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Investigation Effect of Piston Coating on Performance Characteristics of Diesel Engine Fuelled With Diesel Blend (Diesel +Pine Oil)

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Abstract:
In present world, in view of the fast depletion of fossil fuel resources, there is a need to search for an alternative fuels. Looking at huge demand diesel for transportation, the biodiesel is being viewed as a substitute fuel to diesel. The increasing environmental regulations also make it necessary to improve the functioning of the diesel engine in terms of their durability and efficiency. There is a high a scope in engine technology to increase the engine ratings and reduce fuel consumption. For this purpose, the Thermal Barrier Coating (TBC) has been used in engine technology. One of the possible ways to reduce the heat losses from the engine is TBC. The engine parts which are used for TBC are cylinder head and piston crown. In this work the technique used for TBC is Plasma Spray technique. The piston crown of diesel engine was coated with yttria-stabilized zirconia(YSZ) with a thickness of 0.5mm.The pine oil is directly blended with diesel fuel without any trans-esterification process. Several steps have been carried out to examine performance characteristics of the engine. In the first step the test were conducted on four stroke single cylinder diesel engine by using diesel. Further in the second step investigations were carried out on the same engine with same operating parameters by using pine oil and its blends and also by varying injection pressures and results compared with coated and uncoated piston.

Keywords:-Diesel engine, pine oil, TBC, YSZ, plasma spray technique, performance characteristics

1. INTRODUCTION

Aircraft engine was the first engine used for TBC to calculate the engine performance. The attempt for the concept of TBC for diesel engine is successful in 1980's.There is need for the improvement fuels and fuel economy of I.C engines. Uncountable investigations have been modeled and analyzed the effects of thermal barrier coatings to engine parts.

It results reduction in heat losses, reduction in fuel consumption. There is a danger of depletion of energy resources day by day. These situations have forced the researchers to search for alternative fuels.

Vegetable oil has the greatest potential as alternative fuel due to the fact that they are renewable in nature and produce less exhaust emissions. Biodiesel is the most promising alternative fuel.

1.2 Pine oil

In this work oil used is extracted from oleoresins of pine tree, widely grown for its bark, wood, tar and essential oil, has been decidedly chosen to use in the diesel engine.

It is a renewable biomass based source fuel is unique in that the feedstock originates from the forest and can be blended with petroleum based diesel fuel. Pine oil is pale yellow in color which as fresh forest smells. Rarely it available in three varieties known as gum, wood, and sulphate pine oil, each being produced from the different parts of pine tree and have their own distinctions.

1.3Properties of pine oil and diesel

Tabel.1. properties of pine oil comparison with diesel

Properties	Units	Diesel	Pine oil
Density at 15ºC	Kg/m³	840	875
Kinematic viscosity	m²/s	3.6*10¯6	1.3*10¯6
Flash point	ºC	64	52
Boiling point	ºC	180–340	150–200
Calorific value	KJ/Kg	43,000	42,800

1.4 Thermal barrier coatings

Thermal barrier coatings are duplex systems consist of
(i) The top coat (TC), a porous ceramic layer that acts as the insulator
(ii) The bond coat (BC), an oxidation-resistant metallic layer between the substrate and the TC and
(iii) The super alloy or other material substrate that carries the structural load.

A thermal barrier application is shown in figure1.

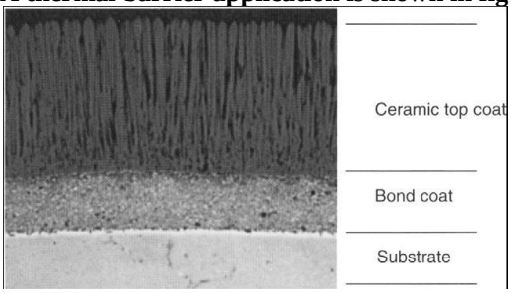

Figure.1. TBC consist of TC and BC

1.5 plasma spray technique

There are four methods of thermal spraying technique they are as follows

1. Chemical deposition method
2. Plasma arc method
3. Physical vapor deposition method
4. Plasma spray method

In this paper we used plasma spray technique method to coat the piston. The main objective of this method is to constitute a thin layer of high protection value over other exposed surfaces.YSZ is sprayed in powered from molten in ionized gas rapidly on the piston crown surface.

2. EXPERIMENTAL SETUP

Here a four stroke diesel engine connected with electrical loading is used to estimate the performance analysis at different loading conditions and diesel blend with piston coating and without piston coating.

Specifications of engine:

Bore		80mm	
Stroke		110mm	
RPM		1500	
BHP		5	
CR	Generator efficiency	16:1	80%

Test rig:

Figure.2.4 stroke single cylinder diesel engine set up with generator loading

Experimental procedure:

Before going to start the engine check whether there is any air gap in between the cylinder head and piston. Then run the engine with diesel fuel for 10 to 15 minutes before using the pine oil blends in order to attain stable condition. After that drain out the diesel fuel completely from the diesel tank and then pour sample of pine oil blends of 500ml in to the tank and note the optimum temperature of the engine. At constant speed of 1500 rpm, engine is loaded with 0%, 5%, 25%, 50%, 75%, 100% load by using an eddy current dynamometer the B5 and B10 proportions of pine oil blends are tested at all load conditions running at the same speed, where the experimental procedure is same for reaming blends to be tested.

3. PERFORMANCE OF DIESEL BLENDS WITHOUT PISTON COATING AT FUEL INJECTION PRESSURE 180BAR

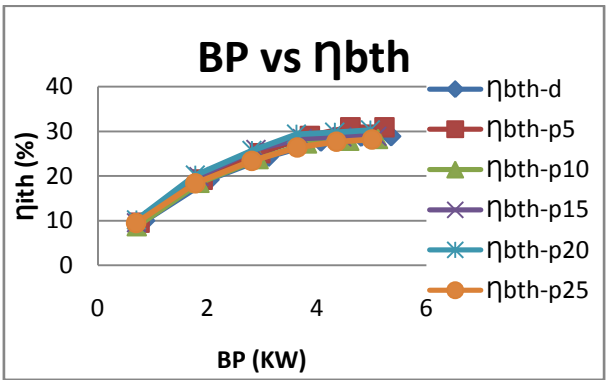

Figure. 3.1performance of diesel blends at 180 bar pressure BP VS ηbth

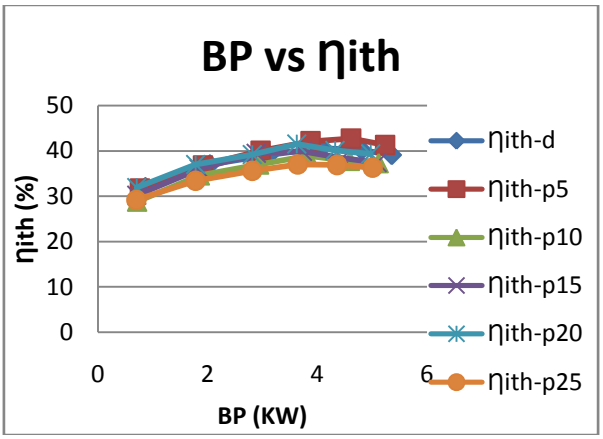

Figure.3.2 Performance of diesel blends at 180 bar pressure BP VS ηith

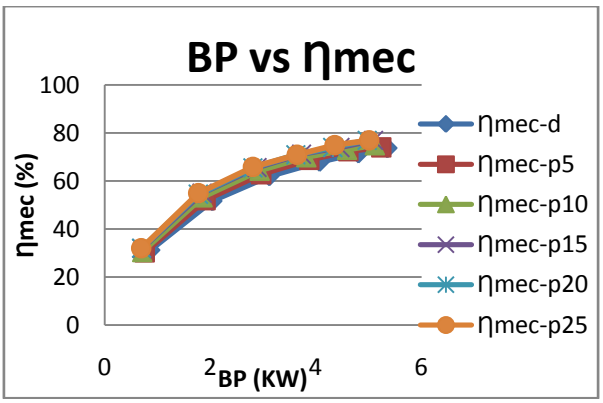

Figure.3.3 Performance of diesel blends at 180 bar pressure BP VS ηmec

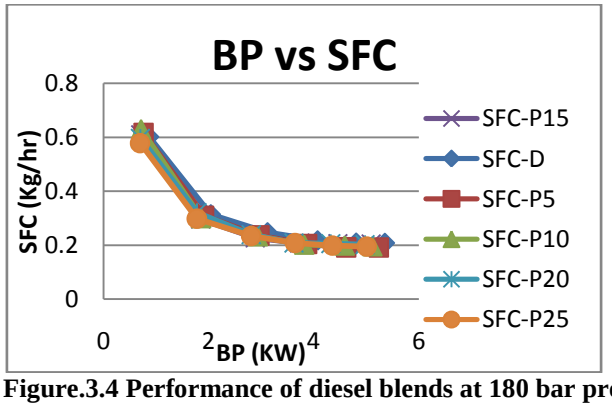

Figure.3.4 Performance of diesel blends at 180 bar pressure BP VS SFC

At fuel injection pressure 205 bar

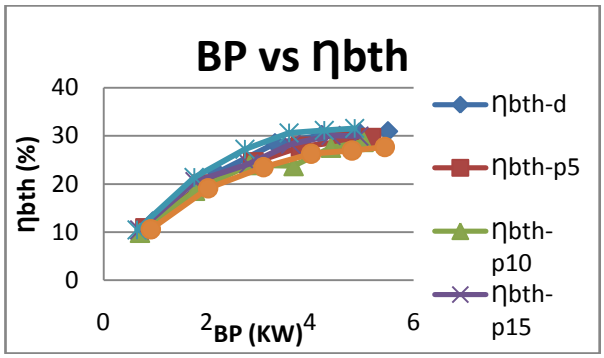

Figure.3.5performance of diesel blends at 205 bar pressure BP VS ηbth

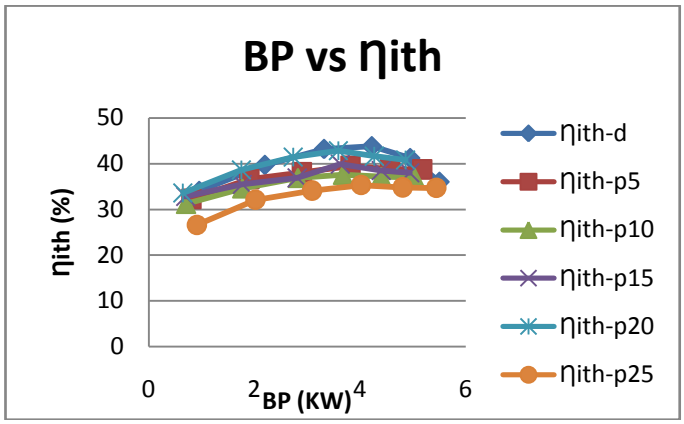

Figure.3.6 Performance of diesel blends at 205 bar pressure BP VS ηith

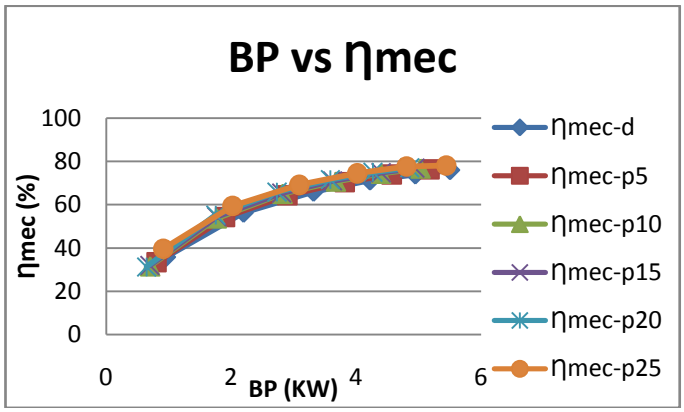

Figure. 3.7 Performance of diesel blends at 205 bar pressure BP VS ηmec

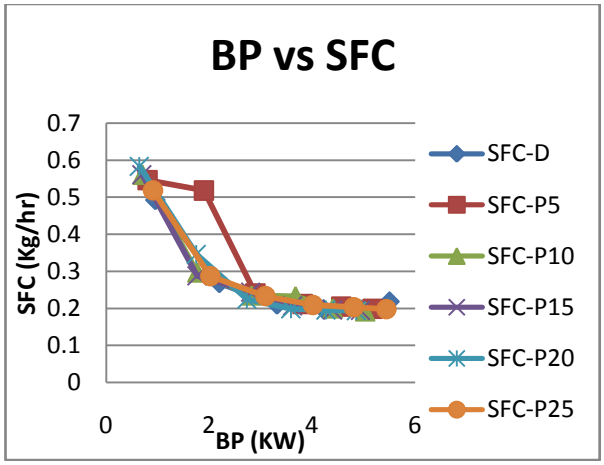

Figure.3.8 performance of diesel blends at 205 bar BP VS SFC

3.2 performances of diesel blends with piston coating
At fuel injection pressure 180 bar

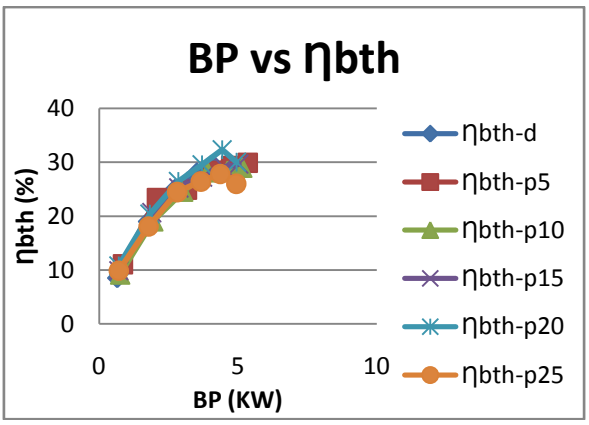

Figure.3.21 performance of diesel blends at 180 bar pressure BP VS ηbth

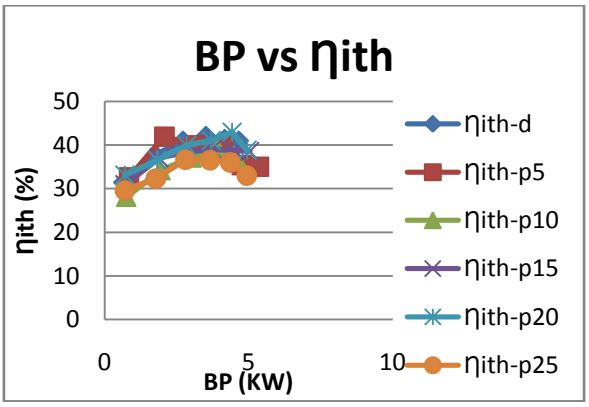

Figure.3.22 performances of diesel blends at 180 bar pressure BP VS ηith

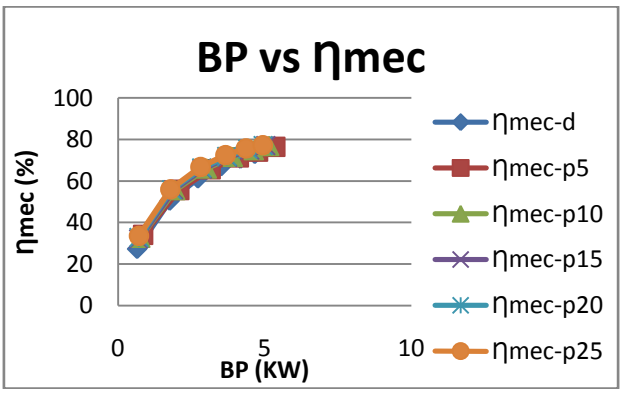

Figure.3.23 Performances of diesel blends at 180 bar pressure BP VS ηmec

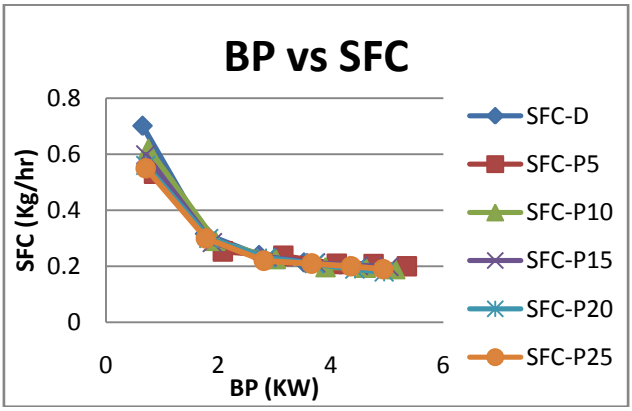

Figure. 3.24 Performance of diesel blends at 180 bar BP VS SFC

At fuel injection pressure 205 bar

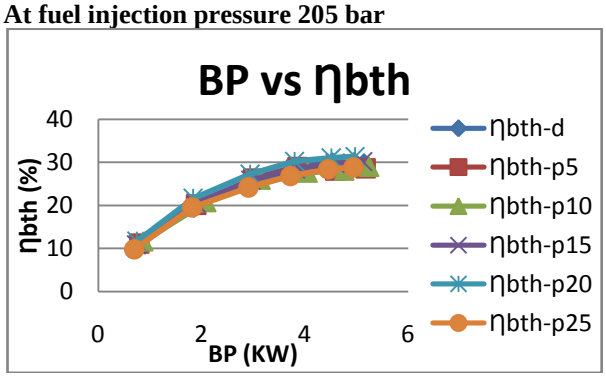

Figure.3.25 Performance of diesel blend at 205 bar pressure BP VS ηbth

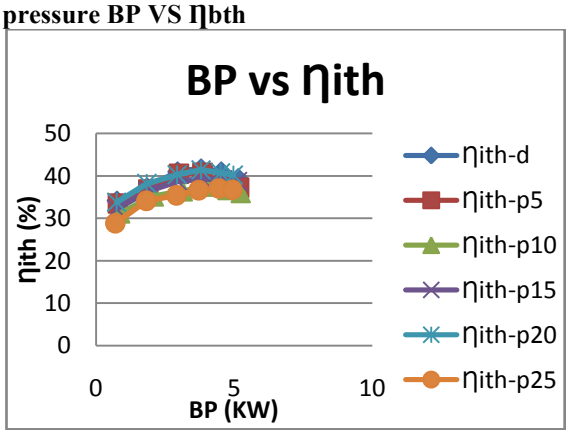

Figure.3.26 Performance of diesel blends at 205 bar pressure BP VS ηith

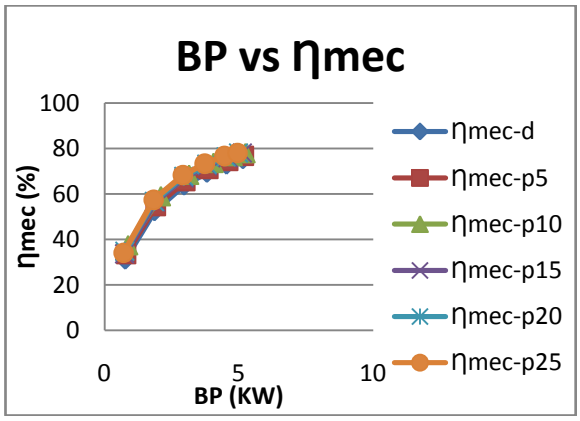

Figure.3.27 Performance of diesel blends at 205 bar pressure BP VS ηmec

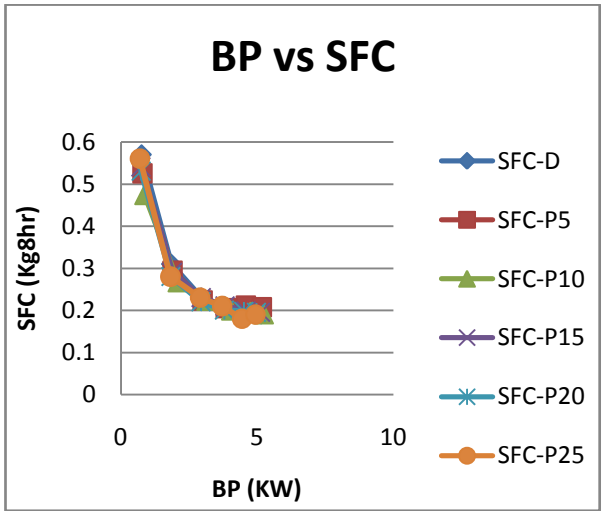

Figure.3.28 Performance of diesel blends at 205 bar BP VS SFC

4. CONCLUSION

With the above results at fuel injection pressure 205 bar, performance of diesel engine with diesel blends is good when compared with fuel injection pressure at 180 bar with piston coating At 25% blend and 20% blend with coating, mechanical efficiency, break thermal efficiency, indicated thermal efficiency is increased and SFC is decreased when it is compared with the pure diesel operation without coating

The performance characteristics of the engine with diesel blends 25% and 20% are giving better results, while comparing these two blends, in account of, mechanical efficiency and SFC 25% blend is good, where as taking in account of brake thermal efficiency and indicated thermal efficiency 20% blend is good. But in point of cost of fuel, the performance characteristics of the engine with 20% diesel blend is better.

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