EXPERIMENTAL INVESTIGATIONS ON THE PERFORMANCE OF CI ENGINE USING DIESEL AND BIODIESEL BLENDS OF PINE OIL WITH MESHED BLUFF BODIES

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Abstract: Due to the increase of automobiles from past decade, emissions are also increasing. In order to reduce emissions and to increase the engine performance some of the techniques used are modification of piston crown, designing the combustion chamber. In the present work meshed bluff bodies are used which is one of the technique to improve the performance of the engine. The purpose of meshed bluff body in the piston crown is, at the end of compression stroke when the piston approaches the TDC, the fuel injector injects a metered quantity of fuel in a finely atomised form into the mesh, this fuel molecules will absorb the heat and carried away by the mesh in the first cycle. In the second cycle the fresh air fuel mixture is injected on the mesh the stored heat which helps to pre-heat the air fuel mixture. Due to this meshed bluff body the delay period is reduced. Due to this complete combustion takes place inside the cylinder and increases the engine performance. In this experiment conventional piston, brass crown and meshed bluff bodies with diesel and blends of pine oil are used on the test engine. Out of all these pistons tested, one of them (meshed bluff body) is found to be best in terms of efficiency.

Index Terms— Direct injection diesel engines, meshed bluff bodies, performance, pine oil.

I.INTRODUCTION

The increasing industrialization, agricultural applications and motorization of the world has led to a steep rise for the demand of petroleum products. Petroleum based fuels are obtained from limited reserves. Therefore rising crude oil prices and the increasing concerns for environment problems. The major part of all energy consumed worldwide comes from fossil sources (petroleum, coal and natural gas). However these sources are limited and will be exhausted by the near future. Thus looking for alternative sources of new and renewable energy, Alternative new and renewable fuels have the potential to solve many of the current social problems and concerns, from air pollution and global warming to other environmental improvements and sustainability issues. Vegetable oils hold good promise as alternative fuel for diesel engines. They are biodegradable and renewable fuels . Certain edible oils such as palm, sunflower,coconut,olive, rapeseed and cottonseed and some of the non-edible oils such as Karanja (Pongamia pinnata), mahua (Madhuca Indica), mustard, neem (Azadiracta indica), rice bran, linseed,pine, jatropha (Jatropha curcas) etc. were tested to their performance in diesel engine. Since straight vegetable oils are not suitable as fuels for diesel engines, they have to be modified to bring their combustion related properties closer to diesel. This fuel modification is mainly aimed at reducing the viscosity to eliminate flow or atomization related problem. A number of vegetable oils like rapeseed oil, neem oil, palm oil, karanji oil, coconut oil, cottonseed oil, jatropha oil, etc., were tested to evaluate their performance in diesel engines. In this experiment pine oil is used because pine oil possesses lower viscosity, boiling point and flash point, similar to other plant based fuels like ethanol and eucalyptus oil. Pine oil has been identified to contain terpineol, a higher alchol , along with pinene, which is an alicyclic hydrocarbon.

II.LITERATURE SURVEY

V.V Prathiba[1] investigated that by cutting grooves on the piston crown will affect the swirl for better mixing and hence reduction in brake specific fuel consumption (BSFC) and smoke. *Sushmith*[2] investigated on Effect of Turbulence on the Performance and Emission of Diesel Engine Run with Safflower Oil Diesel Blends of Circular Groove Piston will effect on air flow motion in the piston bowl hence there will be improvement in combustion efficiency. *C .V. Subba Reddy*[3] reported that Combustion chamber geometry have significance influence on the engine performance, the combustion chamber with the four tangential grooves on the piston crown will effect on air flow motion in the piston bowl hence there will be improvement in combustion efficiency which is due to formation of homogeneous mixture of fuel with air and greater turbulence in the cylinder. The combustion efficiency in the combustion chamber depends on the formation of homogeneous mixture of fuel with air. The formation of homogenous mixture depends on the amount of turbulence created in the combustion chamber. *Dr.K.Kalyani Radha and D.Basker* [4] who had investigated on this work .The tests are conducted on piston with bluff body oriented in parallel and perpendicular to the piston pin axis. In regard to the experimental investigation on the performance and emission characteristics of a direct injection diesel engine by using bluff bodies parallel and perpendicular orientations to piston pin axis on high speed diesel fuel gives improved performance with reduced emissions. In the case of bluff body oriented in perpendicular to piston pin axis has the maximum performance when compared with the piston with parallel bluff body and conventional piston. *G. Soma sekhar and Dr.K.Kalyani Radha[*5] who had investigated on the arrangement of a circular shaped threaded rod of 5 mm diameter is placed in the piston bowl on piston with vertical position to the piston pin axis. In regard to this experimental investigation on the performance and emission characteristics of a direct injection diesel engine gives improved performance with reduced emissions when compared to the circular shaped non-threaded rod. Based on this reference work further experiment has been conducted by some other modifications. In this experiment the modification of the piston is meshed type bluff body. *G. Abhilash*[6] investigated on the performance of 4 stroke DI diesel engine an emission characteristics by different types of air gaps in piston. The concept of air gap insulated piston has been explored by providing 1mm air gap within the piston by using bolted type piston. The bolted air gap insulated piston provides complete sealing of air gap necessary for

continued insulation. The design evolved provides high insulation combining adequate durability. The insulation betterment in fuel consumption at normal operating condition than a conventional piston engine. Based on the above reference work further experiment is conducted by some modifications. In this project work, the various performance characteristics of a single cylinder direct injection diesel engine were studied by using an alternative fuel of the bio fuel mixed with pine oil and its blends. In the present experiment meshed bluff body is arranged in the piston crown. The thickness of the mesh is 0.177mm and it occupies very less space in piston crown when compared with circular shaped threaded rod of 5mm diameter. .The usage of meshed bluff body in the piston crown is when the piston approaches the TDC, a portion of the air-fuel mixture is injected into the meshed bluff body in the form of fluid flow. This fluid gets split into tiny particles while passing through the mesh this fuel molecules will absorbs the heat and carried away by the mesh in first cycle. In second cycle the fresh air fuel is injected on the mesh which further helps to pre-heat the air fuel mixture, due to this delay period is reduced.

III.EXPERIMENTAL SETUP

The experimental set up consists of engine, a Dynamometer, top load system, air filter, fuel tank and manometer. A single cylinder vertical type four stroke, water-cooled compression ignition Kirloskar engine is used. This engine can withstand the peak pressures encountered because of its original high compression ratio. The engine setup enables the evaluation of thermal performance and emission constituents of the engine. The thermal performance parameters include brake power, heat input, brake thermal efficiency, mechanical efficiency and brake specific fuel consumption,. Further, the necessary modifications is made i.e., piston is replaced with brass material and meshed bluff body on the cylinder head and piston crown can be easily carried out, hence this engine is selected for the present project work.

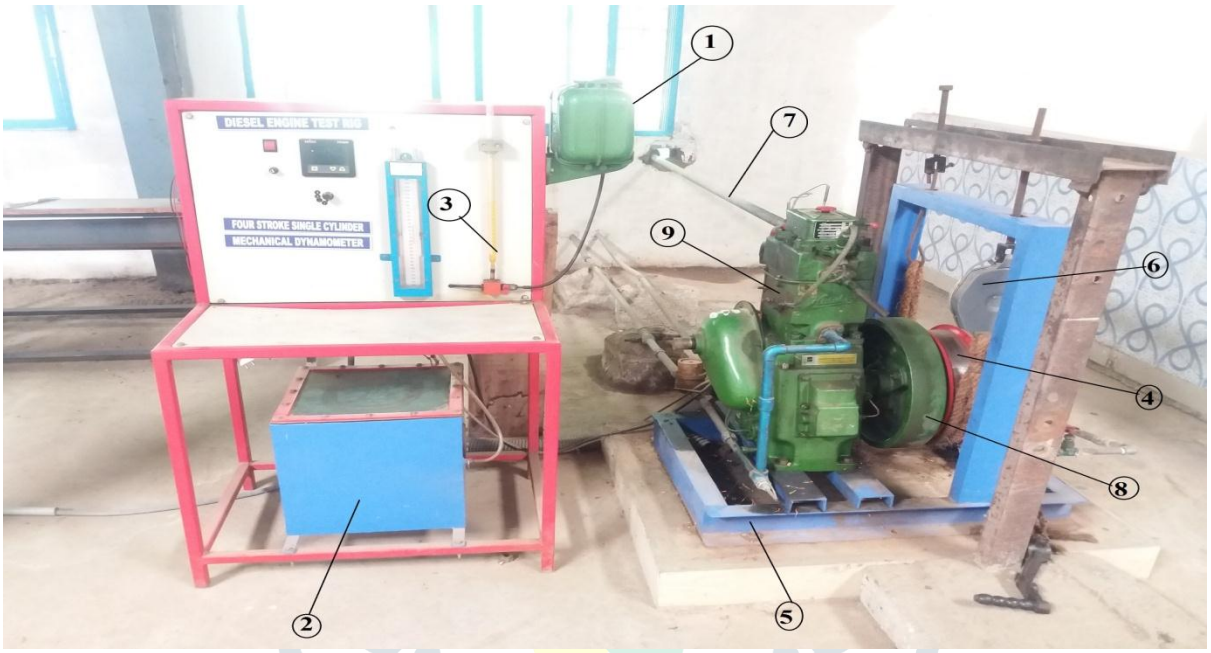


Fig 1: Experimental setup

List of components:

1.Fuel tank; 2.Air filter; 3.Manometer Reading; 4.Dynamometer; 5.Frame; 6.Load cell; 7.Exhaust system; 8.Fly wheel; 9.Engine.

Engine Specifications:

Table 1: Engine specifications of single cylinder diesel engine

Engine parameters	**Specifications**
Maker	Kirloskar
Engine type	Single cylinder four stroke, water cooled, CI engine
Arrangement of cylinder	Vertical
Bore	80 mm
Stroke	110 mm
Fuel	Diesel
Speed	1500 rpm
Rated power	5 HP
Power out put	3.7 KW

Fuel Specifications:

Table 2: Properties of fuel

properties and standards	**Diesel**	**Pine oil**
Density 35^0C (Kg/m^3)	831	857
Calorific Value(KJ/Kg)	42000	41500
Kinematic viscosity(m^2/sec)	3.82	3.07
Color	Reddish	Pale yellow

Flash point(^{0}C)	52	54
Fire point(^{0}C)	65	65

Arrangements of meshed bluff bodies:

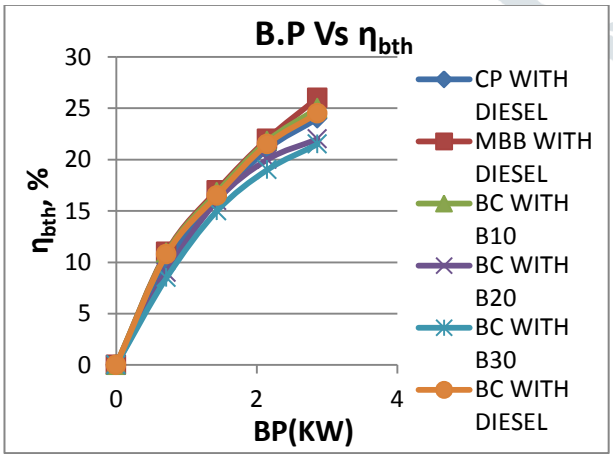
The conventional piston is replaced with brass crown piston, and later replaced with meshed bluff body. The 13mm length of the piston crown is to be cut by using the vertical milling machine. The top of the material is used brass because it has the capacity to withstand higher thermal conductivity and the piston material is used as aluminium. Meshed type layer is used between the top of the piston crown and bottom of the piston crown which is made of aluminium. The weight and diameter of mesh is 1 gm and 80mm respectively. The thickness of the mesh is 0.177mm which is very less, when compared to the volume of the circular shaped threaded rod having 5mm (reference work) The size of the screws used to fit the top of the piston crown is M4*20 by using LN key. Main purpose of using meshed bluff bodies is when the piston approaches the TDC, a portion of the air-fuel mixture is injected into the piston crown While passing through the mesh heat is generated inside the mesh and stored in the first cycle, the stored heat in the first cycle used for the next cycle which helps in pre-heating the air fuel mixture, due to this delay period is reduced. The bluff body can allow the flame to propagate through it and enhance to burn charge completely without any hot spots. By this mechanism, combustion is rapid and complete, resulted in lower engine operating temperatures, and enhanced torque and power through the range of the engine operation, emitting lower emissions, smoother operation and increased engine life. So, the enhancement in performance of a direct injection diesel engine is achieved with diesel and blends of pine oil at constant speed and varying loads at 180 bar injection pressure.

Fig.2. Piston with meshed bluff bodies and brass crown piston

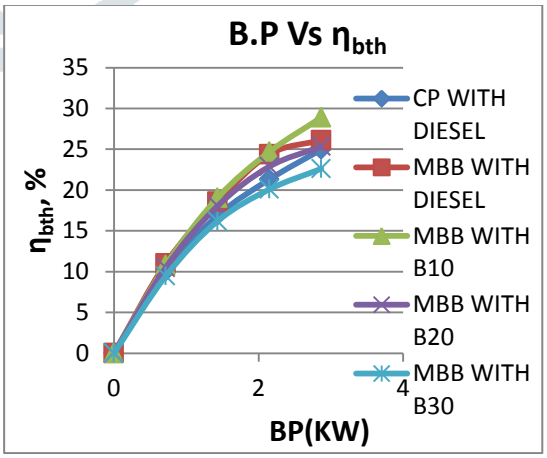
IV.RESULTS AND DISCUSSIONS

The performance of the engine is evaluated in terms of brake power and brake specific fuel consumption, brake thermal efficiency and mechanical efficiency. In this result the efficiency of the engine is improved. The results obtained by brass crown piston and meshed bluff bodies are compared with that of the conventional piston.

1. Brake thermal efficiency:



Graph-1: Brake power vs brake thermal efficiency



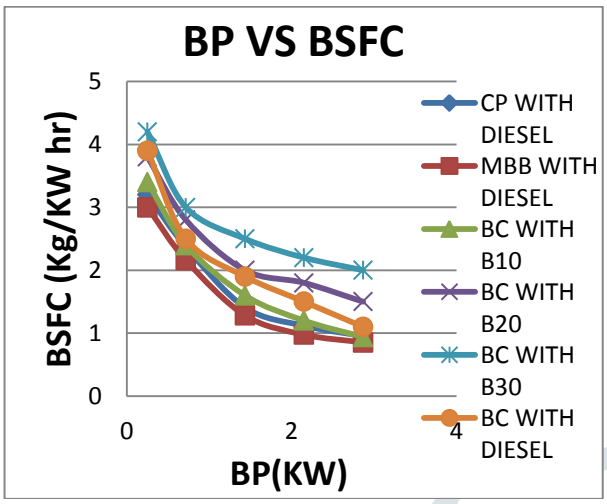
Graph-2: Brake power vs brake thermal efficiency

Where CP- conventional piston
BC- Brass crown
MBB- Meshed bluff body

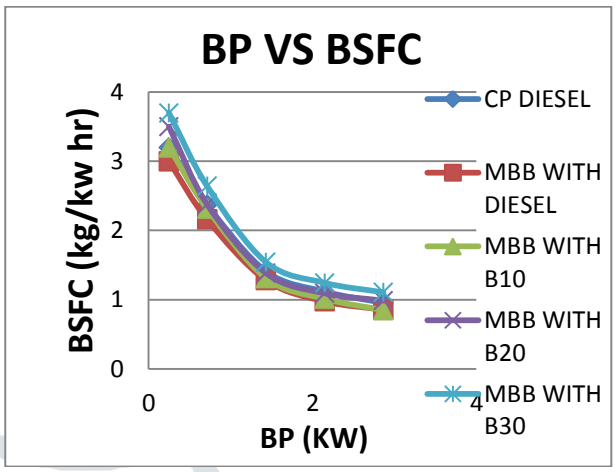
The graph-1 is plotted between the brake power and brake thermal efficiency, the comparison between conventional piston, brass crown piston and meshed bluff body. By comparing three, observed that meshed bluff body with diesel has the highest brake thermal efficiency when compared with the conventional piston and brass crown piston. In graph-2 it is clearly observed that the performance of piston is

meshed bluff body with B10 is high when compared with graph-1. In conventional piston and brass crown air fuel mixture takes place in swirl motion due to this incomplete combustion of air fuel mixture takes place. In meshed bluff body the heat is generated in the first cycle further used in second cycle which helps in pre-heating the mixture due to this complete combustion takes place and increases the brake thermal efficiency.

2. Brake specific fuel consumption:



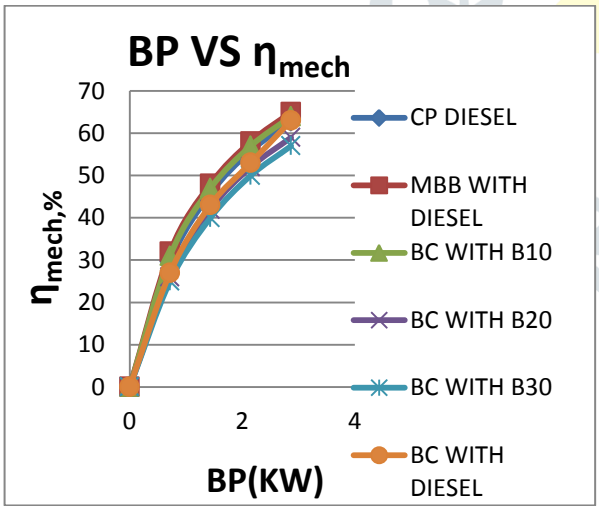
Graph-3: BP VS BSFC



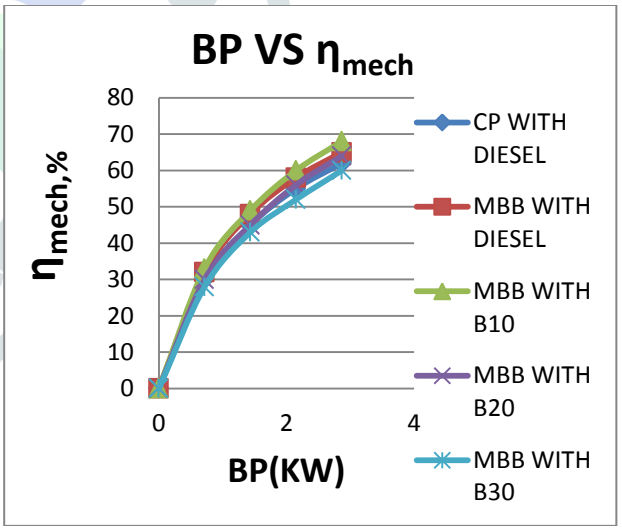
Graph-4: BP VS BSFC

The graph-3 is plotted between the brake power and brake specific fuel consumption (BSFC) the comparison between conventional piston, brass crown piston and meshed bluff body. By comparing three, observed that meshed bluff body with diesel has the lowest brake specific fuel consumption of about 0.953 kg/kW-hr when compared with the conventional piston and brass crown piston. In graph-4 meshed bluff body with B10 has the lowest specific fuel consumption of about 0.848 kg/kW-hr by comparing with the conventional piston and piston with brass crown due to better fuel properties of pine oil less fuel is consumed.

3. Mechanical Efficiency:



Graph-5: BP VS η_{mech}



Graph-6: BP VS η_{mech}

The graph-5 is plotted between the brake power and mechanical efficiency, the comparison between conventional piston, piston with brass crown and meshed bluff body. By comparing three, observed that meshed bluff body with diesel has better mechanical efficiency of 64% when compared with the conventional piston and piston with brass crown. In graph-6 meshed bluff body with B10 has the highest mechanical efficiency of about 69% when comparing with the graph-5, as the engine produces higher power output the frictional losses are changed and hence change in the mechanical efficiency.

V.CONCLUSIONS

In this study, the performance characteristics of a diesel engine operated on diesel fuel and blends of Pine oil with brass crown and meshed bluff bodies were carried out at different loads at constant speed were experimentally investigated and the graphs were drawn. The performance of the engine is calculated in terms of brake thermal efficiency and brake specific fuel consumption and mechanical efficiency. When comparing with conventional piston, brass crown piston has good properties. In all the cases the results obtained for meshed bluff body with B10 pine oil has better properties. The B10 results for variations of conventional piston, piston with brass crown and meshed bluff

body piston gives brake specific fuel consumption as 1.059 kg/kW-hr, 0.938kg/kW-hr, 0.848 kg/kW-hr and brake thermal efficiency of 24.05%,25%, 28.89% respectively. From experimental investigation in case of Meshed bluff bodies has the better performance when compared with the conventional diesel piston and piston with brass crown.

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