Investigation On Conversion Of Municipal Plastic Wastes Into Liquid Fuel Compounds, Evaluation Of Engine Performance And Emission Characteristics

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Abstract: The present rate of economic growth is unsustainable without saving of fossil energy like crude oil, natural gas or coal. Thus mankind has to rely on the alternate/renewable energy sources like biomass, hydropower, geothermal energy, wind energy, solar energy, nuclear energy, etc. On the other hand, suitable waste management strategy is another important aspect of sustainable development. Plastics have been one of the materials with the fastest growth because of their wide range of applications due to versatility and relatively low cost, easy process ability, light-weight, durability etc. The Polymer Energy system uses a process called pyrolysis to efficiently convert plastics in to liquid fuel compounds. The system provides an integrated plastic waste processing system which offers an alternative to landfill disposal, incineration, and recycling-while also being a viable, economical, and environmentally responsible waste management solution.

Introduction

In this experimental analysis an attempt has been to investigate the conversion of municipal plastic wastes into liquid fuel compounds by using pyrolysis process, the performance studies on CI engine and to evaluate emission profiles HC, CO, NO_X and smoke for selected blends of Diesel–Plastic liquid fuels.

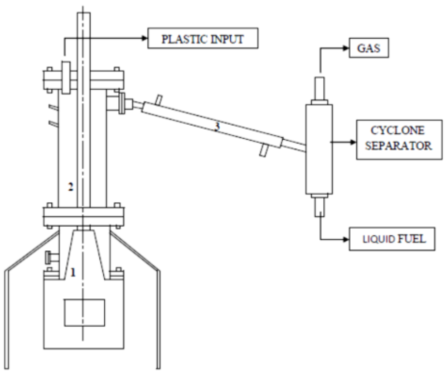

Fig 1: Experimental apparatus

Fig. shows, the experimental apparatus. The design of the apparatus was deliberately kept simple, in line with the aim of the project to develop a recycling approach based on basic technology. The apparatus was designed to operate at high temperatures and atmospheric pressure.

ENGINE TEST

The common rail direct injection (CRDI) system in which the fuel injection pump is tuned to pressurize the Biodiesel more than the recommended value of diesel which is up to 1200 bar and with **preheater** arrangement in the fuel line and in the common rail gave a good result in the trial. The fuel is injected into the combustion chamber at ultrahigh pressures of up to 1200 bar to ensure more complete combustion for cleaner exhaust gas. The engine specification listed in Table.1

Table 1: Engine specifications

Engine Type	CRDI Diesel engine
Capacity	1248cc
Bore	74 mm
Stroke	75.5 mm
Power	75ps@4000rpm
Torque	190Nm@2000rpm
Compression Ratio	17.6:1

RESULTS AND DISCUSSIONS

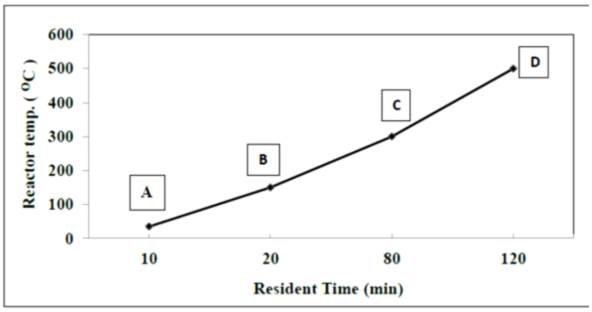

Fig 2: Typical temperature and resident time profiles in thermal process.

The temperatures in the reactor system remain unchanged for first few minutes the after starting the experiment. This is because the furnace is heating up and little energy reaches the reactor. After few minutes (point A) shown in Fig 2, heat transfer to the reactor begins and the temperatures in the reactor start to increase. At the point B the solid plastic starts to melt and considerable energy is taken up in the liquid phase in the form of latent heat. By further increasing in temperature at point C up to 300°c after 80 minutes, some noncondensible gas and heavy oils come out from the reactor. These noncondensible gases are reuses to heat the pyrolysis unit. At the final stage point D, temperature is reaches up to 500°C.

Analysis of liquid fuel yields from catalytic pyrolysis process

In catalytic pyrolysis, increases the gaseous product yields. Under lower temperatures and lower resident time than thermal pyrolysis process, much higher gaseous product yield is observed in the presence of a catalyst. Vapour gets further cracked due to the presence of catalysts. The reactions of catalyst with vapour enhance the yields of gaseous product and formation of carbon residue than thermal pyrolysis process. At point A heat transfer to the reactor begins and the temperatures in the reactor start to increase. At the point B the solid plastic starts to melt and considerable energy is taken up in the liquid phase in the form of latent heat.

ENGINE PERFORMANCE AND EMISSIONS CHARACTERISTICS

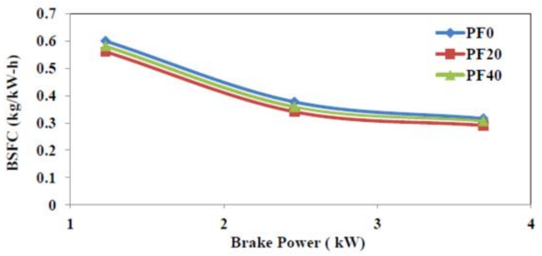

Fig 3: variation of brake specific fuel consumption (BSFC) with BP

The rate of fuel consumption divided by the rate of power production is termed as Brake specific fuel consumption. Brake specific fuel consumptions descend from lower to higher Brake power level. At higher BP the brake specific fuel consumption decreased. Fig. shows the variation of brake specific fuel consumption (BSFC) with BP for PF20, PF40 and diesel fuel. As the BP increases, BSFC decreases for both diesel and plastic fuel blends.

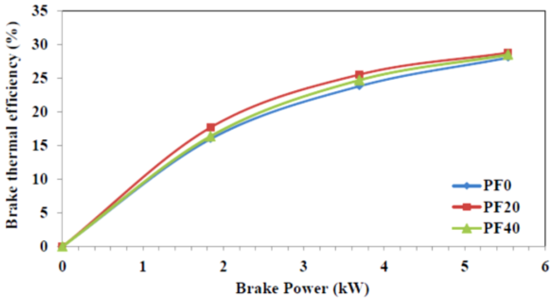

Fig 4: Variation of brake thermal efficiency with brake power at 1500rpm

The variation of brake thermal efficiency with BP is shown in Fig. 4 can be observed that the brake thermal efficiency is 28.03% at maximum BP for diesel and for the PF20 it is 28.78% and for PF40 it is 28.47%. It is clear that the brake thermal efficiency of PF20 is maximum as compared to diesel and PF40. Plastic fuel blend is a mixture of hydrocarbons varying from C10 to C30 having both low and heavy fractions with aromatics and oxygen. This results in smaller peak heat release rate and increases effective pressure to do work. Consequently, the work output is high and therefore the brake thermal efficiency increases. Another reason for higher brake thermal efficiency is better and complete combustion of fuel due to the oxygen present in the plastic fuel blends.

CONCLUSION

In the present work Polymer Energy system, which uses a process called pyrolysis to efficiently convert plastics into liquid fuel compounds.

The results shows, better engine performance than diesel fuel operation.

1. The fuel consumption of the engine was somewhat lower as compared to diesel fuel.
2. Operation and brake thermal efficiency increases with PF20, PF40 blends operation.
3. The emissions of engine like carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOX) is increases when the engine runs with plastic fuel blends.
4. The ability to recover valuable product and/or energy from wastes plastics. Perfect solution for waste

plastic management. Raw material readily available for the process. Waste plastic pyrolysis liquid fuel can be used alternate fuel to the diesel.

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