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EXPERIMENTAL WORK ON DIESEL ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS USING NANO ADDITIVES IN DIESEL AND BIODIESEL

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ABSTRACT
Diesel engines are well adapted by mankind because of their low fuel consumption and better efficiency. In recent times researchers have focused more on alternate fuels, with the depleting trend of petro diesel. Biodiesel is the one of such alternate fuel whose calorific value nearer to diesel. Most of the researchers concluded that with the usage of biodiesels the emissions can be reduced maintaining the consistency in efficiency, compared to diesel. In the present era of Nano technology there is the scope to improve the efficiency of engines using Nano additives in blended fuels.

In this work single cylinder 4 stroke DI diesel engine is selected. The performance of different blends of mahua oil methyl esters for which cerium oxide (CeO_2) Nano additives of size 30-50 nm is added in different proportions in blended fuel.

The experiment has been conducted with neat diesel fuel and diesel–biodiesel blends (addition of cerium oxide (CeO_2) Nano additive) in a four stroke single cylinder direct injection (DI) diesel engine. Those results are compared with conventional diesel fuel, diesel–biodiesel blends showed good performance, lower carbon monoxide (CO), and hydro carbons(HC) but higher oxides of nitrogen (NOx) emission.

KEYWORDS: Biodiesel; Diesel engine performance; Exhaust emissions and cerium oxide (CeO_2) Nano additive.

INTRODUCTION
Diesel engines are blessed with high thermal efficiency and hence widely used in automobiles. However diesel engines are one of the major contributors to the emissions such as hydrocarbons, particulates, nitrogen oxides, and sulphur oxides. These emissions are very harmful to human beings and also responsible for acid rain and photochemical contamination and hence subject to strict environmental legislation. Thuswide use of diesel engines leads to harmful threat of nitrogenoxide and hydrocarbon emissions. Improvement in the performance of diesel engines is an important challenge to be addressed, in the current era due to the fast depletion of fossil fuel resources as well as due to the harmful hydrocarbon and nitrogen oxide emissions. Efforts are also made for there formulation of diesel fuel to reduce these harmful emissions without affecting the physicochemical properties of fuel such as viscosity, flash and fire point, and so forth [1–3].

Various works have been reported on modified fuels for improving diesel engine performance and reducing exhaust emissions. Kim and Choi [4] carried out experiments with Pure diesel, diesel blended with 15% ethanol, and a cetanenumber improver EHN (ethyl hexane nitrate). The mean conversion efficiency of HC and CO emissions by the catalyst was observed to be 60% and the PM emission was reduced by 30–40%, while analyzing diesel blended with 15% ethanol and EHN.

T. Pushparaja*, S. Ramabalanbet al. [5] An experimental investigation is conducted to evaluate the effects of using ethanol and diethyl ether as additives to biodiesel/diesel blends on the emission and performance of direct injection unmodified diesel engine. Biodiesel was made by pyrolysis process. Cashew nut shell liquid (CNSL) was selected for biodiesel production. The experimental results showed that the exhaust emissions for 10% diethyl ether with B20 were fairly reduced, especially the NO is reduced remarkably by 51% while comparing diesel. B20+D10 blend reflect better engine performance and lower emissions than B20+E10and B20 blends.

The effect of Nano-fuel additives [6] [Magnalium (Al-Mg) and cobalt oxide (Co_3O_4)] on the performance and emission characteristics of Jatropha biodiesel (B100) in a single cylinder, air cooled, direct injection diesel engine. The obtained Nano particle size range is from 38-70 nm. The particle size is characterized using scanning electron microscope (SEM). The Nano particles (100 mg/l) were dispersed in the fuel by an ultrasonicator with the assistance of optimized surfactant concentration. It was noticed that the addition of Nano cobalt oxide additive reduced specific energy consumption at part load and full load conditions.

Experimental results have been reported on NO_x emission were higher at neat biodiesel operation compared with neat diesel operation and it was countered by introduction of Nano-fuel additive which resulted in 45% reduction in NO_x emission at the same biodiesel operation. The micro explosion, the air/fuel mixing will be proper and hence it results in 70% reduction in HC emission and 41% reduction in CO emission for B100 with additive at part load and full load conditions respectively.

PROBLEM DEFINITION AND EXPERIMENTAL WORK

2.1 PROBLEM DEFINITION

- The fossil fuels are depleting at faster rate, there is a need to search for alternate fuels and the performance improvement methods.
- Project aims at the performance analysis of biodiesel with influence of nano particles in DI diesel engine.
- Mahua oil is taken as the base oil (Biodiesel).
- Cerium oxide is taken as Nano additive.

2.2 Experimental Procedure and Equipment

The mahua oil biodiesel is utilised to prepare the blends and cerium oxide (CeO_2) is used as Nano additive is used in different proportions. The properties of fuel and blends are given in table1.
The engine used is Kirloskar make single cylinder, naturally aspirated, four stroke, water cooled, 16:1 compression ratio, direct injection diesel engine, and the maximum engine power is 3.7 kW at 1500 rpm. The experiments are to be conducted at 0, 1/3, 2/3 and maximum loads with the prepared fuel blends and additives for the performance and emission analysis of selected diesel engine

Table1: properties of fuel and fuel blends

FUEL	FLASH POINT (^{0}C)	FIRE POINT (^{0}C)	CALORIFIC VALUE(KJ/Kg)
DIESEL	59	65	44200
B25	85	91	41450
B50	105	115	39650
B25+ 0.02gm CeO_2	83	86	41550
B50+ 0.02gm CeO_2	91	95	41380
B25+ 0.06gm CeO_2	74	79	41450
B50+0.06gm CeO_2	91	96	41367

The following are the fuel samples
-Diesel
- B25(75 percentage diesel and 25 percentage biodiesel in volume)
- B50 (50 percentage diesel and 50 percentage biodiesel in volume)
- B25+0.02gm CeO_2(75percentage diesel and 25 percentage biodiesel and 0.02gm(20mg/l) cerium oxide) in volume
- B25 + 0.06gm CeO2(75 percentage diesel and 25 percentage biodiesel and 0.06gm(60mg/l) cerium oxide) in volume

- B50 + 0.02gm CeO2(50 percentage diesel and 50 percentage biodiesel and 0.02gm(20mg/l) cerium oxide) in volume
- B50 + 0.06gm CeO2(50 percentage diesel and 50 percentage biodiesel and 0.06gm(60mg/l) cerium oxide)in volume

Total no of experiments are: 28

ENGINE SPECIFICATIONS

No. of cylinders	:	**1**
Brake power	:	**5HP**
RPM	:	**1500rpm (constant)**
Bore	:	**80mm**
Stroke	:	**110mm**
Loading type	:	**Eddy current dynamometer**
Drum diameter	:	**0.315m**
Orifice Diameter	:	**20mm**

Biodiesel blends

Figure1: B25, B50, B25-0.02gm, B25-0.06gm, B50-0.02gm, B50-0.06gm

RESULTS AND DISCUSSION

The results are very encouraging and reported in detail in this paper. Some of the salient results are summarized below.

3.1 Specific fuel consumption (SFC)

The performance is also given in terms of SFC at various loads, as these parameters directly indicate the mass of fuel consumed per unit power output. Figure 2 shows the variation of the specific fuel consumption (SFC) with load. It is seen from the figure that for all the tested fuels, the specific fuel consumption less in lower loads and with an increase in load it is equal to the diesel fuel, why because the fuel blends is due to the lower calorific value of these fuels, compared to neat diesel.

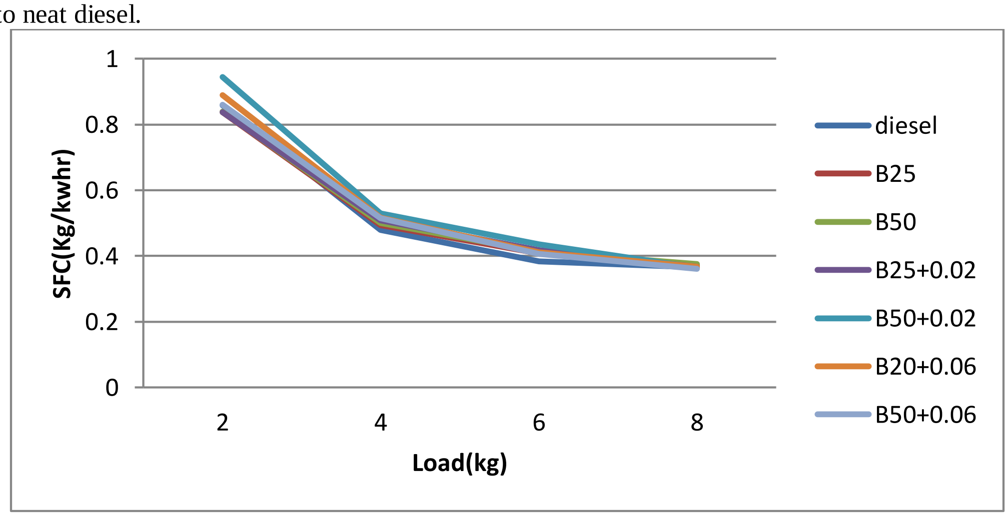

Figure 2: Load Vs SFC

3.2 Break Thermal Efficiency (BTE)

The variation of Break Thermal Efficiency (BTE) with different load for all seven fuels was shown in Figure 3. The BTE of the engine increases with increasing load for diesel and biodiesel and its blends with the addition of Nano additive (cerium oxide (CeO_2)). It was observed that BTE has increase due to increases in power developed with increase in load. Higher efficiency is observed in B25+0.02 gm cerium oxide blend compared to diesel fuel.

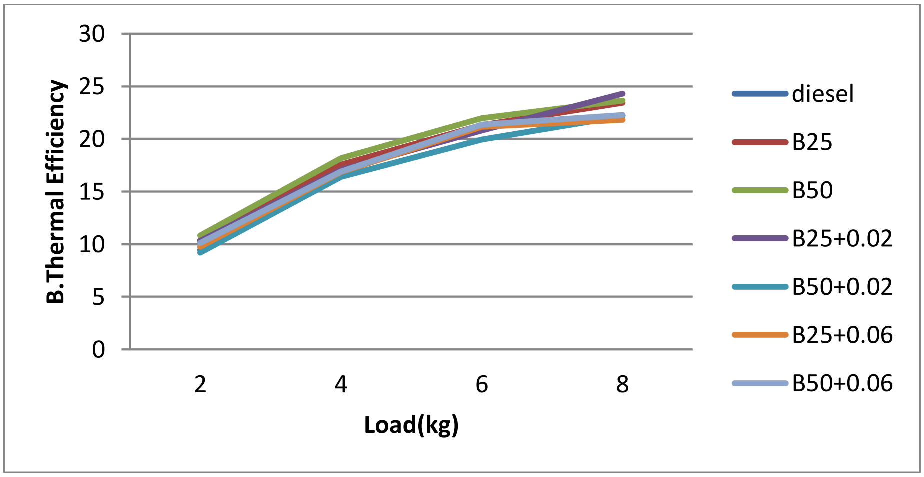

Figure 3: Load Vs B. Thermal Efficiency

3.3 Exhaust gas Temperature (EGT)

The variation of EGT with different loads for all seven fuels was shown in Figure 4. The EGT of the engine decreases with increasing load for diesel and biodiesel and its blends with the addition of Nano additive (cerium oxide (CeO_2)). It was observed that EGT at full load operation is decreases simultaneously with increase in load compared to neat diesel fuel.

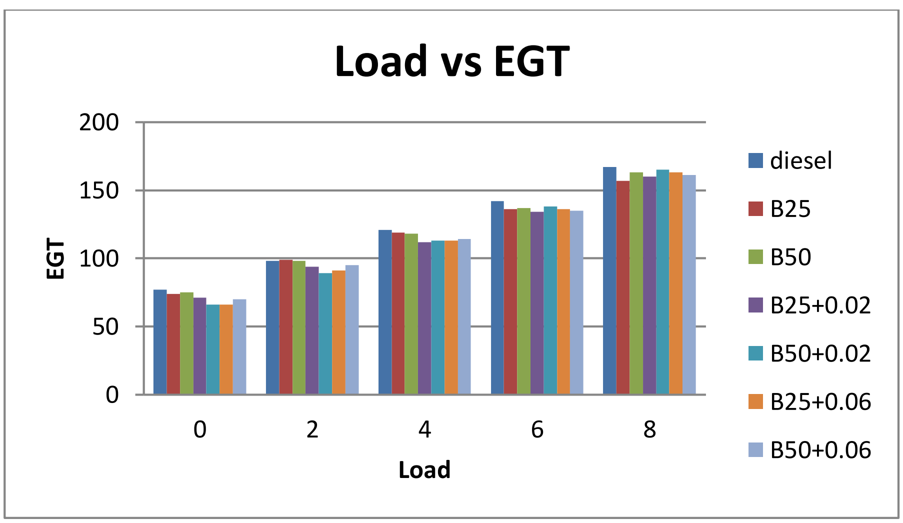

Figure 4: Load Vs Exhaust gas Temperature

3.4 Exhaust emissions

3.4.1 NOx emission

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Figure 5 shows the parts per million (ppm) variations of the NOx emissions of the test engine for mahua oil and its different blends with reference to diesel fuel. The NOx emissions with mahua oil and their different blends B25+0.02 and B25+0.06gm with the addition of Nano additive decrease as compared to diesel fuel. The maximum increase in NOx emissions were obtained in this case of B50 blend.

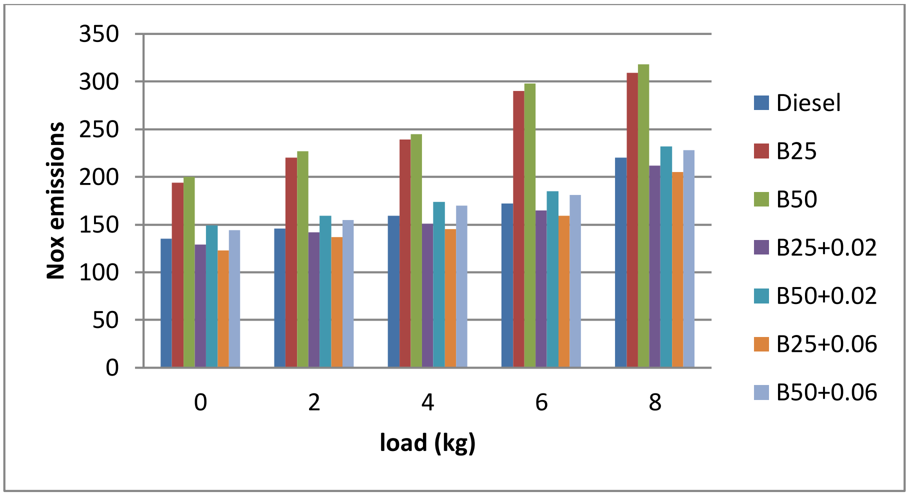

Figure 5: Load Vs NOx Emissions

3.4.2 CO emission

Figure 6 shows the CO emissions of the neat diesel fuel and the biodiesel mixtures with Nano additive. CO is an intermediate combustion product and is formed mainly due to incomplete combustion of fuel. If combustion is complete, CO is converted to CO2. To increase the load the CO emissions will decrease compared to diesel fuel.

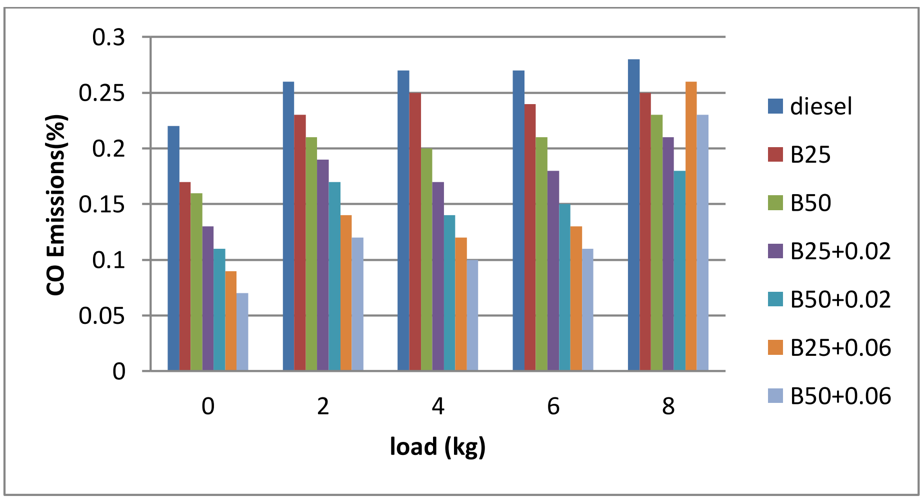

Figure 6: Load Vs CO Emissions

3.4.3 HC Emission

HC is an important parameter for determining the emission behaviour of the engines. It is observed from Figure 7 the HC emissions are decreases as compared to diesel fuel.

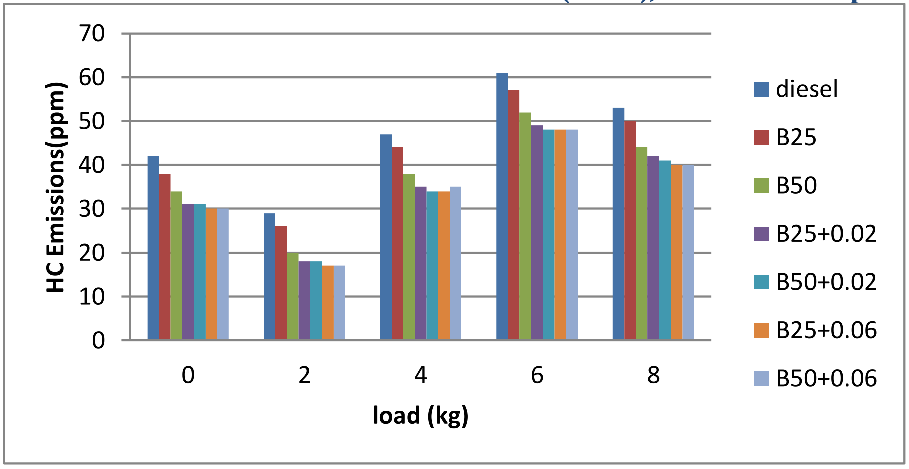

Figure 7: Load Vs HC Emissions

CONCLUSION

The performance, and the emission characteristics of mahua oil and its all blended fuels has been done in a single-cylinder constant speed direct-injection diesel engine. Based on experimental data, the following conclusions have been drawn.

1. The BTE of the engine increases with increasing load for diesel and biodiesel and its blends with the addition of Nano additive (cerium oxide (CeO_2)).
2. The specific fuel consumption is less in lower loads and with an increase in load it is equal to the diesel fuel, why because the fuel blends is due to the lower calorific value of these fuels, compared to neat diesel.
3. The EGT of the engine decreases with increasing load for diesel and biodiesel and its blends with the addition of Nano additive (cerium oxide (CeO_2)).
4. The NOx emissions with mahua oil and their different blends B25+0.02 and B25+0.06gm with addition of Nano additive decrease as compared to diesel fuel.
5. To increase the load the CO emissions will decrease compared to diesel fuel.
6. To increase the load the HC emissions will decrease compared to diesel fuel.

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