

EXPERIMENTAL INVESTIGATION ON PERFORMANCE OF SINGLE CYLINDER FOUR STROKE SPARK IGNITION ENGINE WITH MODIFICATION OF PISTON CROWN

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Abstract

A decent swirl advances the quick burning and enhances the efficiency for engine which is preferably running at low speeds in order to have low mechanical losses and empowering good combustion efficiency. Subsequently to create high turbulence preceding burning inside the cylinder, swirl prompted by the bay channel inside the cylinder head will be useful. The automobile vehicles still satisfying demands for high performance, requires immense efforts to create new engine ideas and deliver less emission. Swirl is used in SI engine to speed up the combustion process in four stroke engines It increases turbulence and accelerates chemical action by intimating mixing of fuel and oxygen there by weak mixtures can be burnt effectively. In Petrol engine, swirl can increase the rate of fuel-air mixing, reducing the combustion duration for re-entrant chambers at retarded injection timings. Swirl interaction with compression induced squish flow increases turbulence levels in the combustion bowl, promoting mixing. In order to achieve the swirl the piston crown of the conventional petrol engine was suitably modified by forming different shaped grooves on it. This facilitates increased intensity of the swirl for proper mixing of air fuel and to examine their effects on the performance of this engine fuelled with petrol and its blends with ethanol. In the present work Experiment was carried out with unmodified and modified piston with different shapes without much changing compression ratio comparative results shows that better combustion in gasoline engine was obtained with single groove hemispherical piston. Brake thermal efficiency increased by 1.39% and Brake specific fuel consumption reduced by 3% for E10P90 blend compared to unmodified piston

Keywords: gasoline Engine, Swirl, Hemispherical Piston (HP), Toroidal Piston (TP), Single Grooved Hemispherical Piston (SGH), Brake Power (BP), Brake Specific Fuel Consumption (BSFC) and Brake Thermal Efficiency (BTE)

1. INTRODUCTION

In Spark ignition engines combustion takes place by igniting the air-fuel mixture through spark from a spark plug. It is observed that the quality of air fuel mixture that governs the proper combustion depends upon proper mixing of air and fuel from the carburetor in case of SI Engine. The air intake chamber geometry plays a key role in governing the quality of A/F mixture.

In the assessment of internal combustion engine the performance, efficiency and emission formation depends upon the formation of air fuel blend inside the engine cylinder. The fluid flow analysis plays a vital part for air-fuel blend to acquire the better engine combustion, performance and efficiency. Because of the extreme conditions inside a typical IC engine (high combustion temperatures and pressures, precipitation of residue and

other combustion products and so on) Experimental test systems have some time restricted in approaching to the above mentioned issue. After clean perception of all the research in swirl movement assumes an import part to increase in engine performance and in addition diminish the emissions.

The ethanol or ethyl alcohol produced in India is fundamentally from molasses the waste item from sugar industries. After extensive research over the years, it has been realized that future energy needs of transport sector may not be fulfilled by one particular alternate fuel. The ultimate choice of alternatives in a particular region depends on availability and economics, apart from its nonpolluting characteristics. In this connection interest is shown in gasoline-ethanol fuel blends in this work.

The concept of project is to improve the quality of A/F mixture by making different types of grooves on piston

crown and to increase the swirl. Design development & analysis of swirl chamber for optimal quality of A/F mixture

2. MATERIALS AND METHODOLOGY

2.1 Materials

The blend of ethanol and petrol prepared for experimental investigation in three different proportions such as E5P95, E10P90 and E15P85. The name E5P95 indicates that 5% ethanol in 95% petrol by volume the other two represents blends with 10% & 15% of ethanol. The blend is prepared by collecting the ethanol and petrol with required proportions in measuring jar and magnetic stirrer is used to have homogeneous mixture. And properties of blends prepared are found out as per ASTM standards is shown in table 1

Table 1:- Properties of blends

Properties	E0P100	E5P95	E10P90	E15P85
Calorific value (KJ/kg)	45200	44250	43500	42750
Density (kg/m ³)	720	738.59	741.30	744
Viscosity (mm ² /s)	0.4246	0.4749	0.5250	0.6247

2.2 Methodology

The main objective of this work is to find experimentally the influence of air fuel swirl in the cylinder on the performance of a single cylinder petrol engine. In order to achieve the swirl the piston crown of the conventional petrol engine was suitably modified by forming three different shaped grooves on it modification on piston crown is done by using CNC Machine. The following three modification are made

- 1) Hemispherical Grooved Piston
- 2) Toroidal Grooved Piston
- 3) Single grooved Hemispherical Piston



Fig 1:- Hemispherical grooved piston



Fig 2:- Toroidal grooved Piston



Fig 3:- Single grooved Hemispherical Piston

2.3 Experimental Setup

The setup comprises of single cylinder, four stroke gasoline engine having specification as specified in table 2. The spark ignition set up along with rope brake dynamometer, spring balance, and Fuel input measuring system is shown in fig 4. This set-up enables the study of Engine brake power, fuel consumption and thermal efficiency.



Fig 4:- Pictorial View of 4 Stroke S.I Engine

Table 2:- Engine Specification

Make	Greaves
Type	4 Stroke, single Cylinder, Air cooled gasoline engine
Bore	70mm
Stroke	66.7mm
Rated Power	2.2kW @ 2650rpm
Cooling System	Air cooled
Compression Ratio	Unmodified piston- 4.67 Hemispherical Grooved piston- 4.709 Toroidal grooved piston-4.704 Single groove hemispherical piston-4.709

3. RESULTS AND DISCUSSIONS

3.1 Pure Gasoline

3.1.1 Brake Specific Fuel Consumption

The BSFC with BP for Various modified pistons is compared with unmodified piston with only petrol and as shown in Fig 5. The BSFC for unmodified piston at full load is 47% it can be observed that the engine with HP, TP & SGH piston gives the BSFC of 49%, 45%, and 43% correspondingly at full loads. It can be observed that there is diminishment of 4% fuel consumption with SGH piston compared to unmodified piston. From figure 5 it is concluded that the BSFC was reduced with a rise in BP.

SGH piston was found to offer improved BSFC over the unmodified piston. This may be because of the improved mixing rate in case of SGH piston conveyed by turbulence in the combustion chamber.

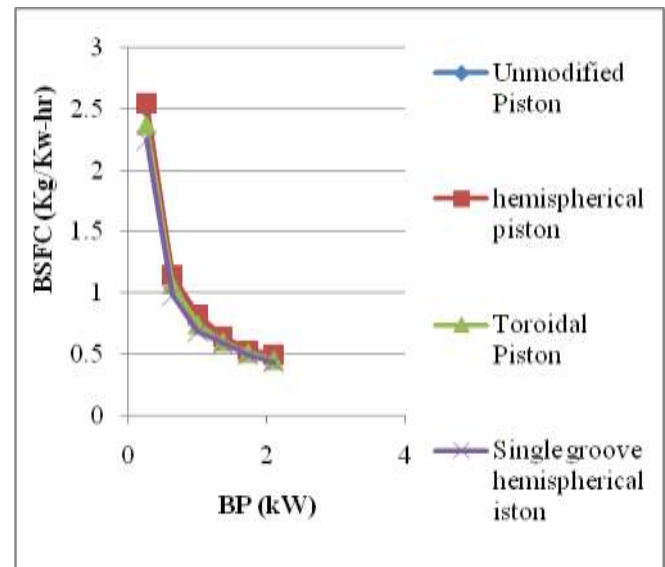


Fig 5 :- BP vs BSFC for EOP100 Blend

3.1.2 Brake Thermal Efficiency

The BTE with BP for various modified pistons is compared with unmodified piston with only petrol and as shown in Fig 6. The BTE for unmodified piston at full load is 16.83% it can be observed that the engine with HP, TP & SGH piston gives the BTH of 16.13%, 17.46% & 18.07% correspondingly at full loads. It can be observed that there is rise of 1.24% of BTE with SGH piston compared to unmodified piston. From figure 6 it is concluded that the BTE was increased with a rise in BP. SGH piston was found to offer improved BTE over the unmodified piston. This may be cause of the improved mixing rate in case of SGH piston conveyed by turbulence in the combustion chamber.

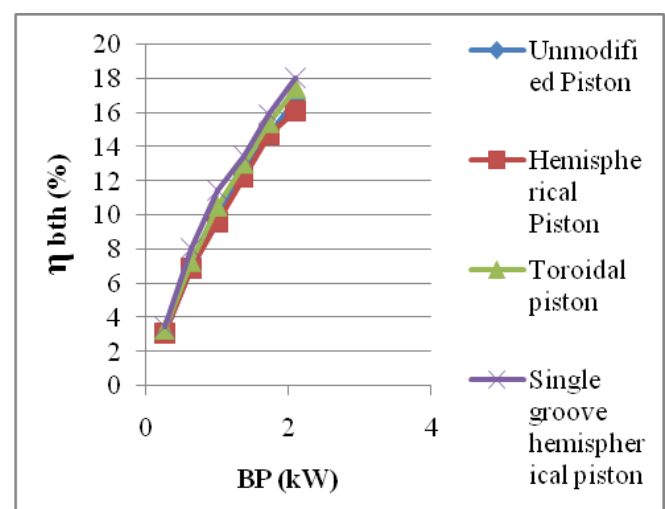


Fig 6 :- BP vs BTE for EOP100 Blend

3.2 E5P95 BLEND

3.2.1 Brake Specific Fuel Consumption

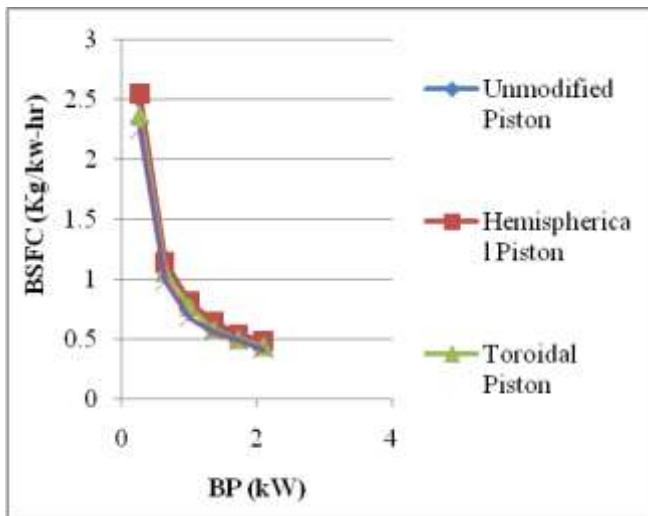


Fig 7 :- BP vs BSFC for E5P95 Blend

The BSFC with BP for various modified pistons is compared with unmodified piston with **E5P95 blend** as shown in Fig 7. The BSFC for unmodified piston at full load is 46% it can be observed that the engine with HP, TP, and SGH piston gives the BSFC of 48%, 44%, and 41% correspondingly at full loads. It can be observed that there is diminishment of 5% fuel consumption with SGH piston compared to unmodified piston. From figure 7 it is concluded that the BSFC was reduced with an increase BP. SGH piston was found to offer improved BSFC over the unmodified piston. This may be cause of the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. In combustion process by adding ethanol complete combustion is achieved due to more oxygen as well as gives water as product of combustion and compared with gasoline ethanol is having lower heating value.

3.2.2 Brake Thermal Efficiency

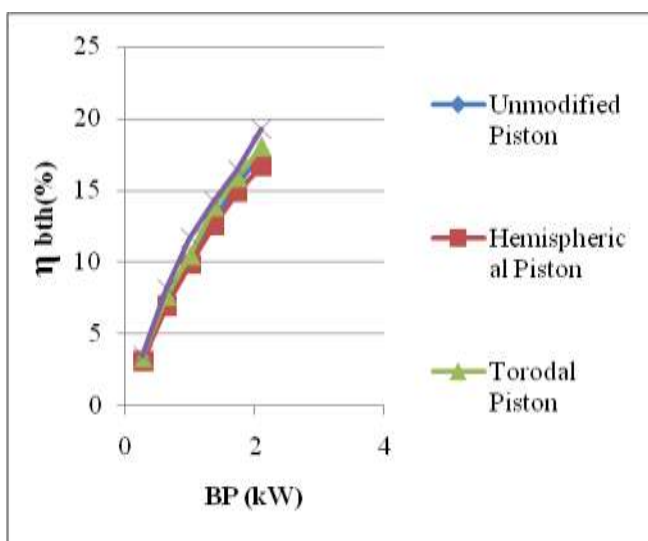


Fig 8 :- BP vs BTE for E5P95 Blend

The BTE with BP for various modified pistons is compared with unmodified piston with **E5P95 blend** and as shown in Fig 8. The BTH for unmodified piston at full load is 17.38% it can be observed that the engine with HP, TP, and SGH piston gives the BTE of 16.71%, 18.04%, & 19.29% correspondingly at full loads. It can be observed that there is rise of 1.91% of BTE with SGH piston compared to unmodified piston. From figure 8 it is concluded that the BTE was increased with a rise in BP. SGH piston was found to offer improved BTE over the unmodified piston. This may be cause to the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. In combustion process by adding ethanol complete combustion is achieved due to more oxygen as well as gives water as product of combustion and compared with gasoline ethanol is having lower heating value.

3.3 E10P90 BLEND

3.3.1 Brake Specific Fuel Consumption

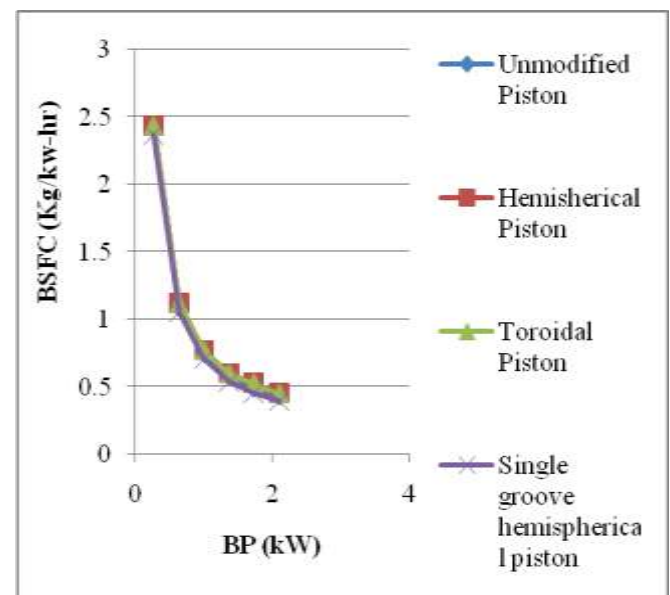


Fig 9 :- BP vs BSFC for E10P90 Blend

The BSFC with BP for various modified pistons is compared with unmodified piston with **E10P90 blend** as shown in Fig 9. The BSFC for unmodified piston at full load is 43% it can be observed that the engine with HP, TP & SGH piston gives the BSFC of 45%, 41%, and 40% correspondingly at full loads. It can be observed that there is diminishment of 3% fuel consumption with SGH piston compared to unmodified piston. From figure 9 it is concluded that the BSFC was reduced with a rise in brake power. SGH piston was found to offer improved BSFC over the unmodified piston. This may be cause of the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. In combustion process by adding ethanol complete combustion is achieved due to more oxygen as well as gives water as product of combustion and compared with gasoline ethanol is having lower heating value.

3.3.2 Brake Thermal Efficiency

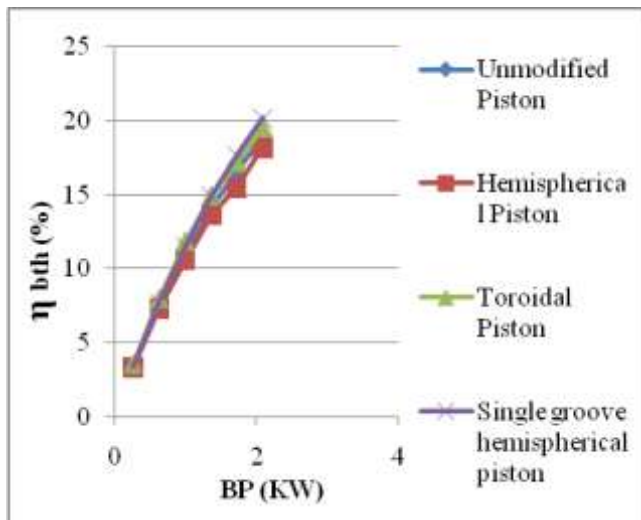


Fig 10 :- BP vs BTE for E10P90 Blend

The BTE with BP for various modified pistons is compared with unmodified piston with **E10P90 blend** and as shown in Fig 10. The BTE for unmodified piston at full load is 18.8% it can be observed that the engine with HP, TP & SGH piston gives the BTE of 18.2%, 19.54%, and 20.19% correspondingly at full loads. It can be observed that there is rise of **1.39%** of BTE with SGH piston compared to unmodified piston. From figure 10 it is concluded that the BTE was increased with an increase brake power. SGH piston was found to offer improved BTE over the unmodified piston. This may be cause of the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. In combustion process by adding ethanol complete combustion is achieved due to more oxygen as well as gives water as product of combustion and compared with gasoline ethanol is having lower heating value.

3.4 E15P85 BLEND

3.4.1 Brake Specific Fuel Consumption

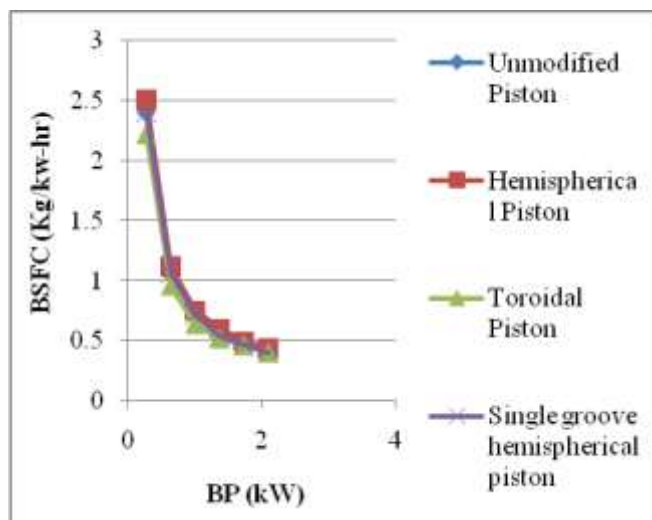


Fig 11 :- BP vs BSFC for E15P85 Blend

The BSFC with BP for various modified pistons is compared with unmodified piston with **E15P85 blend** as shown in Fig 11. The BSFC for unmodified piston at full load is 42% it can be observed that the engine with HP, TP & SGH piston gives the BSFC of 43%, 40%, and 40% correspondingly at full loads. It can be observed that there is diminishment of **2%** fuel consumption with SGH piston compared to unmodified piston. From figure 11 it is concluded that the BSFC was reduced with a rise in BP. SGH piston was found to offer improved BSFC over the unmodified piston. This may be cause of the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. As we increase the percentage of ethanol in fuel BSFC goes on increases due to unable in correct combustion of fuel which effects in higher fuel consumption.

3.4.2 Brake Thermal Efficiency

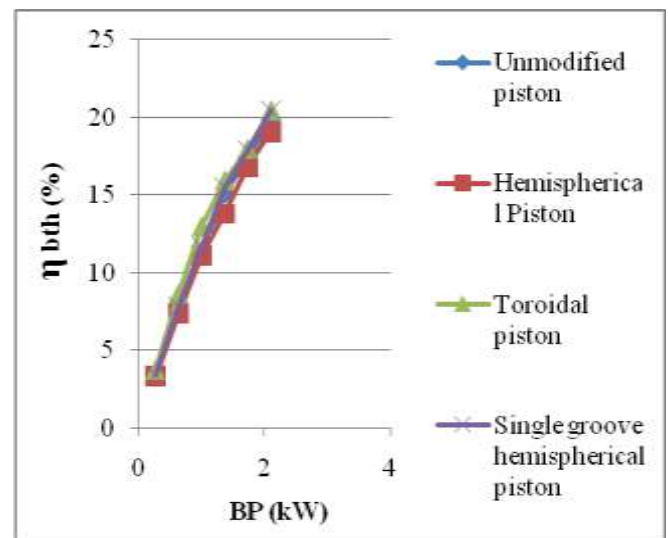


Fig 12 :- BP vs BTE for E15P85 Blend

The BTE with BP for various modified pistons is compared with unmodified piston with **E15P85 blend** and as shown in Fig 12. The BTE for unmodified piston at full load is 19.80% it can be observed that the engine with HP, TP & SGH piston gives the BTE of 19.1%, 20.46%, and 20.46% correspondingly at full loads. It can be observed that there is rise of **0.66%** of BTE with SGH piston compared to unmodified piston. From figure 12 it is concluded that the BTE was increased with a rise in BP. SGH piston was found to offer improved BTE over the unmodified piston. This may cause of the improved blending rate in case of SGH piston conveyed by turbulence in the combustion chamber. As we increase the percentage of ethanol in fuel BTE goes on decreases due to unable in correct combustion of fuel which effects in lower thermal efficiency.

4. CONCLUSION

In the present experiment study engine performance test for 4-stroke S.I engine with petrol and its blend with ethanol was carried out with unmodified and modified pistons. The results were compared with petrol fuel and the main results of this study are summarized as follows

- 1). Experiments were conducted by using ethanol and petrol blends mixed with the ratio of 5:95, 10:90 & 15:85.
- 2). Brake Thermal Efficiency of single groove hemispherical piston was increased by 1.24% and BSFC reduced by 4% for pure gasoline when compared to unmodified piston
- 3). Brake Thermal Efficiency of single groove hemispherical piston was increased by 1.91% and BSFC reduced by 5% for **E5P95** blend when compared to unmodified piston.
- 4). Brake Thermal Efficiency of single groove hemispherical piston was increased by 1.39% and BSFC reduced by 3% for **E10P90** blend when compared to unmodified piston
- 5). Brake Thermal Efficiency of single groove hemispherical piston was increased by 0.66% and BSFC reduced by 2% for **E15P85** blend when compared to unmodified piston.

Performance of **E10P90** blend shows an appreciable result compared to E5P95 & E15P85 blends with single groove hemispherical and unmodified piston because of increase in octane number and higher oxygen content in ethanol makes better combustion of fuel.

Brake thermal efficiency increased by 1.39% compared to unmodified piston because Single groove hemispherical piston increases turbulence, swirl intensity, homogeneity of air-fuel mixture and accelerates chemical action by intimating mixing of fuel and air in combustion chamber. Thus Swirl motion plays a significant effect on air-fuel mixture, combustion and heat transfer which improves efficiency and reduces noise.

Hence Ethanol Blends was found to be potential alternative fuel to petrol in case of modified pistons when compared to unmodified piston in SI Engine.

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