are nearly 500 degree celcius. The residence time of gas may range from minutes to days. Slow devolatilization takes place during this process and tar and char are taken back as main products. Repolymerization/recombination reactions occur after the primary reactions take place.^[8]

❖ 3.2.2 FLASH PYROLYSIS

- ❖ **Suriya et al.**, Flash pyrolysis occurs at rapid heating rates and moderate temperatures between 400 and 600 degree celcius. However, vapour residence time of this process is less than 2 seconds. Flash pyrolysis produces fewer amounts of gas and tar when compared to slow pyrolysis.^[8]

3.3.3 FAST PYROLYSIS

SindhaMydeen et al., This process is primarily used to produce bio-oil and gas. During the process, biomass is rapidly heated to temperatures of 650 to 1000 degree celcius depending on the desired amount of bio-oil or gas products. Accumulation of char is higher and it has to be removed frequently as it is in larger quantity. As the temperature of the fast pyrolysis is comparatively higher to the above said two types it literally takes a minimum amount of time than the two processes.^[7]

4. CONVERSION PROCESS AND FUEL PROPERTIES

Suriya et al.,

The pyrolysis plant consists of majorly three chamber to complete the process. They are,

- ❖ The induction chamber
- ❖ The condensation chamber
- ❖ The collector chamber^[2]

4.1.1 THE INDUCTION CHAMBER

Vijay et al., Initially the low density poly ethylene plastics are collected and they are

cut into small pieces and filled into the induction chamber. The induction chamber is covered by an insulation material such as the cotton or sponge to avoid the heat transferring from both inner and outer region to the chamber. Here, the plastics are heat treated by the heater coils fitted in the induction chamber. The coils are electrically heated upto a temperature of 800°C.^[2]

Vijay et al., The plastics are tightly packed into this chamber without air gap inside. This chamber consists of a lid with bolts and nuts nearly about 8. The heater gets heated up in the absence of oxygen inside the chamber and the heat treatment process takes place. Hence the plastics are converted into hot gases and let out through an outlet valve to the next chamber. The process of induction chamber to get complete takes about an hour and then the condensation chamber process takes place.^[2]

4.1.2. THE CONDENSATION CHAMBER

Suriya et al., This chamber plays the major role in this method. Here, the conversion of phase process takes place. The hot gases let out from the induction chamber is being collected here and condensed to liquid state. The hot gases are just cooled to the extreme level of low temperature suddenly to change its state of property. Due to the high pressure given by the condenser over the hot gases it gets cooled immediately and changed to liquid respectively.^[6]

4.1.3 THE COLLECTOR CHAMBER

SindhaMydeen et al., The collector chamber is the last chamber of the whole unit. This unit just collects the whole oil converted from plastics to liquid state. The calculation also takes place here. The amount of plastics that were put into the chamber are measured in kilograms and the output liquid is measured in litres. Depending upon the variation in the input and the output from the collection chamber the efficiency of the whole chamber is being calculated.^[6]

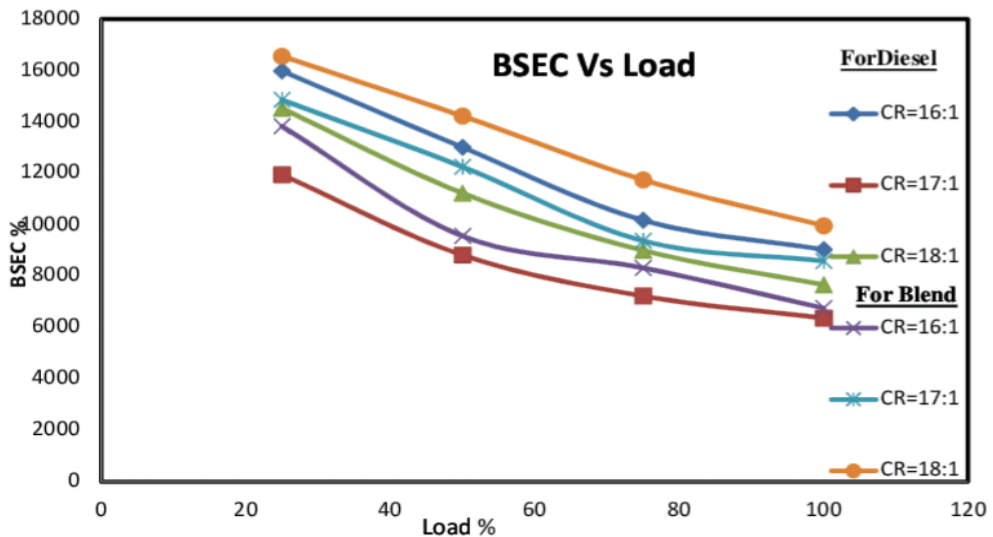
5. PREPARATION OF BLENDS

Suriya et al., The blending of pyrolysis oil with the diesel is done either using automatic stirring mechanical devices or even could be prepared by hand stirring. The ratio plays the major role in blending. The pyrolysis oil is taken as 10% and 20% while the diesel is taken as 90% and 80% to blend.

This stirred prepared blend oil is made to run in the VCR engine. The blends could be of any ratio and any variant that could be reasonable to give better efficiency through its emission and performance. The diesel is chosen as a blend for its cost effectiveness and also its characteristic performance in engines.^[3]

5.1 VARIABLE COMPRESSION RATIO (VCR)

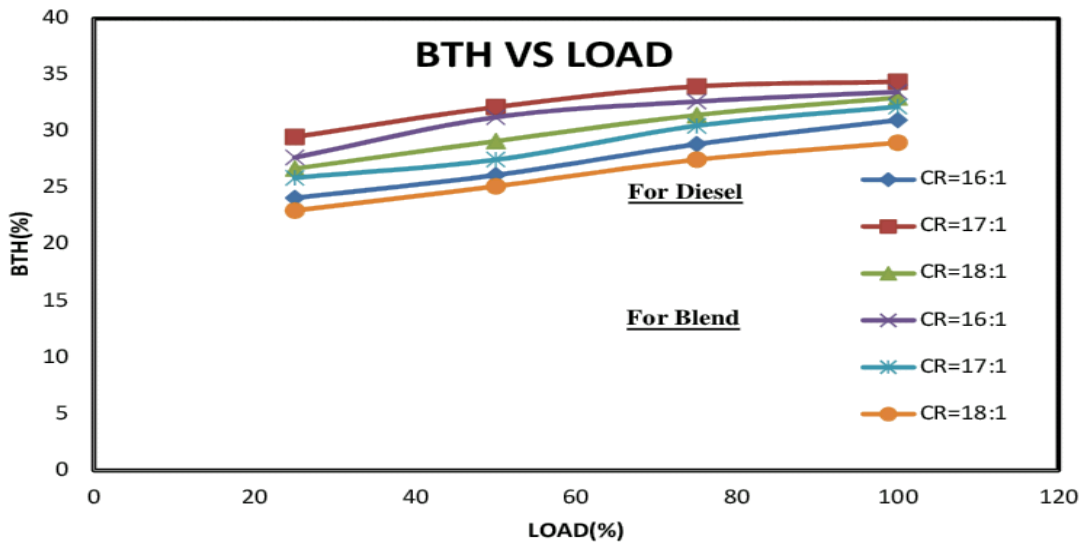
SindhyaMydeen et al., Variable compression ratio is a technology to adjust the compression ratio of an internal combustion engine while the engine is in operation. This increases the fuel efficiency even when various loads are applied.



Brake Specific Energy Consumption Vs Load

Higher loads require lower ratio while lower loads require higher ratio respectively. The blend prepared from the previous process is

made to run in this engine to check the performance and emission of the engine using the plastic pyrolysis oil.^[5]



^[4]Brake Thermal Efficiency vs Load

6. TESTS CONDUCTED TO THE PYROLYSED OIL

Suriya et al.,

- ❖ Flash point
- ❖ Fire point

- ❖ Viscosity
- ❖ Density^[4]

6.1 FLASH POINT

Vijay et al., Flash point is the point at which the source fire material starts to ignite at

the very lowest temperature vapour of the oil. In flash point the combustion do not continues even after taking away the fire source over the oil.^[4]

6.2 FIRE POINT

Suriya et al., Fire point is the point at which the oil itself starts to ignite at a certain temperature vapour of the oil. Here, continuous fire source is not required to sustain the combustion. The vapour liberated from the oil keeps the fire sustained even after the source fire is being removed. Fire point is always higher than that of the flash point temperature hence the continuous evaporation takes place. In both the cases, it is noted that the ignition source temperature could be higher than that of the both flash and fire point.^[4] 7.

CONCLUSION

Suriya et al., Hereby the process of pyrolysis on plastic waste specifically the polyethylene terephthalate done on the pyrolyser equipment, the pyrolysis oil as fuel is extracted and made to blend with diesel with certain ratio which is made to run in the variable compression ratio engine to check the emission and performance characteristics of the engine. Thus, the emission characteristics are checked and all the data's about them is being collected. With this we could conclude that the efficiency of the engine with use of this blend oil gives a betterment of emission and performance.

Vijay et al., through this method we could able to get free from the hazardous growing factor called the plastics. Plastics has become the major threat in modern scenario. The plastics which could not be get recycled were just dumped into the land or water or being burnt. These sort of activities just bring people harmness. They can be relieved from the diseases caused by the plastics and also a healthy life.

SindhaMydeen et al., this process gives a good innovative initiative to the fields of automobiles fuelling. The plastics are cleaned up through this process and makes the

environment and city clean from pollution. Following this method and developing brings good result such as zero emission of harm gases to the atmosphere also all the produced plastics so far could be recycled. This project plays the major role in bringing clean country within a period of 5 years if this is being executed and followed.

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