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The Influence of Swirl on Performance Characteristics of Diesel Engine Using Biodiesel Blends

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ABSTRACT

Diesel engines combustion quality is predicated on the formation of fuel-air amalgamation. The in-cylinder air kineticism in internal combustion engines is one of the most consequential factors controlling the combustion process of CI engine and emissions can be controlled by engendering turbulence, by designing intake system, by designing combustion chamber. A good swirl promotes expeditious combustion to amend the efficiency.

In the present context, the world is confronted with the twin crisis of fossil fuel and environmental degradation. The fuel economy is achieved by efficient combustion inside the cylinder which is possible by uniform commixing of air and fuel in the cylinder. The fuel injection pressure and the swirl kineticism have a great impact on efficient combustion.

The objective of the present study is to enhance the swirl effect in the cylinder which causes better performance and reduces the emissions. In this work an endeavor is made on D.I Diesel engine with grooved piston fuelled with pine oil coalesced with diesel in sundry proportions.

KEY WORDS: Diesel engine, pine oil, performance characteristics

1. INTRODUCTION

The combustion efficiency in the combustion chamber depends on the formation of homogeneous coalescence of fuel with air. The formation of homogenous cumulation depends on the amount of swirl engendered in the combustion chamber. This further increases the thermal efficiency of the engine. This investigation leads to amendment in performance, combustion and emission characteristics of a D.I diesel engine through methods enabling amendment in ignition characteristics of the fuel by engendering turbulence in the cylinder, for the achievement of better fuel air commixing

To enhance the efficiency of an engine it is paramount to optimize thermal efficiency, which is obtained at the highest possible compression ratio. However, if the compression ratio is too high, there is a chance to have knock, which should be evaded at all cost. A solution for this quandary is to promote rapid combustion, to reduce the available time for the self-ignition to occur [1]. For the promotion of rapid combustion, adequate immensely colossal-scale turbulence (kinetic energy) is needed at the cessation of the compression stroke because it will result in a better commixing process of air and fuel and it will withal enhance flame development. However, high turbulence leads to exorbitant heat transfer from the gases to the cylinder walls, and may engender quandaries of flame propagation [2] [3] [4]. The key to efficient combustion is to have ample swirl in the combustion chamber prior to ignition.

The Swirl can be engendered in the diesel engine by modifying three parameters in the engine, they are the cylinder head, the piston i.e. modification of combustion chamber and the inlet manifold [5]. Lin.et.al [6] has invented a multi impingement wall head is located at the center of the cylinder head to enhance the swirl and squish. Somendersingh [7] has identified a method to amend turbulence in combustion chamber by making grooves on the cylinder head, to reduce the heat losses; the burn time needs to

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be as expeditious as possible. According to Al-Rousan[8] swirl is engendered in the inlet manifold by inserting a loop inside the intake manifolds to increment the swirling in the air during induction. Rasul and Glasgow [9] prepared a convergent-divergent induction nozzle and is tested in order to increment the airflow into the engine, which may increase the overall performance.

2. Pine Oil –an overview

In this study, oil derived from oleoresins of pine tree, widely grown for its bark, wood, tar and essential oil, has been decidedly chosen to be utilized as fuel for diesel engine. Pine oil, stable under all conditions of avail and storage, is unique in that the feedstock originates from the forest and can be coalesced with petro-predicated diesel fuel yarely. For the current study, gum pine oil is being used and extracted from pine oleoresin, which is traditionally obtained from pine tree, is pale yellow in colour with fresh forest smell and is soluble in alcohols and other mineral oils. The estimated world engenderment of pine was reported to be 30,000 tons per annum and the authoritative ordinance for pine oil by 2022 was soothsaid to be 853,894 tons.

The constituents of pine oil are terpineol, which is a tertiary alcohol, dipentene (an isomer of pinene), unreacted pinene and some minor quantities of other by-product and impurities. The α-pinene, amassed from pine tree, has been converted into α-terpineol (c10H18O) by acid-catalyzed hydration process. It could be comprehended from the molecular formula of pine oil that it contains intrinsically oxygen within the structure, which is obtained as the result of the hydration reaction, catalyzed by an acid. Homogeneous to lower alcohols such as ethanol and methanol, pine oil has C, H and O atoms in its structure, emerging as a renewable feedstock in the realm of other alternate fuels. However, contrary to other alcohol type of fuels, pine oil has higher calorific value,which make it as one of the congruous biofuel to be utilized in diesel engine. Moreover, pine oil has lower viscosity and boiling point, which could increment the fuel atomization and its vaporization. All the other properties of pine oil, determined by some standard methods, and it qualify as a potential candidate for diesel engine.

Tabel1: properties of pine oil comparison with diesel

Properties	Units	Diesel	Pine oil
Density at 15ºC	Kg/m^3	840	875
Kinematic viscosity	m^2/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

3. Experimental setup and arrangement

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3.1 Test engine

The experimental setup encompasses a Kirloskar stationary diesel engine and a water cooled eddy current dynamometer. The engine employed for the current investigation is a naturally aspirated engine and it has hemispherical shaped bowl in piston combustion chamber. Fig. 1 clearly depicts the experimental setup and various instrumentation. The engine develops a power of 5.2 kW and is operated at an injection pressure of 220bar. The operating and design conditions of the engine are kept at manufacturer's default value. Mechanical type fuel injection system is used and the engine is tested using pine oil without any modifications. The specifications of the engine are shown in Table 2.

3.2 Experimental procedure

Prior to starting the experiments with various blends of pine oil, the engine was made to run for 30 minutes with diesel so as to attain a steady state and create normal working temperature environment. After the test run, the base fuel was completely drained out from the tank, fuel pump and lines and replaced by test fuels. Further, before monitoring the results, the lubrication oil and cooling water temperature were noted to ensure whether the engine has reached warm up condition. The engine was loaded from 10% to 50%, progressively in the steps of 10% by controlling the current supplied to the eddy current dynamometer. Since the engine being used is a constant speed engine, operated at 1500 rpm, the fuel pump is adjusted to maintain the constant speed at different loading conditions. Different blends of pine oil with diesel such as 10% pine (pine-10% and diesel-90%) ,20% pine (pine-20% and diesel-80%) and 50% pine (pine-50%and diesel-50%), were prepared and tested for its performance characteristics. All the readings, pertaining to the engine experimentation and investigation, were noted down at ambient conditions, when the engine was stabilized and has attained steady state condition.Same procedure is continued for tangential grooved piston engine.

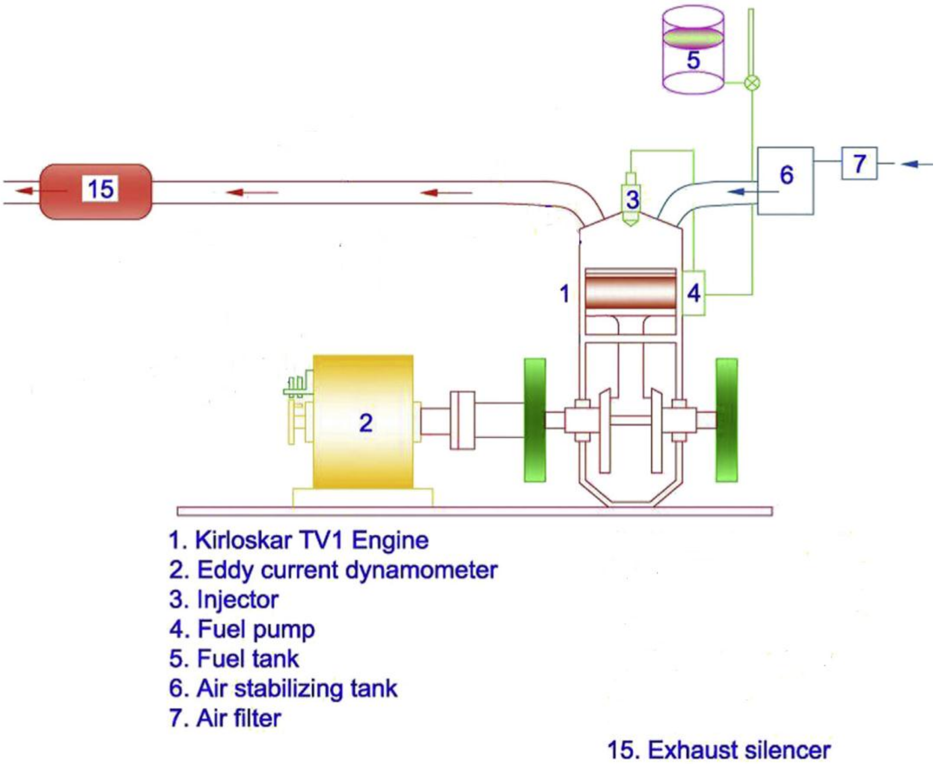

Fig Schematic diagram of experimental setup.

Table Engine Specifications

Type	**Four stroke, Kirloskar make, compression ignition, direct Injection, constant speed, vertical, Water cooled**
No of cylinders	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Rated power	5.2 kw
Rated Speed	1500 rec/min
Start of injection	23^0 BTDC
Injection Pressure	205 bar
Type of injection	Mechanical pump-nozzel injection
Lubricant oil	SAE40

The piston crown of 80 mm diameter of base line engine is modified by producing four tangential grooves. In the present experiment, four tangential grooves of width of 6.5mm, was produced on piston of 80 mm diameter and maintaining constant depth of 1 mm in piston. The experiments are conducted with the tangential grooved pistons and their performance and emissions are compared with base line piston of diesel engine (BLE) and with pine oil blends. The effect of the geometry of the grooves shown in Figure-1 on combustion performance is analysed in the study.

Figure 3 Tangential grooves on piston

4. Results and discussion

The results obtained from tangential grooved pistons of TGP for all blends of pine oil with 0BD, 10BD, 20BD, 30BD,40BD and 50BD blends are analyzed. The results thus obtained are compared with that of base line diesel engine (BLE). Based on the output results, the discussions are presented in the following.

4.1 Brake Thermal Efficiency

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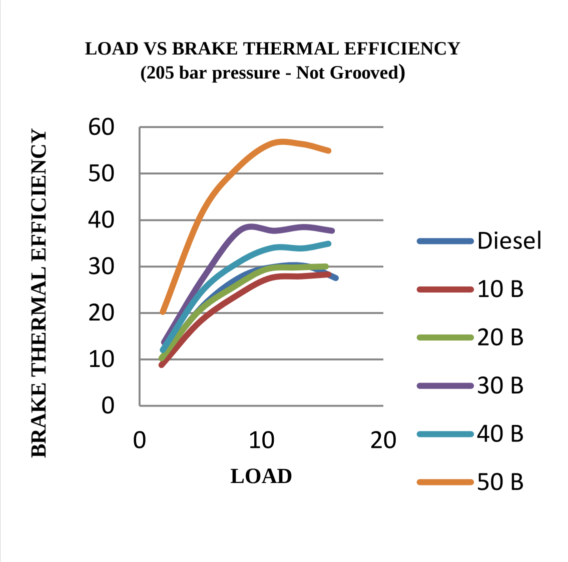
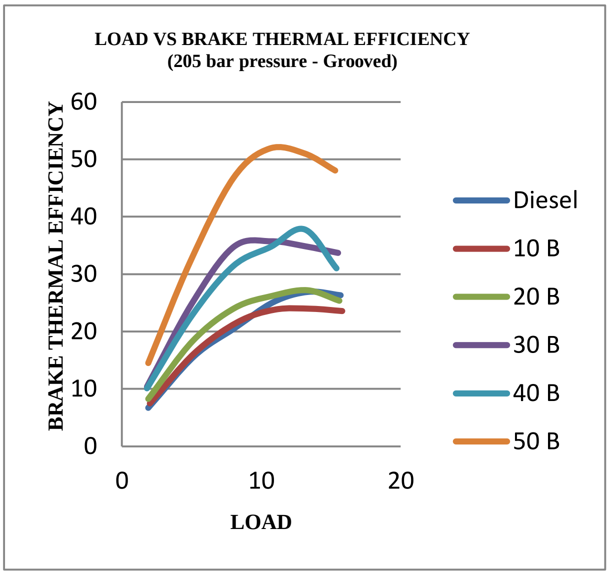
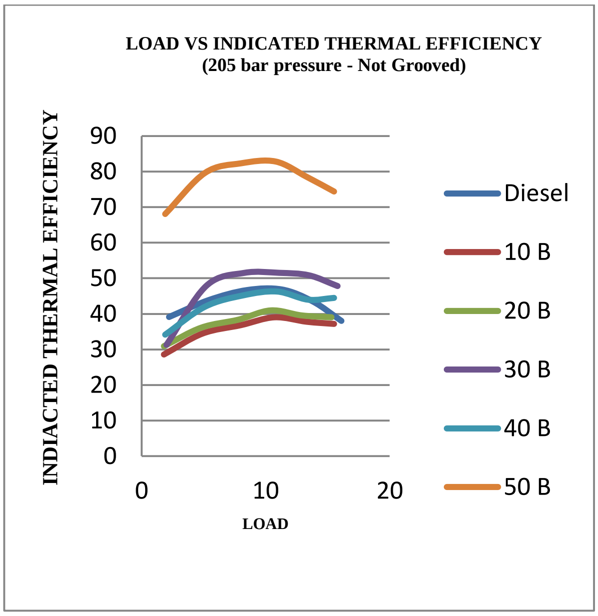
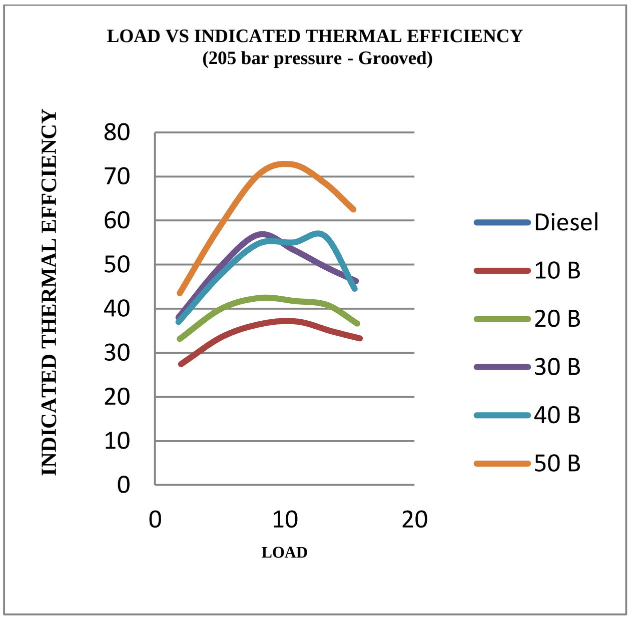




4.2 Indicated Thermal Efficiency





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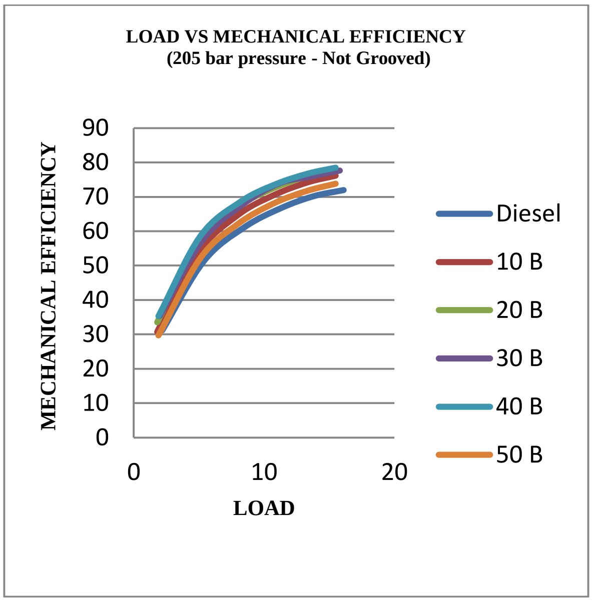
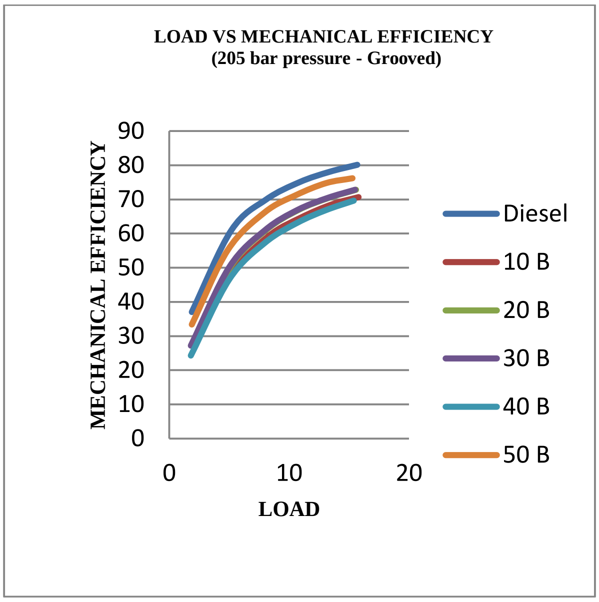
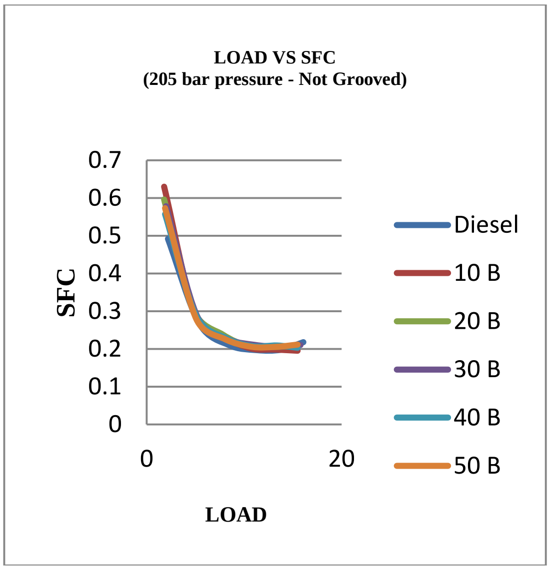
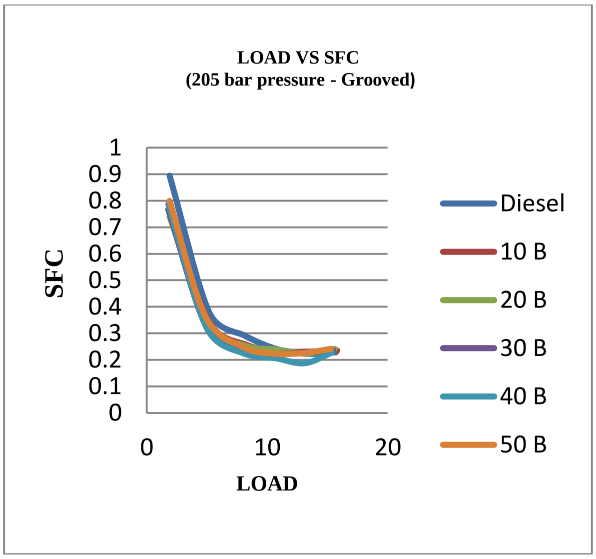
4.3 Mechanical Efficiency





4.4 Specific Fuel Consumption





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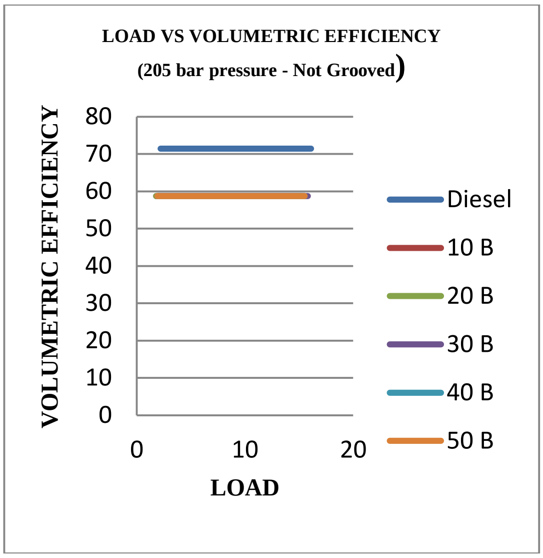
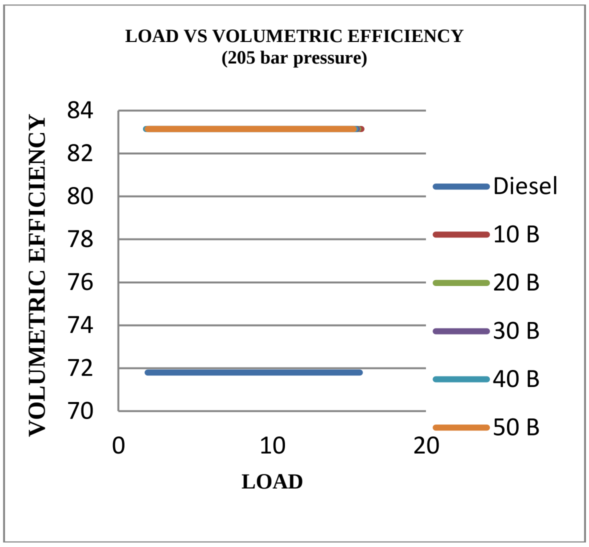


4.5 Volumetric Efficiency



5. RESULT

By blending the pine oil with diesel the efficiencies of the engine can be increased.

- At the injection pressure of 205 bars (blending of diesel with pine oil and without piston grooves) brake thermal efficiency, indicated thermal efficiency, mechanical efficiency and volumetric efficiency increases. Specific fuel consumption is merely same as diesel.
- At the injection pressure of 205 bars (blending of diesel with pine oil and with piston grooves) brake thermal efficiency, indicated thermal efficiency, mechanical efficiency and volumetric efficiency increases. Specific fuel consumption reduces.

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