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Effect of Tangential Grooves on Piston Crown Of Diesel Engine and Pongamia Biodiesel as a Fuel

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Abstract— In this work, an attempt has been made to improve the performance of diesel engine by grooving the piston crown tangentially using Pongamia biodiesel as a fuel. Experiments were carried out on the C.I. diesel engine using biodiesel blends with conventional piston and grooved piston. Different proportions of blends such as B10, B20 with diesel were studied and compared with conventional piston. The experimental result reveals that grooved piston with B20 blend gives improved brake thermal efficiency, lower brake specific fuel consumption and less emissions of HC, COwhen compared to the conventional piston using diesel as a fuel.

Keywords-Grooving, Pongamia, Brake Thermal Efficiency.

I. INTRODUCTION

The vehicle population throughout the world is increasing rapidly. It is quite evident that the problem cannot be solved with the conventional fossil fuels, however stringent the emission control norms may be. The world's rapidly dwindling petroleum supplies, their rising cost and the rapid growing of automobile pollutions from fossil petroleum fuels have led to an intensive search for alternative fuels to replace diesel fuel.

In recent years, there has been a significant increase in research into the use of bio-fuels as a substitute for mineral fuels. The Energy comes in a variety of renewable forms like wood energy, wind energy, solar energy, ocean water power, geothermal energy. Bio energy generated by bio fuels is viewed as a strong source of energy in the coming years. Energy crisis and environmental degradation are two major challenges on which considerable efforts has given recently. Fossil fuels are being used as a major source of energy now days. Combustion of fossil fuels also contributes in higher environmental pollution. Therefore, urgent attention has given to search alternate fuels and transportation. Promising alternate fuels for Internal Combustion (I.C.) engines are biodiesel, bio-ethanol, methanol, biogas, producer gas etc. The Energy is also available in the non-renewable form of fossil fuels that is oil, natural gas and coal, which provide almost 80% of the world's supply of primary energy.

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. Correspondingly, there is a demand for reducing exhaust emissions from in-use diesel vehicles. One of the possible ways to reduce exhaust emissions from existing diesel vehicles is through improvement of the fuel being used alternative fuels. India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. India has to look for an alternative to sustain the growth rate. Biodiesel is a promising alternative for our Diesel needs. With vast vegetation and land availability, certainly bio-diesel is a viable source of fuel for Indian conditions. Recent studies and research have made it possible to extract biodiesel at economical costs and quantities. The blend of Bio-diesel with fossil diesel has many benefits like reduction in emissions, increase in efficiency of engine, higher Cetane rating, lower engine wear, low fuel consumption, reduction in oil consumption etc. It can be seen that the efficiency of the engine increases by the utilization of Bio-diesel. This will have a great impact on Indian economy.energy they can be used to provide reliable as well as steady supply of electricity.Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as windfarms, are becoming an increasingly important source of renewable energy and are used by many countries as part of a strategy to reduce their reliance on fuels.

C.V. Subba Reddy, C. Eswara Reddy & K. Hemachandra Reddy[1] in their workeffect of tangential grooves on piston crown of D.I. diesel engine with blends of cotton seed oil methyl ester were performed**.** The effect of three different sizes of tangential grooves on piston crown on the performance and emission characteristics are studied. From the experimental investigations, it is found that 200 bar is the optimum injection pressure with 20BD blend of COME, which has resulted in better performance and emission characteristics among the biodiesel blends. Based on the results it is concluded that the base line engine with tangential grooved piston configuration (TGP-2) gives maximum performance in all aspects and reduces emissions.Vaibhav Bhatt, Vandana Gajjar [2] conducted Experimental Investigation of Performance and Exhaust Emission Characteristics of Diesel Engine by Changing Piston Geometry**.**Combustion efficiency of CI Engine can be increased by creating turbulence, by designing intake system, by designing combustion chamber.From the investigation, it is evident that out of all pistons configurations tested in the single cylinder D.I diesel engine, piston with grooves i.e. NP 12 gives better performance in all the aspects. M. N. Channappagoudra, Sunil Thaned, N.R. Banapurmath, K. Ramesh, G. Manavendra [3] in their work**,** Effect of Swirl on DI Diesel Engine Operated with Honge Biodiesel was done. The standard baseline piston is altered by cutting different number of grooves on the piston i.e. in the order of 3-grooves, 6- grooves and 9-grooves.Brake thermal efficiency for 6-Groove Piston Configuration is greater compare to the other configurations which is attributed to better swirl and proper combustion.P. L. Naik, D. C. Katpata [4]made Performance Analysis of CI Engine using Pongamia Pinnata (Karanja) Biodiesel as an Alternative Fuel. Various proportions of Karanja oil methyl ester blends (10%, 20%, and 30%) were used for conducting the performance test at varying load conditions. Engine parameters such as brake specific fuel consumption, brake thermal efficiency were calculated and emission parameter such as emission of carbon dioxide, hydrocarbons and oxide of nitrogen gases in exhaust were recorded. By using Karanja oil methyl ester blends with diesel fuel, the result showed that the brake thermal efficiency of biodiesel blends with diesel fuel wee less as compared to diesel fuel. The test results indicate that biodiesel B-20 and lesser can be used as an alternative without any modifications of diesel engine. .Raghavendra Prasada S.A, K V Suresh [5] this paper reviews the Production of biodiesel from Pongamia Pinnata oil, various properties, performance and emission of Pongamia Pinnata biodiesel in compression ignition (CI) engine. Hence it can be concluded that the blends of honge methyl ester with diesel up to 40% by volume could replace diesel for running the diesel engine for getting less emissions without sacrificing the power output and will thus help in controlling air pollution to a great extent. Based on this study on karanja biodiesel, we can conclude that the karanja oil can be used as an alternative fuel for diesel engine without any modification.S. Ghosh, D. Dutta[6] conducted Performance and Exhaust Emission Analysis of Direct Injection Diesel Engine Using Pongamia Oil. A four stroke water cooled single cylinder direct injection diesel engine was run successfully using Pongamia oil and its blends (B25, B50, B75 and B100) as fuel. The performance and emission characteristics have been analyzed and compared to baseline diesel fuel. At full load condition brake thermal efficiency of the biodiesel blends were marginally lower than the neat diesel fuel. There was 4% reduction of CO emission of B25 than neat diesel at full load condition.

II. METHODOLOGY

A. Tangential Grooves On Piston Crown

Here, tangential grooves have been made on piston crown to enhance the swirl effect. Grooves were made to achieve the increase in swirl intensity for better mixing of fuel and air.Increasein efficiency and reductionof emissions were achieved by enhancing the swirl effect in the cylinder. Swirl motion can have a significant effect on air-fuel mixing, combustion, heat transfer, and emissions. Tangential grooves made on the piston crown have a significant effect on air flow motion in the piston bowl, when the piston approaches the top dead centre . This result in increase the rate of evaporation, swirl motion of fuel and air and combustion efficiency.It increases the turbulence levels in the combustion bowl, promoting mixing and evaporation of fuel.

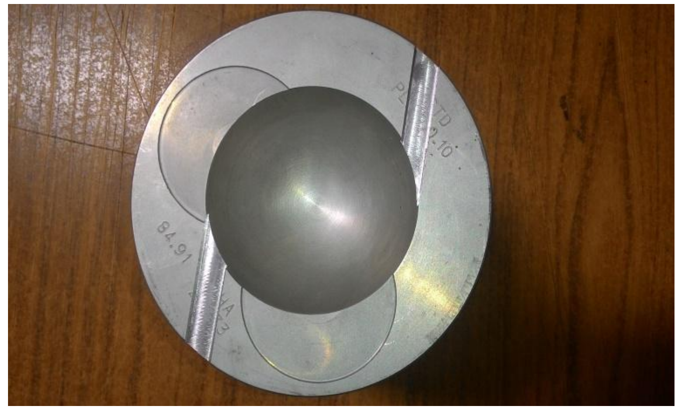

Fig 2.1Tangential grooved piston

The tangential groove depth is kept constant at 2 mm. Groove width is 6.5 mm.

B. Experimental Setup

Fig.4.2 shows the photograph of the experimental set up.The Engine chosen to carry out experimentation is a single cylinder, four stroke, vertical, water cooled, direct injection Texvel CI Engine. This engine can withstand higher pressures encountered and also is used extensively in agriculture and industrial sectors. Therefore this engine is selected for carrying experiments

Fig.2.2 Texvel Engine set up

This experimental test was conducted in single cylinder, direct injection, water cooled, compression ignition engine. The engine is fully instrumented for measurements of necessary operating parameters.

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C. Engine Specification

Table 2.1 Engine specification

Manufacturer	Texvel Oil Engines
Type of Engine	Direct Injection Diesel Engine
Number of Strokes	Four Stroke
Number of Cylinders	Single Cylinder
Cooling	Water Cooled
Rated power	5 kW
Rated speed	1500 rpm
Bore	85 mm
Stroke	110 mm
Dynamometer	Mechanical Spring balance
Method of Starting	Manual Cranking
Air box	Orifice meter with
Fuel tank	10 lit capacity

D. Exhaust Gas Analyzer

Fig 2.3: Exhaust gas analyzer

Exhaust gas analyzer used in this experiment is AVL DI 444 model made by the AVL India pvt.Ltd. In this cable one end is connected to the inlet of the analyzer and the other end is connected at the end of the exhaust gas outlet. Continuous charging of the analyzer is essential to work in an effective way. Fig.3 show the actual photos of Exhaust Gas Analyzer attached to engine at the exit. The measuring method is based on the principle of light absorption in the infrared region, known as "non-dispersive infrared absorption". The broadband infrared radiation produced by the light source passes through a chamber filled with gas, generally methane or carbon dioxide.This gas absorbs radiation of a known wavelength and this absorption is a measure of the concentration of the gas. There is a narrow bandwidth optical filter at the end of the chamber to remove all other wavelengths before it is measured with a pyro-electric detector.

III. Results And Discussion

A. Brake Thermal Efficiency

Fig 3.1shows the variation of Brake Thermal Efficiency with brake power for diesel, biodiesel blends such as 10%,20% with conventional piston and grooved piston in the test engine.The brake thermal efficiency of the diesel engine depends on the combustion efficiency of the engine. This increase in brake thermal efficiency might be due to enhanced mixing rate carried by the turbulence in the combustion chamber.The efficiency of engine is nearer to diesel at lower load and increased due to better combustion produced by tangential grooved piston with 20% blend.

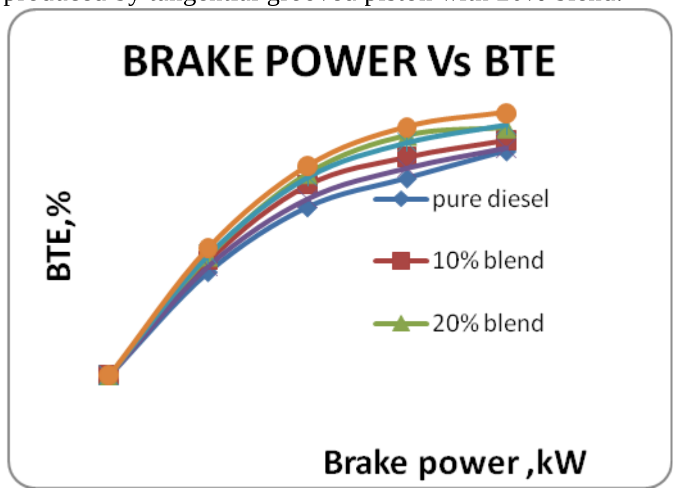

Fig 3.1 Brake Thermal Efficiency (%) Vs Brake power (kW)

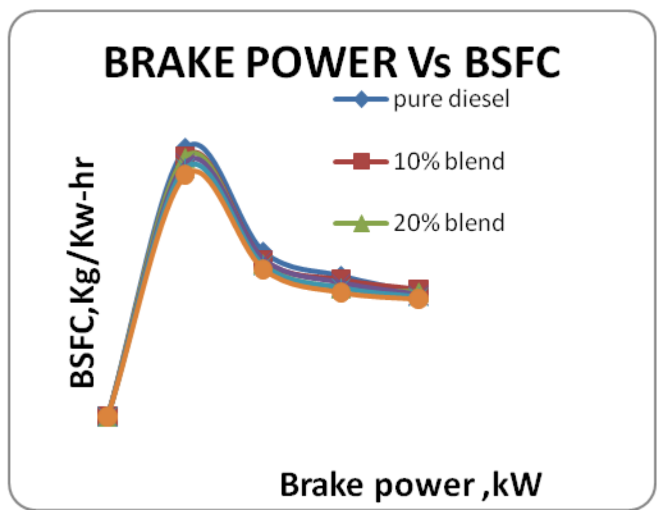

Fig 3.2 Brake Specific Fuel Consumption (kg/kW hr) Vs Brake power (kW)

B. Brake Specific Fuel Consumption

Fig 3.2shows the variation of Brake Specific Fuel Consumption with brake power for diesel ,biodiesel blends such as 10%,20% with conventional piston and grooved

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piston in the test engine. It is observed that grooved piston with 20% blend configuration has the lowest brake specific fuel consumption when compared to diesel engine. This is because of the complete combustion of charge in the combustion chamber by liberating maximum energy due to the inducement of enhanced air swirl in the combustion chamber.

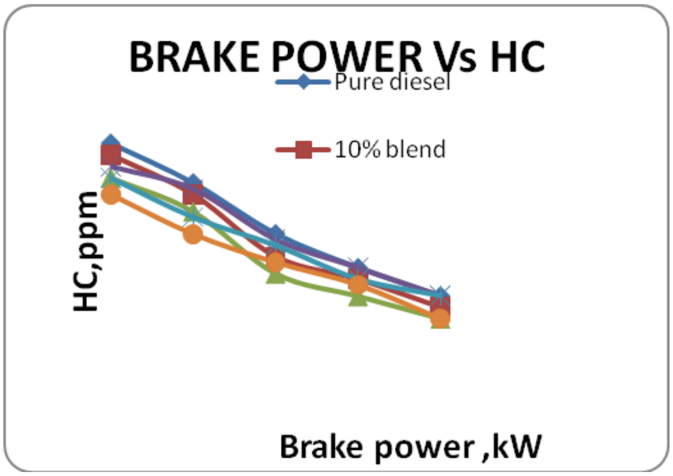

Fig 3.3 Hydrocarbon content (ppm) Vs Brake power (kW)

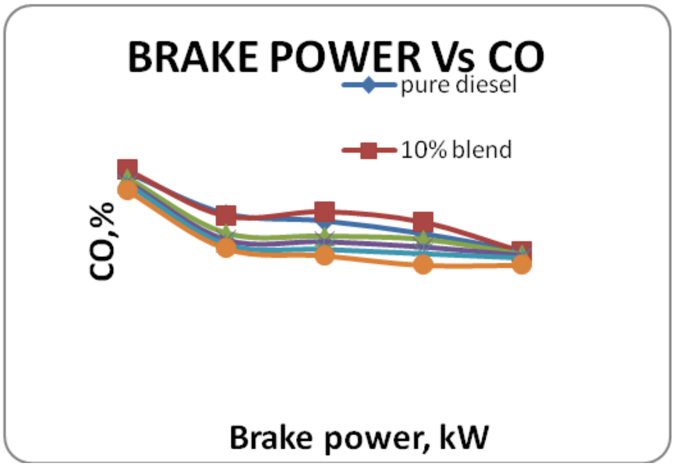

Fig 3.4 Carbon monoxide content (%) Vs Brake power (kW)

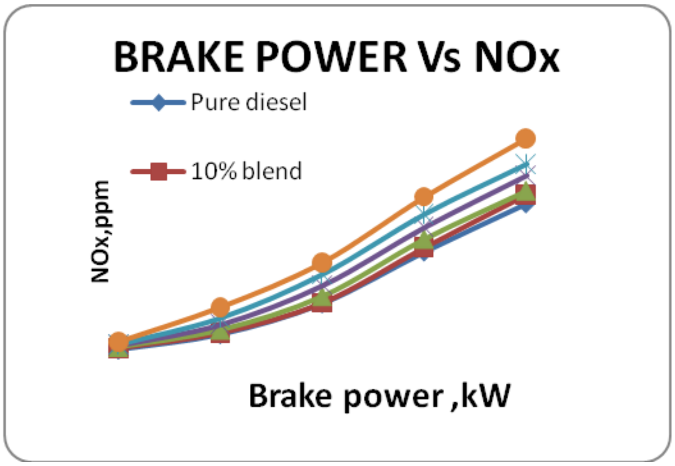

Fig 3.5 Oxides of Nitrogen content (ppm) Vs BP (kW)

C. Engine Emissions Of Diesel And Pongamia Biodiesel Blends

D. Hydrocarbon

Fig 3.3 shows that, Hydrocarbon content (HC) decreases with increase in load. HC emission of pongamia blends decreases when compared to that of diesel. The Un-burnt hydrocarbon emission is the direct result of incomplete combustion. HC emission of pongamia blends decreases with increase in biodiesel concentration. HC emissions of 20 % blend decreases with the increase in the turbulence, which results in complete combustion.

E. Carbon Monoxide

Fig 3.4 shows that, Carbon monoxide content (CO) decreases with increase in load. CO emission of pongamia blends decreases when compared to that of diesel.With the higher turbulence in the combustion chamber, the oxidation of carbon monoxide is improved which reduces the CO emissions. The CO emissions are less for grooved piston with 20 % blend when compared to normal engine at full load.

F. Oxides Of Nitrogen

Fig 3.5 shows that, Oxides of Nitrogen content (NO_X) increases with increase in load. NO_X emission of pongamia blends increases when compared to that of diesel due to high oxygen content in biodiesel. These emissions are generally more in diesel engines because of their high temperature operations and also availability of excess oxygen. NOx emissions are increased due to better air-fuel mixing and faster combustion process in the combustion chamber.

IV. CONCLUSION

- Brake Thermal Efficiency (BTE) has been increased by 3% for tangentially grooved piston with B20 blend when compared to diesel with conventional piston.
- Brake Specific Fuel Consumption (BSFC) has been reduced by 10.76% for tangentially grooved piston with B20 blend when compared to diesel with conventional piston.
- In emission characteristics, Hydrocarbon emission has been reduced by 20.45% for tangentially grooved piston with B20 blend when compared to diesel with conventional piston.
- Carbon monoxide emissions have been reduced by 8.42% for tangentially grooved piston with B20 blend when compared to diesel with conventional piston.
- Oxides of Nitrogen emissions have been increased by 25.9% for tangentially grooved piston with B20 blend when compared to diesel with conventional piston**.**
- Increase in biodiesel content in diesel and grooves on piston crown shows increase in performance parameters and better emission characteristics except NO_X content.
- Biodiesel up to 20% blend with diesel shows nearly equal performance characteristics and enhanced emission characteristics compared with diesel. So B20 blend could be used as a commercial applicant.

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