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Performance and Emission Characteristics of Diesel Blended With Eucalyptus / Pine Seed Oil on a DI Diesel Engine

A.R. Pradeep Kumar
Professor,
Dept. of Mechanical Engineering
Dhanalakshmi College of Engineering,
Tambaram, Chennai, India

P V Elumalai
Professor
Dept. of Mechanical Engineering
Dhanalakshmi College of Engineering,
Tambaram, Chennai, India

D Nandhkumar
Professor
Dept. of Mechanical Engineering
Dhanalakshmi College of Engineering,
Tambaram, Chennai, India

Abstract

This experimental work involves carrying out performance, combustion and combustion parameters of a Direct Injection (DI) diesel engine when it is operated with a blended fuel of Diesel and Eucalyptus/ Pine seed. The performance parameters considered are brake thermal efficiency, specific fuel consumption, indicated thermal efficiency, volumetric efficiency and mechanical efficiency. All these results implied that the blended fuel with neat diesel could be used as a substitute for the conventional fuel. This research paper gives a compiled report of several tests which have been conducted at various ambient and load conditions. Though there are plenty of researches went on with various biodiesel fuels for two decades, those studies have been rarely reviewed to favour understanding and popularization for biodiesel so far. From these reports, the effect of biodiesel on engine power, economy, durability and combustion and the corresponding effect factors are surveyed and analyzed in detail. In this research work a novel attempt has been made by blending of Eucalyptus and Pine seed with neat diesel in the proportion of 20:10:70 and 15:15:70.

Keywords: Eucalyptus Oil, Pine Seed Oil, Neat Diesel, Oil Blends, Testing In CI Engine, Emission Control.

Introduction

Rapid depletion of fossil fuels, stringent emission norms, day to day increase of automotives on road are the main reason or threat for the researchers in the field of alternative fuel. Vegetable being the first alternative fuel for a compression ignition engine, later it produced serious problems, like clogging in the nozzle, slower combustion and more emissions. Hence the extract of vegetable oil known as biodiesel was tested as the alternative fuel in the DI diesel engine. The various fuels tested were Jatropha, Pongamia, Mahua, Neem, Nerium, etc. India being a developing country, researchers were keen about testing non-edible oils for the research on alternative fuels.

In this experimental work, transesterification process has been used for extracting biodiesel from raw oil of eucalyptus and pine seed. Methonal has been used as reactant and NaOH (Sodium Hydroxide) has been used as the catalyst.

In previous researches the tests have been carried out in the range of 30:70 for Eucalyptus oil and Pine seed oil. Hence in this research an attempt has been made to blend both Eucalyptus and Pine seed oil with neat diesel in the proportion of 20:10:70 and 15:15:70

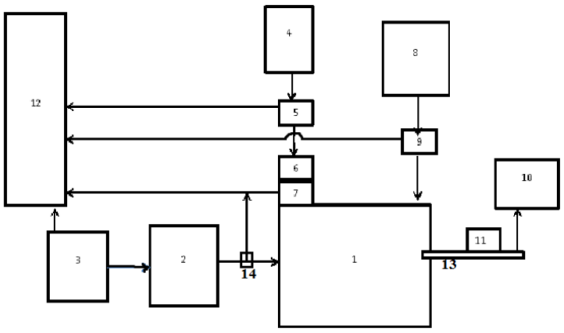
Experimental Setup

The experimental setup consists of a Kirloskar TAF 1 single cylinder, air cooled, 4 stroke and Direct Injection (DI) diesel engine. The experimental setup also consists of alternator. The load is controlled by the load cell which in turn activates the alternator for applying load on the engine. Air is taken by the air box and flows through an air flow sensor which measures the amount of air taken. Fuel consumption readings were measured with the help of a a fuel sensor. These measurements are provided as inputs to the data acquisition system. AVL 444 gas analyzer is used to measure the emissions from exhaust pipe. The neat diesel fuel has been considered as reference fuel and blended fuels were considered as test fuel.

Table 1 Properties of reference fuel and test fuels

Properties	Neat Diesel	Eucalyptus	Pine Oil
Flash point ^{o}C	65	32	54
Fire point ^{o}C	78	42	65
Viscosity at 40 ^{o}C	2.86 cSt	4.85 cSt	3.07 cSt
Calorific value (MJ/kg)	44.34	42.5	41.50

Figure 1 Schematic Layout of Experimental Setup



1. Engine 2. Alternator 3. Load cell withcontrol panel
4. Fuel tank 5. Fuel Sensor 6. Fuel filter 7. Fuel pump
8. Air box with air filter 9. Air flow sensor
10. Gas analyser 11. Thermocouple 12. Computerised data acquisition system 13. Exhaust pipe 14. Speed sensor

Figure 2 Photograph of Experimental Setup

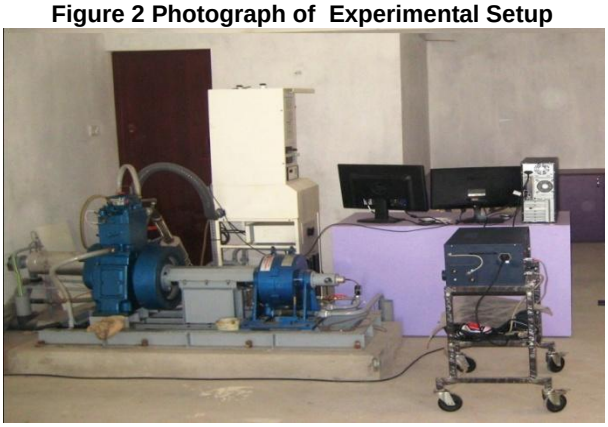
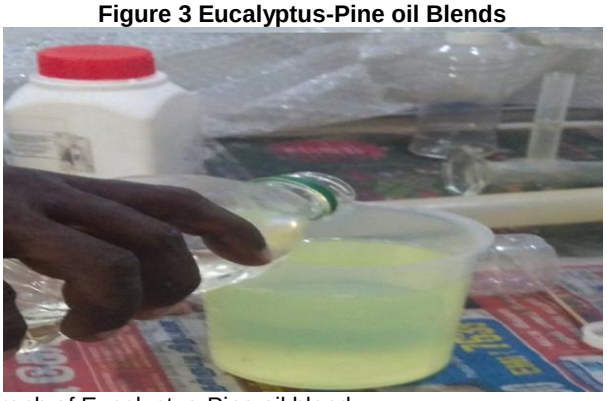


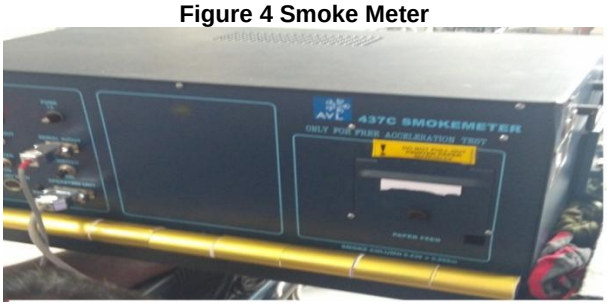
Figure 2 shows the photograph of the experimental setup which has been shown as schematic layout in figure 1.

Figure 3 Eucalyptus-Pine oil Blends



The figure 3 shows the photograph of Eucalyptus-Pine oil blend.

Figure 4 Smoke Meter



The figure 4 shows the AVL brand smoke meter used to measure smoke opacity during the emission test.

Figure 5 Gas Analyser

The figure 5 shows the gas analyser which measures hydrocarbon, carbon monoxide, carbon dioxide and oxides of nitrogen emission.

Figure 6 Experimental setup

Result and discussion

5(a) Engine Performance results

Table.2 Engine Performance Analysis

Blend Details	Total fuel consumption (TFC) kg/h	Specific fuel consumption (SFC) kg/kWh	Brake power (BP)kW	Indicated Power (IP) kW	Mechanical efficiency (η_M) %	Brake thermal efficiency (η_{BT}) %	Indicated thermal efficiency (ηIT) %
ND	1.31	0.26	5.06	6.73	75.22	32.72	43.5
B10	1.22	0.24	5.1	6.02	84.69	35.45	41.86
B15	1.28	0.25	5.1	5.89	86.49	33.89	39.18

Table.3 Brake Power and Specific Consumption

Blend Details	Brake power (BP) kW	Specific fuel consumption (SFC) kg/kWh
DIESEL	5.06	0.26
B10	5.1	0.24
B15	5.1	0.25

Table.4 Mechanical Efficiency

Blend Details	Brake power (BP) kW	Mechanical efficiency (η_M)
DIESEL	5.06	75.22
B10	5.1	84.69
B15	5.1	86.49

Table.5 Indicated Thermal Efficiency

Blend Details	Brake power (BP) kW	Indicated thermal efficiency (η_{IT})
DIESEL	5.06	43.5
B10	5.1	41.86
B15	5.1	39.18

Table.6 Brake Thermal Efficiency

Blend Details	Brake power (BP) kW	Brake thermal efficiency (η_{BT})
DIESEL	5.06	32.72
B10	5.1	35.45
B15	5.1	33.89

5(b) Combustion characteristics

Fig.6 Crank Angle Vs Cylinder Pressure (DIESEL)

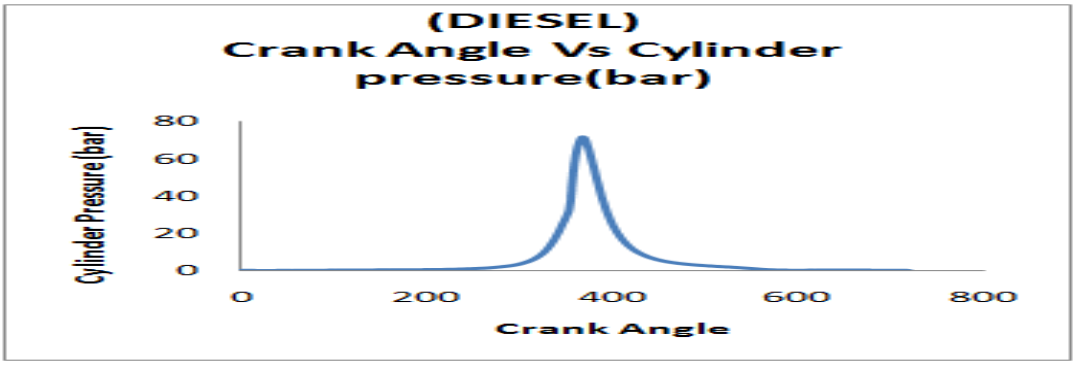


Fig.7 Crank Angle Vs Cylinder Pressure (B15/B10)

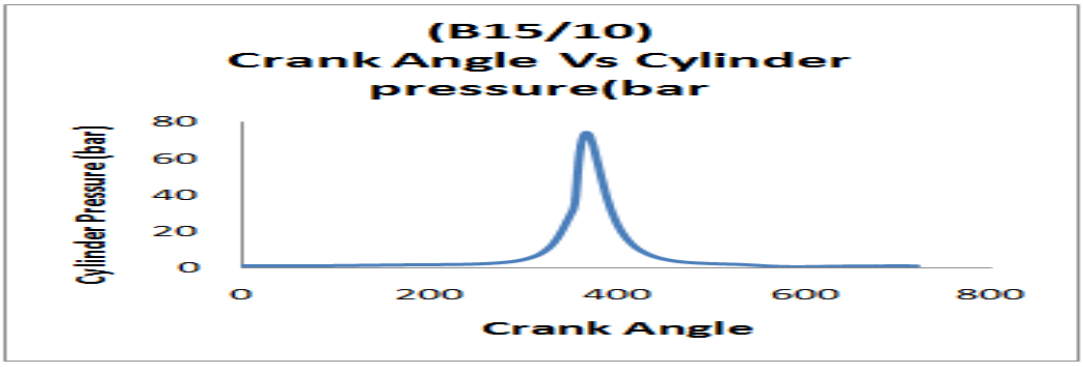


Fig.8 Crank angle vs heat release J/degree (DIESEL)

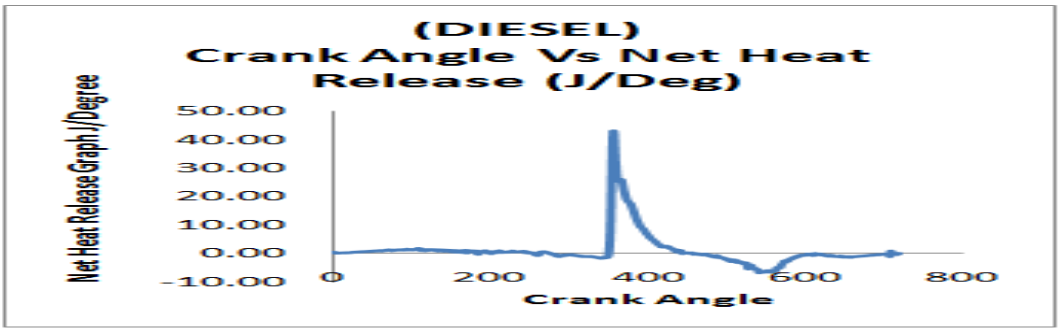


Fig.9 Crank angle vs heat release J/degree (B10)

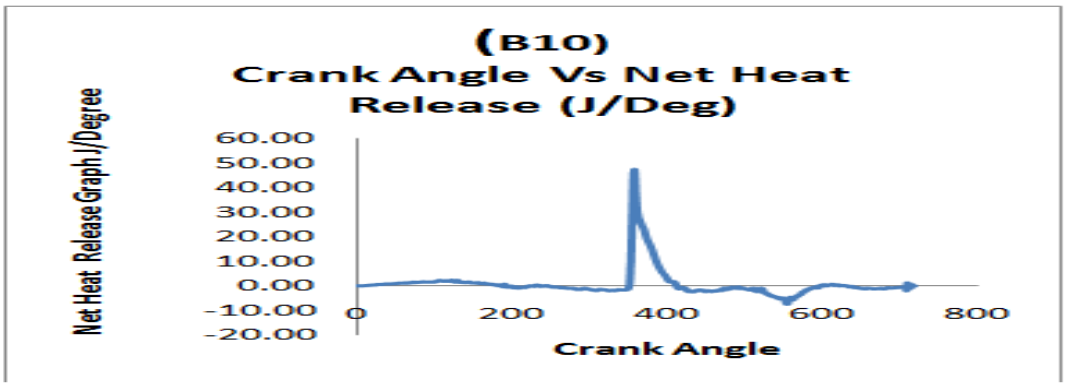
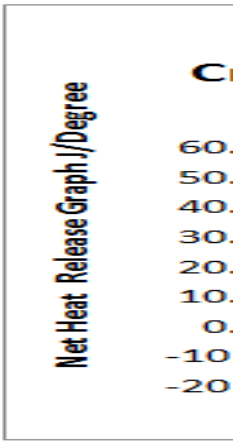


Fig.10 Crank angle vs heat release J/degree (B15)



5(c) Comparison of Emissions Results - Engine

Blend	CO	HC	NO_x	CO_2
Details	%	PPM	PPM	%
DIESEL	0.239	45	2023	9.96
B10	0.075	15	2328	9.4
B15	0.078	19	2316	9.55

Table.7 Engine Emissions

Conclusion

The present experimental investigation has dealt with the production of biodiesel from eucalyptus, pine oil measurement of properties and performance evaluation on blends of biodiesel at various loads. From investigation, the following conclusions can be drawn. The fuel properties like density, flash point, viscosity and calorific value of all the blends are very

similar to diesel and therefore diesel may be well replaced by biodiesel in near future. This makes the fuel to become the "On Farm Fuel" where farmer can grow his own resource, convert to biodiesel and use in agricultural sets itself without the need of any diesel for blending. The low efficiency may be due to low volatility, slightly higher viscosity and higher density of the biodiesel of pine oil, which affects mixture formation of the fuel and thus leads to good combustion. The performance characteristics of single cylinder compression ignition engine fuelled with eucalyptus, pine oil and its different blends have been studied and compared to the standard diesel fuel. The experiment was carried out with different parameters Vs various loading conditions. The investigation results pointed out that, the pine oil can be directly used in a diesel engine as a result of its unique chemical possessions. Based on the experimental results the following conclusions were made. 5% of pine oil showed significantly comparable thermal efficiency and consumption of specific fuel with diesel, which is noteworthy as a biodiesel while alcohol fuels suffer a setback of higher fuel consumption According to the emission reports, the HC and CO and CO_2 emissions level have been considerably reduced for pine oil compared with regular diesel at full loading conditions. On the other hand, pine oil shows an advanced level of NOX emission compared with normal diesel. As a result, it was concluded that HC and CO and CO_2 emission reduction is possible when the outlay of advanced NOX attained from the pine oil biofuel used in a constant speed single cylinder diesel engine without any alterations.

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