



Effect of Cylinder Air Swirl on Petrol Engine Performance

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Abstract:

The main objective of the proposed work is to find experimentally, the influence of air swirl in the cylinder on the performance and emissions of a single cylinder gasoline engine (Bajaj 2-stroke 150cc gasoline super engine). It is proposed to modify piston face, by creating rhombus shaped grooves on it. In this work it is also to propose to vary number shaped grooves from 6, 9 & 12 to intensity the swirl for better mixing of fuel and to investigate their effects on the performance and emissions.

In the present work the better combustion and lesser emissions in gasoline engine can be obtained. But it is necessary to achieve a good spatial distribution of the injected fuel throughout the entire space. In other words, matching the combustion chamber geometry fuel injection and gas flows is the most crucial factors for attaining a better combustion. In gasoline engine, swirl can be increased the rates of fuel-air mixing, reducing the combustion duration for re-entrant chambers at retard injection timings. Swirl interaction with compression induced squish flow increases turbulence levels in the combustion bowl, promotion mixing. The flow in the combustion chamber develops, from interaction of the intake flow with the in-cylinder geometry, the goal of this work is to characterize the role of combustion chamber on in-cylinder flow thus the air-mixing, combustion and pollutant formation processes of

the gasoline engine.(Bajaj 2-stroke 150cc gasoline super engine) .

Keywords: gasoline engine, air swirl, efficiency, emissions, thermal efficiencies, brake power

INTRODUCTION

Internal combustion engines have been a relatively inexpensive and reliable source of power for applications ranging from domestic use to large scale industrial and transportation applications for most of the twentieth century. Gasoline engines have evidences of higher thermal efficiencies than all other engines. And also governs the fuel –air mixing and burning rates, is generated during induction process and developed in compression stroke. So better understanding of fluid motion process is critical for developing engine designs with the most desirable operating and emission characteristics.

In the present work the effects of air swirl in combustion chamber are experimentally studied on performance of single cylinder light duty gasoline engine (Bajaj 2-stroke 150cc gasoline super engine).

The experiments were conducted on a gasoline engine .the general specifications of the engine are given in table -1.

The engine is equipped with electro-magnetic pick –up, thermocouples to measure the temperature of water, air and gas, to intensify the air swirl numbers of elliptical grooves were made on the piston crown .the different types of piston configurations which were tested in gasoline engine are shown in fig.1

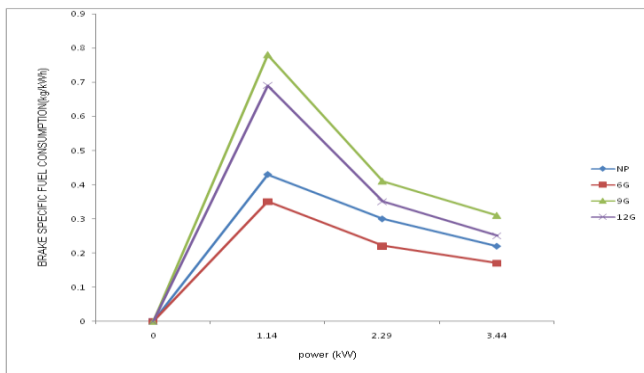
Engine specifications:

Items	Specifications
Engine power	5kW
Cylinder bore	57mm
Stroke length	125mm
Engine speed	3500rpm
Compression ratio	6:10
Brake drum diameter	20cms
Swept volume	145.5cc



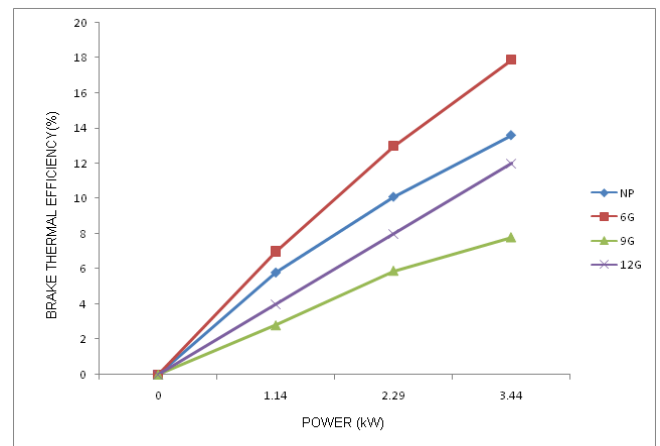
Experimental Procedure

Brake Specific Fuel Consumption:



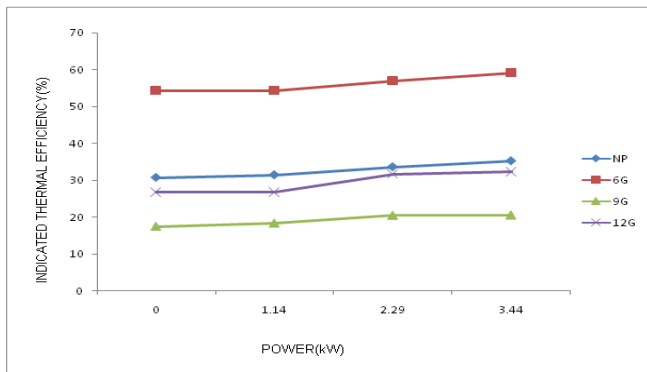
The brake specific fuel consumption with brake power for different configurations are compared with the normal engine configuration and is shown in figure 1. The brake specific consumption for normal engine at full load is 22%. It can be observed that the engine with GP 6, GP 9 and GP 12 gives the brake specific fuel consumption of 19%, 30%, 24% respectively at full loads. It is observed that there is reduction of 3% fuel consumption with GP 6 compared to normal engine. The thermal efficiencies of GP 9 and GP 12 are higher compared to GP 6. From figure 1 it is inferred that the BSFC was reduced with an increase brake power.GP 6 was found to offer better BSFC than the normal engine. This might be due to the enhanced mixing rate in the case of GP6 carried by turbulence in the combustion chamber.

Brake Thermal Efficiency



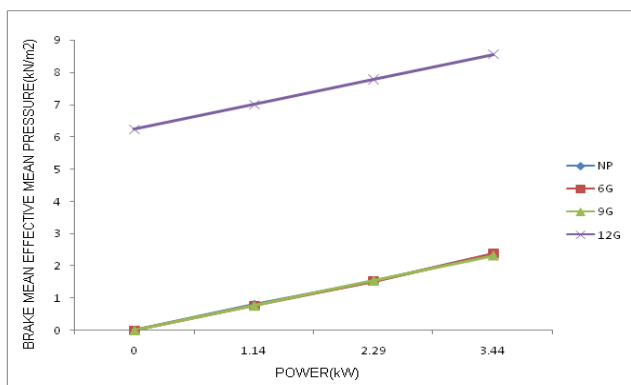
The brake thermal efficiency with brake power for different configurations is compared with the normal engine configuration and is shown in figure 2. The brake thermal efficiency for normal engine at full load is 14%. It can be observed that the engine with GP 6, GP 9 and GP 12 gives the brake specific fuel consumption of 18%, 8%, 10% respectively at full loads. It is observed that there is reduction of 4% fuel consumption with gp6 compared to normal engine. The thermal efficiencies of GP 9 and GP 12 are lower compared to GP 6. From figure 2 it is inferred that the brake thermal efficiencies was reduced with an increase brake power.gp6 was found to offer better brake thermal efficiencies than the normal engine. This might be due to the enhanced mixing rate in the case of GP 6 carried by turbulence in the combustion chamber.

Indicated Thermal Efficiency



The variation of Indicated thermal efficiency with respect to loads different configurations of pistons is shown in Fig 3. It can be observed that the thermal efficiency is 38% for normal piston. It can be observed that the engine with GP 6, GP 9 and GP 12 gives Indicated thermal efficiency of 58%, 20%, and 35.78% respectively at full load. Because of the increase in indicated power and reduction in heat input, the Indicated thermal efficiencies of GP 6 are high particularly at full load conditions.

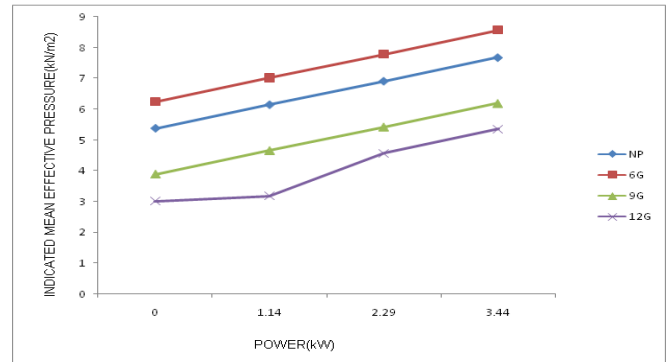
Brake Mean Effective Pressure



Brake mean effective pressure with respect to load exists for all kinds of pistons is can be observed at full loads load Brake mean effective pressure for the normal piston is 2.38kN/m², whereas for GP 6 , GP 9 and GP 12 is 2.40kN/m², 2.38kN/m²and 2.39kN/m² respectively. Linear variations of brake mean effective pressure can be observed

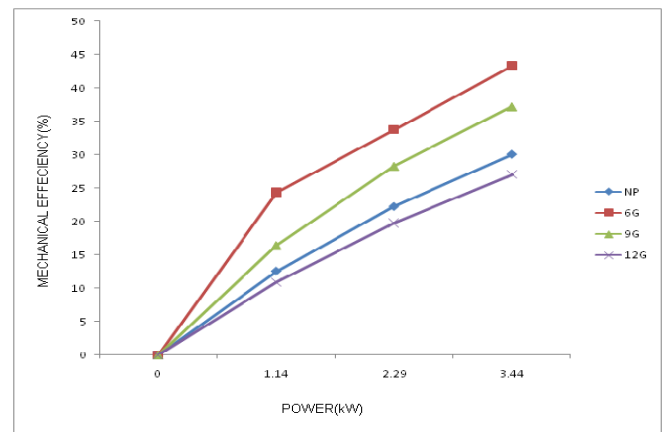
and there is no significant deviation in brake mean effective pressure for normal piston and piston with different grooves

Indicated Mean Effective Pressure



Linear variations of indicated effective pressure with respect to load exist for all kinds of pistons is can be observed. Indicated mean effective pressure for the normal piston at full load is 7.9kN/m², where as for GP 6, GP 9 and GP 12 is 8.5kN/m², 6.1kN/m²and 5.8kN/m² respectively. Linear variations of Indicated mean effective pressure can be observed and there is significant deviation in indicated mean effective pressure for the different pistons with normal piston. GP 6 is the better enhancement in the above figure.

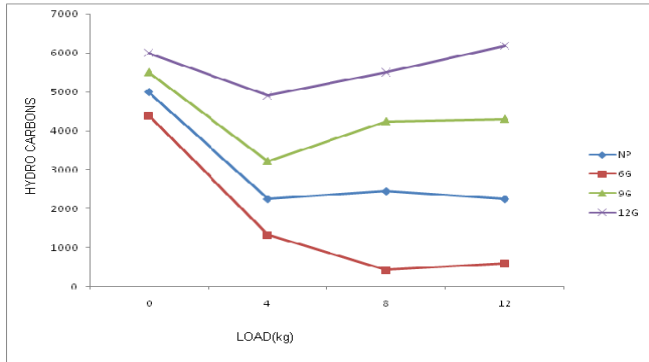
Mechanical Efficiency



The variation of mechanical efficiency with respect to load can be observed. Mechanical efficiency of the normal piston tested is observed as 38%, at full load conditions for GP 6, GP 9 and GP12 are 43%, 30%, and 28% respectively at full load .it is observed that there is a gain of 5% with gp6.from

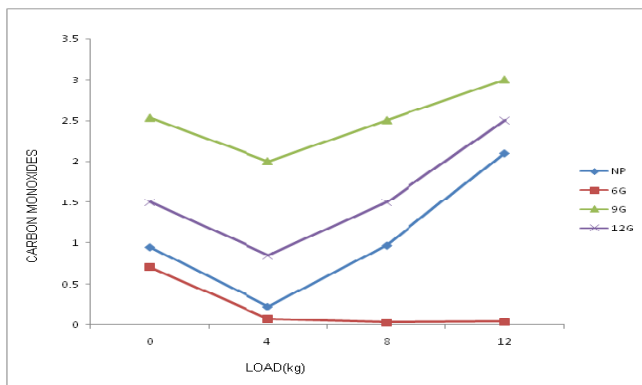
fig. it can be noted that mechanical efficiencies were increasing with increase in brake power, this might be due to the air swirl motion in the turbulence combustion chamber.

HC-EMISSION



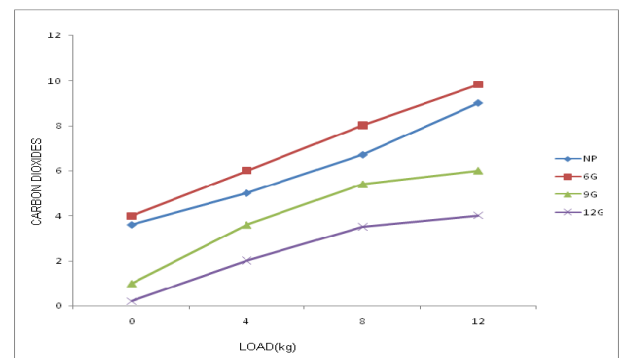
The hydro carbons with brake power for different configurations are compared with the normal engine configuration and are shown in figure. The hydro carbons for normal engine at full load are 2400ppm. It can be observed that the engine with GP 6, GP 9 and GP 12 gives the hydro carbons of 800ppm, 4500ppm, 6000 ppm respectively at full loads. It is observed that there is reduction of 2600ppm with GP 6 compared to normal engine. The HC emissions of GP 9 and GP 12 are higher compared to GP 6. From figure it is inferred that the emissions was reduced with an increase brake power.GP 6 was found to offer better than the normal engine. This might be due to the enhanced mixing rate in the case of GP 6 carried by turbulence in the combustion chamber.

CO EMISSION



The carbon monoxides with brake power for different configurations is compared with the normal engine configuration and is shown in figure. The carbon monoxide for normal engine at full load is 21%. It can be observed that the engine with GP 6, GP 9 and GP 12 gives the carbon monoxides of 2%, 25%, 30% respectively at full loads. It is observed that there is reduction of 19% with GP 6 compared to normal engine. The HC emissions of GP 9 and GP 12 are higher compared to GP6. From figure it is inferred that the emissions was reduced with an increase brake power.GP 6 was found to offer better than the normal engine. This might be due to the enhanced mixing rate in the case of GP 6 carried by turbulence in the combustion chamber.

CO₂EMISSION



The carbon dioxides with brake power for different configurations is compared with the normal engine configuration and is shown in figure. The carbon dioxides for normal engine at full load are 9%. It can be observed that the engine with GP 6, GP 9 and GP 12 gives the carbon dioxides of 9.9%, 6%, and 4% respectively at full loads. It is observed that there is increase of 0.9% with GP 6 compared to normal engine. The HC emissions of GP 9 and GP 12 are lower compared to GP 6. From figure it is inferred that the emissions was increased with an increase brake power.GP 6 was found to offer better than the normal engine. This might be due to the enhanced mixing rate in the case of GP 6 carried by turbulence in the combustion chamber.

CONCLUSION

The effect of swirl in the engine combustion chamber is investigated in order to achieve improvements in gasoline engine performance and emission characteristics by three different techniques Cutting grooves on the piston crown on the remaining face. The results are considered at 3/4 of the rated load of the combined system and compared with normal engine

The following conclusions are drawn based on the effect of air swirl in the cylinder:

- The brake thermal efficiency of GP6 is increased when compared to normal engine at 3/4 of the rated load.
- The increase in volumetric efficiency of GP6 is more and is when compared normal engine at 3/4 of the rated load.
- The improvement in brake specific fuel consumption of GP6 is when compared normal engine at 3/4 of the rated load.
- The hydro carbons and carbon monoxides with GP6 is minimum than any other and at 3/4 rated load, it is less than normal engine.

REFERENCES

1. Hammonton, Y., Tomita, E., Tanaka, Y., and Katayama, T. "The effect of swirl on spark ignition engine combustion", International Symposium on Diagnostics and Modeling of Combustion in Reciprocating Engines, Tokyo, September, 1985.
2. Ganesan, V. "Internal Combustion Engine, Second Edition". Tata-Mc Graw Hill 2004.
3. Blair, G. P, "Design and Simulation of Four-Stroke Engines", Warren dale (U.S.A), SAE, 1999
4. Stone, R, "Motor Vehicle Fuel Economy", Middlesex (England), Macmillan education Ltd. 1989.
5. .W.Pulkrabek, "Internal Combustion Engine", Second Edition PEARSON Prentice Hall, New Jersey, 2004.
6. Glenn Horrocks, "Numerical study of a rotary internal combustion engine", Ph .D .thesis the

- University of Technology, Sydney, 2001. pp. 63-84.
7. Dyer, T .M Characterization of one- and two-dimensional homogeneous combustion phenomena in a constant volume bomb", SAE Paper 790353, 1979.