Effect of Turbulence on the Performance and Emission Characteristics of Diesel Engine Run with Safflower Oil Diesel Blends

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Abstract: ***In the proposed project it is planned to carry out an experimental investigation on 4- stroke Direct Injection Diesel Engine run with different proportions of Safflower oil blended with Diesel, with a piston having number of grooves on it to create turbulence in order to find out thermal efficiency of the engine and emission characteristics.***

Keywords: Diesel Engine, Turbulence, Safflower oil, Engine Performance, Emissions

1. Introduction

Now-a-days, Increase in the population of automobile vehicles directly causing increase in the Emissions. More over, petroleum products are going to extinct in coming decades. Hence there is a need for best alternate fuel to replace the diesel usage. In search of that best alternate fuel, in this project Safflower oil biodiesel is used and experimental investigation is done to measure performance of engine and emission characteristics. To obtain a better combustion with lesser emissions in direct-injection diesel engines, it is necessary to achieve a good spatial distribution of the injected fuel throughout the entire space available in the combustion chamber. In DI diesel engines, swirl can increase the rate of fuel-air mixing due to the turbulence provided by the grooved piston.

2. Literature Survey

There is a wide variety of Alternative Fuels available as renewable fuels to replace diesel fuel. Swarna Kumari$_{etal}$ (ref 1), have concluded based on experimentation conducted on a Diesel Engine with various proportions of Safflower oil blended with diesel fuel, that, the thermal efficiency of an engine is increased by 5.2% with blend B20 in comparison with diesel. The smoke opacity of the engine is found low with the fuel B20 and all the emissions are compared with Diesel.

Subba Reddy$_{etal}$ (ref 2), have carried out an experimental investigation on D.I Diesel Engine with three different tangential grooved pistons with cotton seed oil methyl ester blended with diesel in various proportions. They have reported a decrease in Brake Specific Fuel Consumption and a slight increase in thermal efficiency, when the engine is operated on blended fuel of 20% cotton seed oil methyl ester and 80% diesel (20BD), compared to that with diesel fuel.

Prathibha $_{etal}$ (ref 3), have carried out an experimental investigation to study about influence of the air swirl in the cylinder upon the performance and emission of a single cylinder diesel direct injection engine by using diesel on volume basis. The swirl intensification was done by cutting grooves over the piston crown. In this work three different configurations of piston i.e. in the order of number of grooves 6,9,12 are used to intensify the swirl for better mixing of fuel and air and their effects on the performance and emission are recorded. In several other reported research works, it has been concluded that the thermal efficiency of an engine enhances with the turbulence created with the help of grooves provided on the piston crown.

3. Safflower oil

Figure 1: (a) Safflower Figure 1(b)Safflower seed

Table 1: Properties of safflower oil

Property	Diesel	B10	B20	B30	B40
Density(kg/m^3)	805.4	811	811.9	821.2	832.3
Calorific value(kJ/Kg)	41991.9	37672	37382	38058	34677
Specific gravity	0.805	0.811	0.8119	0.8212	0.8323
Flash point(^{o} C)	52	70	74	78	80
Fire point(^{o} C)	56	78	80	82	88

4. Experimental Setup

In order to find out the effect of turbulence created by the Grooves provided over the Piston crown, on the performance and emission characteristics of DI Diesel Engine when run with Safflower oil diesel blends, a single cylinder vertical type four stroke, water-coo1ed, self governed type, compression ignition engine is used in the present work.

Table 2 : Specifications of Engine

Engine type	4- Stroke Diesel Engine
B.H.P	5HP
Rated speed	1500 rpm
Bore size	85mm
Stroke length	110mm
Number of cylinders	Single cylinder
Cooling	Water cooled
Cylinder arrangement	Vertical

Table 3: Groove cut specifications

Number of grooves	5
Width of cut	2mm
Depth of cut	1mm

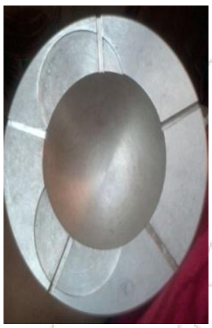

Figure 2: Grooved Piston

5. Results and Discussions

5.1 Brake Thermal Efficiency

Brake thermal efficiency is more for all the blends compared to that of diesel. Among all the blends, B40 blend has more brake thermal efficiency at all all load conditions. This is may due to complete combustion of fuel admitted into the cylinder.

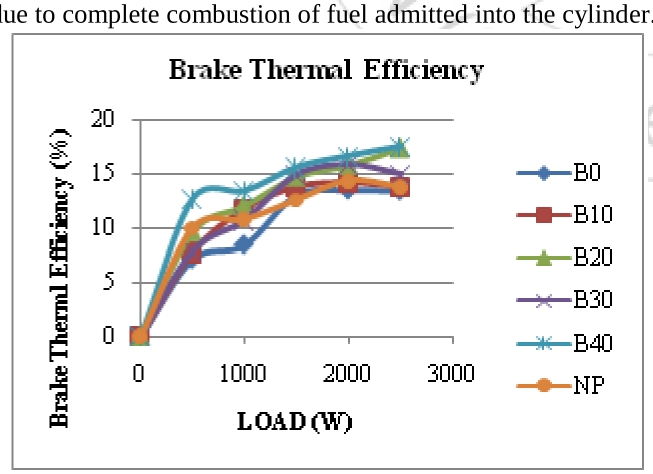

Figure 3: Load Vs Brake Thermal Efficiency

5.2 Indicated Thermal Efficiency

At 3/5th load and 4/5th load conditions, Indicated thermal efficiency is more for the blend B30 compared to that of diesel and other blends. At full load condition, it is more for blend B20 than that of blend B40 by 6.21%.At all load conditions, it is less for blend B40. This may due to variation in amount of total power produced by the engine with respect to heat supplied in the form of fuel.

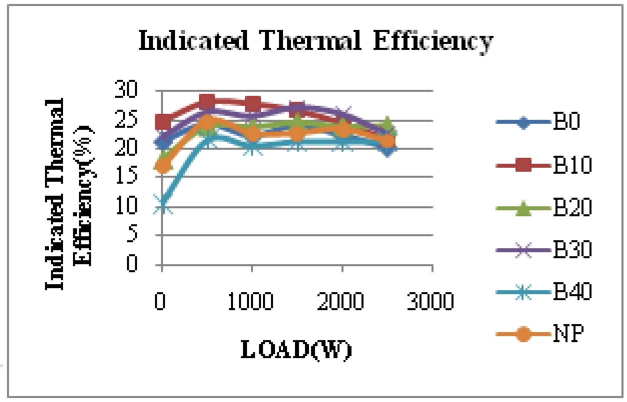

Figure 4: Load Vs Indicated Thermal Efficiency

5.3 Mechanical Efficiency

At all load conditions, Mechanical efficiency is more for the blend B40 compared to that of diesel and other blends.

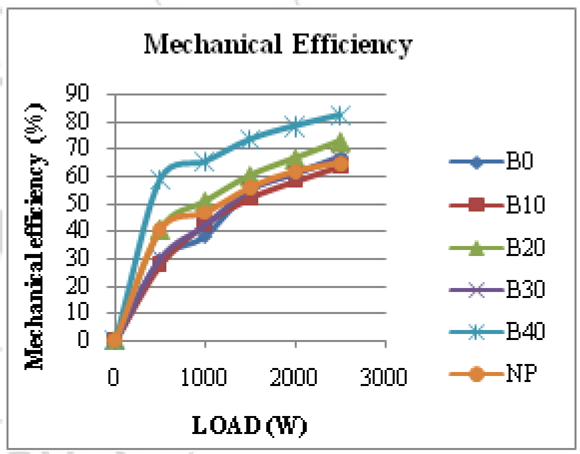

Figure 5: Load Vs Mechanical Efficiency

BSFC:

At all the load conditions, Brake Specific fuel consumption is more for the blend B10.

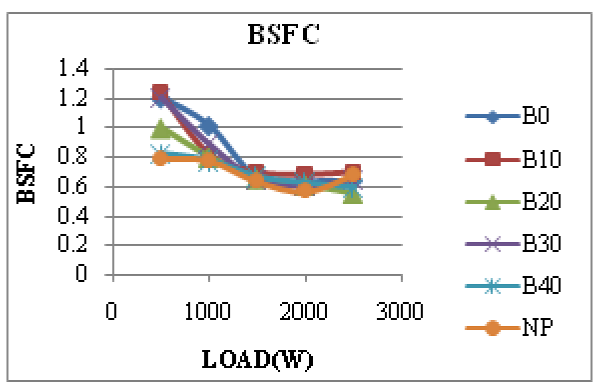

Figure 6: Load Vs BSFC

5.4 NO_x Emissions

Higher NO_x emissions are observed for diesel with Normal piston. At all the load conditions, all the blends have lesser NO_x emissions than that of diesel. In the operating range, NO_x emissions are more for blend B40. This may due to the increase in temperature inside the engine cylinder because of complete combustion of fuel.

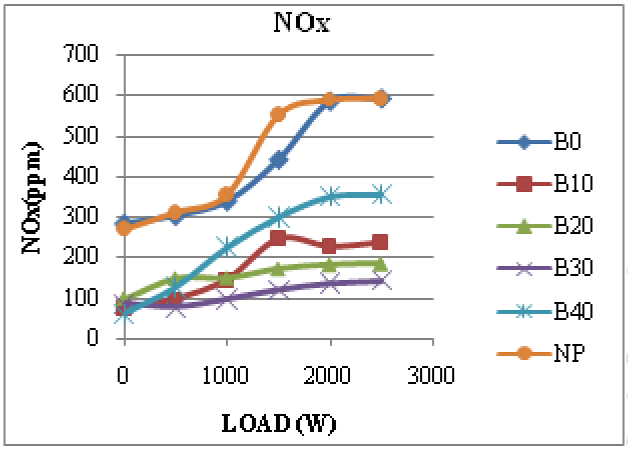

Figure 7: Load Vs NO_x

5.5 CO Emissions

Higher CO emissions are observed for diesel with Normal piston. At all the load conditions, all the blends have lesser CO emissions than that of diesel. In the operating range, CO emissions are less for blend B40. This may due to more availability of oxygen for complete combustion of fuel particles.

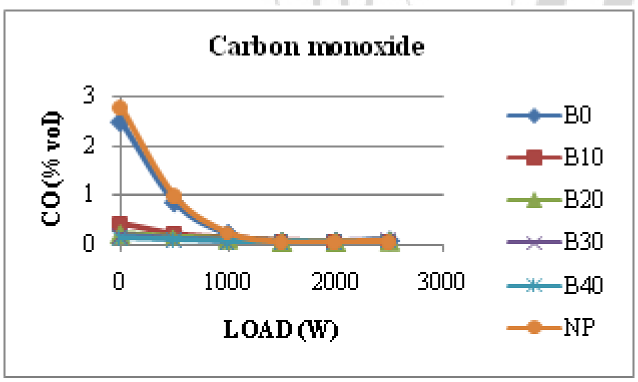

Figure 8: Load Vs CO

5.6 CO_2 Emissions

Higher CO_2 emissions are observed for diesel with Normal piston. At all the load conditions, all the blends have lesser CO_2 emissions than that of diesel. In the operating range, CO2 emissions are more for blend B40.This may due to the complete oxidation of carbon particles present in the fuel.

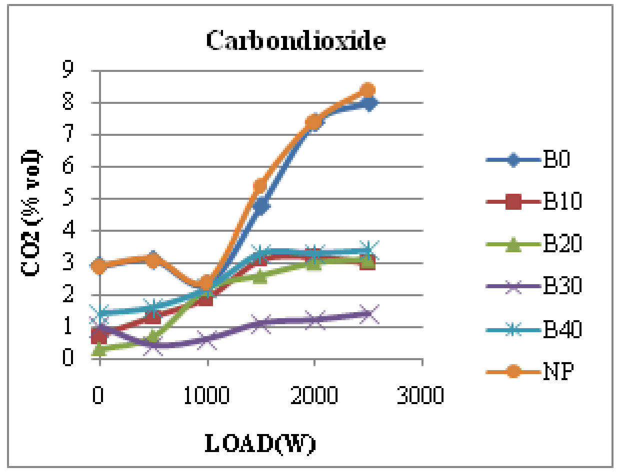

Figure 9: Load Vs CO_2

5.7 HC Emissions

Higher HC emissions are observed for diesel with Normal piston. At all the load conditions, all the blends have lesser HC emissions than that of diesel. In the operating range, HC emissions are less for blend B40 compared to that of all other blends and diesel. This may be due to an increase in residual gas temperature within the cylinder and decrease in flame quenching thickness at higher loads in the engine.

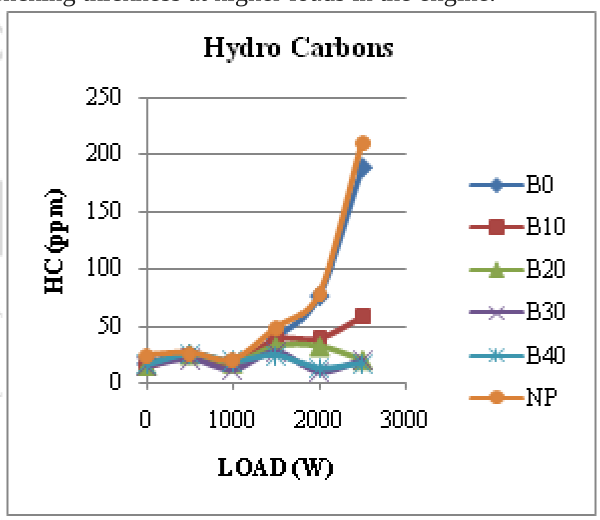

Figure 10: Load Vs HC

6. Conclusions

1. At all the load conditions, Mechanical Efficiency is more for the blend B40.
2. At all the load conditions, Brake thermal Efficiency is more for the all blends compared to that of diesel and is highest for blend B40.
3. At all the load conditions, Indicated Thermal Efficiency is less for the blend B40. At $3/5^{th}$ load and $4/5^{th}$ load conditions, Indicated thermal efficiency is more for the blend B30 compared to that of diesel and other blends. At full load condition, it is more for blend B20 than that of blend B40 by 6.21%

4. In the operating range, at 5/6th load, and full load, BSFC is more for the blend B10 compared to that of diesel by 8.48% and 5.244% respectively.
5. At all the load conditions in the operating range, NO_x emissions are more for blend B40.
6. At all the load conditions in the operating range, CO emissions are less for blend B40.
7. At all the load conditions in the operating range, CO2 emissions are more for blend B40.
8. At all the load conditions in the operating range, HC emissions are less for blend B40.

7. Scope of Future Work

This work can be extended by varying the number of grooves over piston crown or by varying the dimensions of groove cut or by using various types of alternate fuels performance and emission characteristics of engine can be find out.

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