Assessment on performance and emission parameter of diesel engine using waste plastic oil used as a fuel

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Abstract: The two important parameters to be considered in the diesel engine are performance characteristics of the engine and emission characteristics. At the present energy scenario of fossil fuels can be depleted any time and in order preserve these fuels for the longer time alternate fuels such as biodiesel, plastic oils have gain prominent importance. In this paper, studies focused on study of diesel engine using waste plastic fuel. The use of alternate fuel produces HC, CO and oxides of nitrogen as products of emission. The parameters such as brake thermal efficiency; heat release rate of engine can be improved by plastic oil as energy source. Another important point is the fuel is extracted using plastic which is not degradable and not environmental friendly.

1. Introduction
One of real source of natural contamination is diesel engines. The strict emission standards are imposed to decrease the level of air pollution. In order to do so the performance of engines need to be improved. A critical investigation has been carried out to improve the fuel economy.

The various studies have been carried out by researchers to find out potential alternate source to the fossil fuels. In view of this waste plastic oil has gained important fuel which can be used and also as we are aware of the problem of waste plastic disposal. The plastic oil is used in the pure form and can also be blended with diesel. The researchers have discovered that the properties of plastic oil are nearer to diesel except the viscosity. Most of the plastic material used for packing materials are not recycled and create environment problem. The amount of consumption of plastic had increased due to economic development and urbanization. The great consumption would leads to environmental problems.

Diesel engines are most favoured power plants in vehicle because of their outstanding drive capacity and higher efficiency. The 100% waste plastic oil can be utilized as fuel for diesel engines. It is found out that engine could work with 100% waste plastic oil and can be utilized as a fuel in diesel engine. It additionally shows higher thermal efficiency. It is additionally figured out that oxides of nitrogen,
carbon dioxide were more for plastic oil contrasted with diesel fuel operation [1]. It is observed that when contrasted with standard injection timing of 23$^\circ$ BTDC the hindered injection timing of 14$^\circ$ BTDC brought about diminished oxides of nitrogen, carbon monoxide and unburned hydrocarbons [2]. Experimentally investigated shown that the use of exhaust gas recirculation along with plastic oil reduces Nox emission.[3]

2. Experimental setup and methodology
The engine that was used for the experiments is a four cylinder, direct injection, turbocharged water cooled engine. The specification of engines is compression ratio (17:1), displacement (4.58lt), rated power (68 kW), rated speed (1500 rpm), injection pressure (240 bar), bore (110 mm) and stroke (125 mm)

The experiments were conducted at the rated engine speed of 1500 rpm and four different loads, namely 25%, 50%, 75% and 100% of rated power. Five blending ratios of PPO and diesel namely 25%, 50%, 75%, 90% and 100% (v/v%) were tested at each load. They are designated as PPO 25 to PPO 100 in the following text. During the test, the engine was started firstly on diesel and switched to PPO after 30 min when all the conditions such as coolant and oil temperatures were stabilised. All the data were collected five minutes after the engine was set on the desired power output and fuel blend conditions. More specifically, the in-cylinder pressure data was taken for 100 consecutive cycles while the flow-meter measurements, temperatures, manifold pressure and emissions were taken for a period of five minutes with one reading per second and the average values were calculated. At the end of each test, the engine was switched back to diesel and run for 30 min in order to flush out the fuel lines and the injection system.

3. Engine performance and emission parameters
It has been demonstrated that there is ignition delay coming about high peak heat release rates. The increase in ignition delay upgrades air fuel blending bringing about lean blend. It has been observed 45% more heat release rate in contrast with diesel. The outcomes appear that the BTEs of the fuel mixes are fundamentally lower than diesel, also, that the contrast between the PPO700 and PPO900 is roughly 1%. Moreover, the expansion of diesel appears to just somewhat enhance the effectiveness of the oils. The primary reason for the producing of NOX discharges in diesel engine is the thermal mechanism, due to the high oxygen accessibility and increased cylinder temperatures. It can be seen that the NOX discharges of the PPO900 are much higher than those of diesel and PPO700. PPO900 creates twofold the UHC emissions contrasted with diesel, while PPO700 has half higher UHC discharges. The addition of diesel essentially decreases the UHC emissions, which could be clarified by the increased combustion performance related with the lower aromatic substance of diesel. The high UHC emissions of the oils can be credited to their expanded aromatic substance and longer ignition delay, which brings about shorter combustion duration. [4]

3.1. Brake specific fuel consumption.
It is the measure of fuel expended per unit power produced.
3.2. Thermal efficiency
It is the amount of work produced to the input energy supplied. The heat supplied is the product of mass of the fuel burnt and its heating value. The brake thermal efficiency of diesel and biodiesel are very close to each other [6].

3.3. Emission parameters
The different pollutants of the diesel engines are nitrogen oxides, hydrocarbons, particulate matter, and carbon monoxide.
3.4. Nitrogen oxides (Nox)

![Figure 3: Comparison in oxides with load](image)

The causes for Nox formation are thermal, prompt and fuel mechanism. It has been noticed that there is increase in Nox due to longer ignition delay, but LDPE900 produces low Nox emissions [7].

3.5. Hydrocarbons

It is seen that there is increment in unconsumed hydrocarbons for with increment in level of plastic oil mixes. In any case, for same mixing proportion, unconsumed hydrocarbon diminishes with increment in load. The explanation behind increment in unconsumed hydrocarbon is due to higher aromatic content, low viscosity, higher density and cetane number in the plastic oil [5].

![Figure 4: Comparison of unburnt hydrocarbon with load](image)
3.6. Carbon monoxide and carbon dioxide.

![Graph showing comparison of carbon monoxide with load]

**Figure.5:** Comparison of carbon monoxide with load

It has been observed that carbon monoxide emission decreases for input energy source as load increase. It is an indication of stable combustion [7].

![Graph showing variation of carbon dioxide with load]

**Figure.6:** Variation of carbon dioxide with load

Carbon dioxide being green house gas and that is the reason to reduce the carbon dioxide emissions. For all three loads there is reduction in the carbon dioxide emission.[7]

4. Conclusion

- The spray test of the plastic oil fuel can be solution for increase in unburnt hydrocarbon.
- The Nox can be reduced by using exhaust gas recirculation.
- By retarding injection timing diminishes the cylinder pressure as result lessening of Nox happens.
- By advancing injection it increments in BTE yet builds the cylinder temperature.
5. References

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