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Research Article

PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE FUELLED WITH RENEWABLE OIL AND POLYMER OIL

Ganapathi P*

Thiagarajar Polytechnic College Salem

A R T I C L E I N F O

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A B S T R A C T

This paper describes an experimental study of using Cotton seed oil as a fuel in diesel engine. In this study the effect of using polymer oil – renewable oil (cotton sees oil) blends (PC5,PC15) on the engine performance, exhaust emission have been experimentally investigated. This present work deals with 5% renewable oil (cotton seed oil) and 90% polymer oil called PC5, 15 % renewable oil (cotton seed oil) and 85% polymer oil called PC15% were used in single cylinder four stroke, water cooled diesel engine. The experimental result showed that the carbon monoxide, hydrocarbons and exhaust gas temperature were significantly reduced.Oxides of nitrogen, Brake specific fuel consumption was increased and also brake thermal efficiency were found to have increased with polymer oil– renewable oil (cotton seed oil) blends.

INTRODUCTION

At present the rapid increase in the consumption of fossil fuels is resulting into climate change which is considered as the most important environmental problem. Also due to gradual depletion of the world petroleum reserve, rising petroleum prices, increasing threat to the environment from exhaust emission and global warming have generated an intense international interest in developing alternative non petroleum fuels[1] Plastics are polymers, very long chain molecules that consist of monomers, linked together by chemical bonds. The monomers of petrochemical plastics are inorganic substances and are non-biodegradable.As per the survey conducted in India in the year 2000, nearly 6000 tonnes of plastic waste were produced on a daily basis and only 60% got recycled [2]. The remaining 40% could not be recycled.Many of the industries have developed several processes to convert waste plastics into fuels [3].Almost all plastics are derived from petroleum. Plastics are polymers, very long chain molecules that consist of monomers, linked together by chemical bonds.Many researches involving thermal degradation of waste plastics into liquid fuel have been conducted. Thermal degradations are not only used for polymer but it is also used for aromatics and gas [4-5]. The production of liquid fuel from plastic waste would be a better alternative as the calorific value of the plastics is comparable to that of fuels, around 40 MJ/kg.[6]. The polymer oil is derived from the plastic waste.

Corresponding author:* **Ganapathi P
Thiagarajar Polytechnic College Salem

Biofules are renewable and reduce gases emissions they is increasingly used as alternative topetroleum fuels. Cottonseed oil and its methyl estersare expected to become one of these biofuels incountries where cottonseed oil is plentiful such as India it may become an important alternative fuel.Many researchers have experimentally investigatedthe performance and emissions characteristics of both the cottonseed oil [7-8] and cottonseed oil methyl ester.The biodiesel is similar in fuel characteristics to conventional diesel in which it compares the fuel characteristics specified by standard specification of different countries. In fact it is not possible to run a CI Engine on 100% biodiesel like Jetropha and Pongamia without any major modifications in the presently available engine. The objective of the present study is to investigate the performance, the emission characteristics of a diesel engine fuelled with cottonseed oil-plastic oil blends.

Plastic Waste to Polymer Oil

Plastic waste material was converted into uniform size by the process of crushing, cutting and shredding in the feed system, for the purpose of handling and melting. This process of sizing and grading the waste was semi-automatic. The graded feed was stored in a hopper before feeding into the reactor by a conveyor feeder. The dust and the other fine wastes collected from the cyclone filter were disposed through a vent with particle size monitoring system. The plastic waste was treated in a reactor along with a catalyst and maintained at a temperature of 275◦C–375◦C at atmospheric pressure for about 3 to 4 hours. The outlet gas from the pyrolysis process was condensed in a series of condensers and the liquid obtained was taken as fuel. The uncondensed gases were let

out into the atmosphere. Properties of diesel, polymer oil and cotton seed oil are compared in Table 1.

Experimental Set Up

Tests were conducted on a singlecylinder four stroke, direct injection, water cooling kirlosakar diesel engine atan engine speed of 1500 rpm. The engine has a 800cc cylinder volume. The test engine specifications are givenin Table 2.The schematic arrangement of the experimental set upand photographic view are shown in Figs. 1 and 2. The test engine was directly coupled to an eddycurrent dynamometer for load measurement. Airflow meter was used to measure the airflow. The fuel measuring tube (burette) was used to measurethe fuel flow rate. The pressure transducer was used to measure the cylinder pressure.

It was fit onto the cylinderhead with a charge amplifier. AVL di-gas analyzer was used to measure NOx, HC and CO emissions in the exhaust gas. Exhaust gas temperature was measured with a thermo couple. AVL smoke meter was used to measure the smoke density in the exhaust.Combustion characteristic of the engine was measured by the AVL combustion analyzer.

Table 1 Specification of Test Fuels

Property	Diesel (10)	Polymer oil (10)	Cotton seed oil
Gross calorific value (kJ/Kg)	46,500	45,216	39600
Density @ 30 ^{0}C in (gm/cc)	0.84	0.794	830
Kinematic viscosity, cst @ 40^{0}C	2.0	2.85	6.0
Cetane number	55	51	52
Flash point (^{0}C)	50	41	110
Fire point (^{0}C)	56	43	113

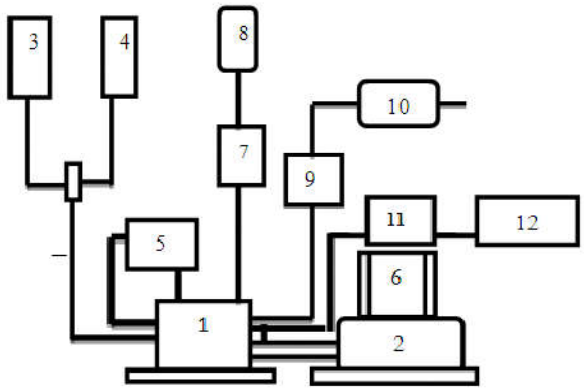

Fig 1 Experimental setup

The volume percentage tested were 5%, and 15% of cotton seed oil, with 95% and 85% of polymer oil respectively which were named as PC5 and PC15. The fuel blends were prepared just before starting the experiment so that the fuel mixture is homogenous.

The nomenclature of the numbers are mentioned below:

- Engine
- Dynamometer
- Fuel Tank
- Fuel Measuring Tube(burette)
- Cooling Water Inlet and Outlet
- Thermometer
- Control panel
- Air flow meter
- Air filter
- Smoke meter
- Exhaust gas analyzer
- Charge amplifiermonitor

Table 2 Specifications for kirlosakar diesel engine

Parameter	Specification	Unit
Power	3.7	Kw
Speed	1500	rpm
Cylinder bore	0.08	m
Stroke	0.11	m
Number of Cylinders	1	--
Number of Strokes	4	--
Type of cooling	Water	--

RESULTS AND DISCUSSION

The experiment was conducted in a standard diesel engine at an engine speed of 1500rpm. A comparison of the engine performance and the emission for the following.

Combinations was made and the results have been presented.

- Diesel (DF)
- Polymer oil (PO)
- Polymer oil-renewable oil (cotton seed oil) (PC5,PC15)

Performance

Brake thermal efficiency

The brake thermal efficiency with the engine load of polymer oil-cotton seed oil blends is compared with the diesel and the polymer oil as shown in Fig. 3. It can be observed from the figure that the brake thermal efficiency of PC5 and PC15 are 25.8% and 25.5%, while those of diesel and polymer oil are 29% and 27.5%. The brake thermal efficiency has slightly decreased with the increase of cotton seed oil in the blends. It is noted that diesel fuel has the higher brake thermal efficiency compared to cotton seed biodiesel blends.The reason may be the Lower calorific value and higher viscosity is the reasons for the lower brake thermal efficiency for polymer oil-cotton seed oil blends.

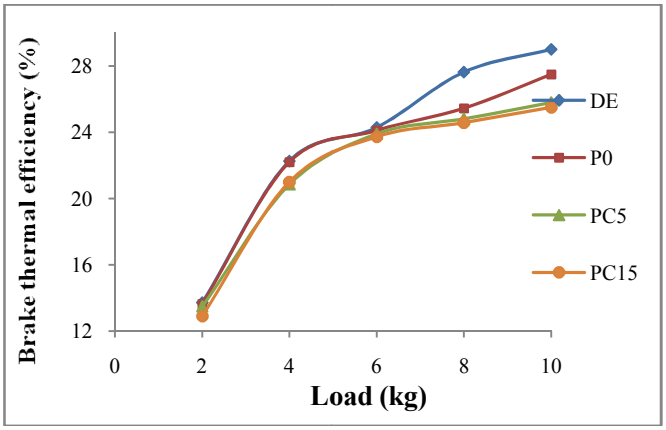

Fig 2 Variation of BTE with load

Brake specific fuel consumption

Fig. 4 shows that the variation of the brake specific fuel consumption with load for the tested fuels. It can be observed from the figure, that the brake specific fuel consumption has increased with the increase percentage of cotton seed oil in the blends. Brake specific fuel consumption of diesel and polymer oil are0.28kg/kWhr and 0.29kg/kWhr at full load. In the case of polymer oil- cotton seed oil blends, it varies from 0.66kg/kWhr and 0.67kg/kWhr at 20% of load to 0.30kg/kWhr and0.31kg/kWhr at full load. The result noted that increasing cotton seed oil ratio in the fuel blend causes an increase in the brake specific fuel consumption. Themain reason for the

increase of specific fuel consumption is due to the lower heating value of than that of diesel. The increases the viscosity which in turn increased the specific fuel consumption due to poor atomization of the fuel.

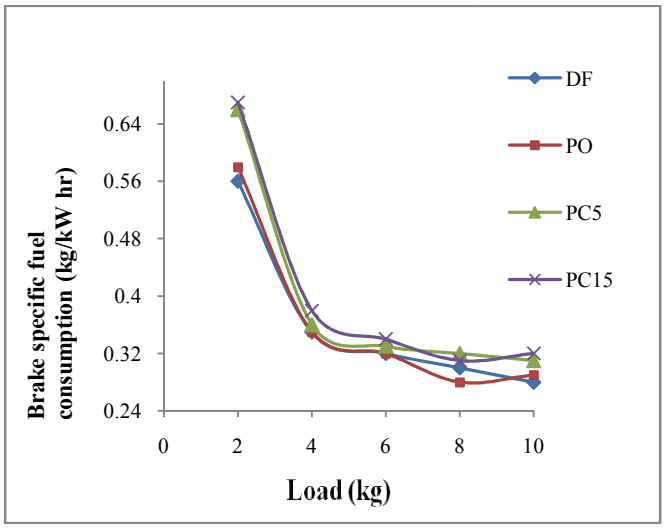

Fig 3 Variation of Bsfc with load

Emission

Carbon Monoxide

The variation of carbon monoxide with load is shown in Fig. 5. The concentration of CO emission varies from 0.07% at 20% of load to 0.14% at full load for diesel. It varies from 0.08% at 20% of load to 0.15% at full load for polymeroil, whereas it varies from 0.07% and 0.13% at 20% of load to 0.06% and 0.12% at full load for polymer oil-cotton seed oil blends (PC5, PC15). The results showed that when the cotton seed oil ratio in the mixture increased, the CO concentration in the exhaust decreased. An enrichment of oxygen owing to cotton seed oil addition can be noticed and the increase in the proportion of oxygen will promote the further oxidation of CO during engine exhaust process.

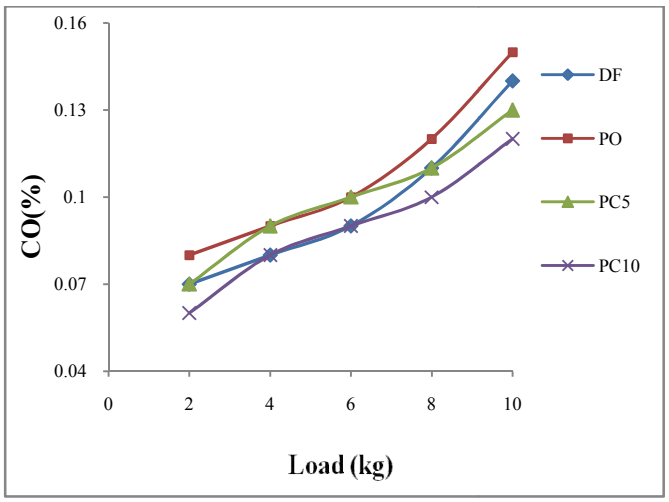

Fig 4 Variation of CO with load

Unburned Hydrocarbon

It is shown that increasing cotton seed oil in the blends reduces significantly HC emissions comparatively to ordinary diesel and polymer oil. The variation of unburned hydrocarbon with load for tested fuels is shown in Fig. 5. Unburned hydrocarbons are formed when the fuels are burned partly. Unburned hydrocarbon varies from 32ppm at 20% of load to 57ppm at full load for diesel. It varies from 34ppm at 20% of load to 60ppm at full load for polymer oil. In the case of polymer oil-cotton seed oil blends (PC5, PC15), it varies from 30ppm and 29ppm at 20% of load to 53ppm and 51ppm at full load. From the results, it can be noticed that the concentration of the. HCemission decrease is higher with a higher percentage of cotton seed oil in the blend. This is due to the increase in oxygen content in the blend which improves the combustion quality in the combustion chamber.

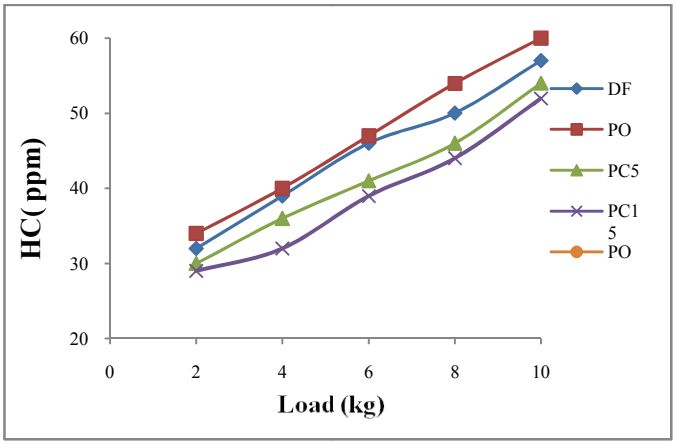

Fig 5 Variation of HC with load

Oxides of Nitrogen

In the figure: 6NOx emissions with engine load of DF, PO, PC5, and PC15 are compared with each other. At load 2 kg NOx emission for DF is 129 ppm, PO is 150 ppm, PC5 is 170ppm, and PC5 is 182ppm at maximum load DF have 1005ppm, PO have 1020 ppm, PC5 have 1100ppm, PC15 have 1200ppm NOx emissions. Here the value of PC5 and PC15 are comparatively higher than DF and polymer oil in medium and maximum load. This result was reasonable, since higher values of combustion temperature and presence of oxygen with biodiesel result in an increase in NOx generation.

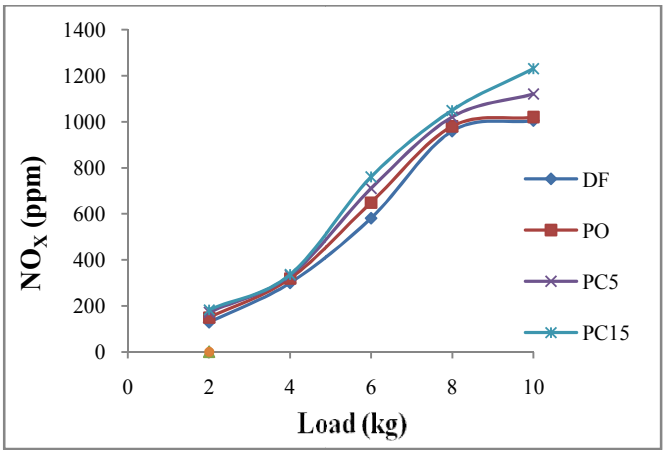

Fig 6 Variation of NO_X with load

Smoke

The variation of smoke emission with load for neat diesel fuel and blend was shown in fig. 7 Smoke opacity is indicative of dry soot emissions which are one of the main components of particulate matter. Smoke level value for diesel and plastic oil is 53.5% and 55.1. % at full load.45% and 38% for PC5 and PC15. For biodiesel mixtures, smoke emission was less compared to neat diesel fuel.

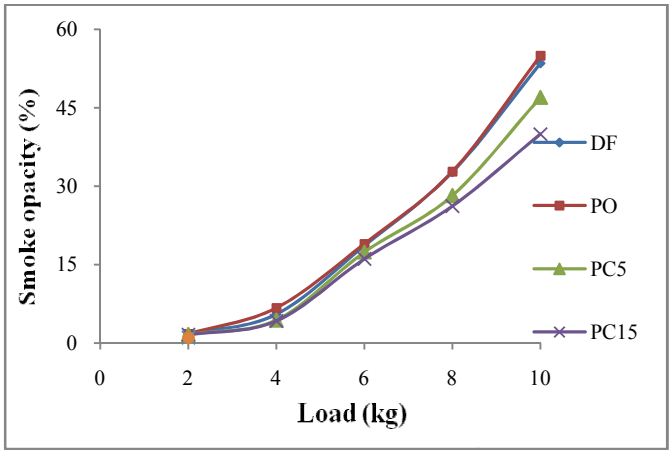

Fig 7 Variation of Smoke opacity with load

CONCLUSION

The variations in the engine performance and the emission of a diesel engine using polymer oil- renewable oil (cotton seed oil) blends have been investigated. Based on the experimental results, the following conclusions are drawn.

- Lower brake thermal efficiency is achieved by increasing the percentage of cotton seed oil in the blends.With the different percentage of cotton seed oil blends (PC5, PC15), the brake specific fuel consumption is found to have increased for PC5 and PC15 blend fuel compared to the diesel and the Polymer oil. This increase is higher because of the higher percentage of cotton seed oil in the blend.
- PC5 and PC15 blend fuel tends to produce lower exhaust CO values than the diesel and polymer oil.
- The use of cotton seed oil-polymer oil blends (PC5, PC15) caused anincrease in the emission of NOX compared to the diesel and the polymer oil. HC emission of PC5 and PC15 blend fuels are marginally lower than that of the diesel and polymer oil.
- The soot emitted by the cotton seed oil-polymer oil blends (PC5, PC15) is significantly lower than the corresponding neat diesel and polymer oil, with this reduction being the result of the higher percentage of cotton seed oil in the blend.

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