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Performance test on Diesel Engine by Changing Triangular Piston Crown

N. Balasubramani[1], U. Aravind[2], S. Karuppusamy[3], K. Navaneetha Krishnan[4], M. Silambarasan[5]

[1]Assistant Professor, Department of Mechanical Engineering, P.A College of Engineering and Technology, Pollachi, TamilNadu, India

[2, 3, 4, 5]UG Scholars, Department of Mechanical Engineering, P.A College of Engineering and Technology, Pollachi, TamilNadu, India

***Abstract*—** *In internal combustion engines is one of the most important factors controlling the combustion process. It governs the fuel-air mixing and burning rates in diesel engines. The main drawback is incomplete combustion of fuel - air in a combustion chamber. This is due to emissions of pollution and the performance of the diesel engine become lowered. Hence it can be solved by modifying the piston crown configuration. The main objective of the paper is to reduce the emission and improve the performance level. The different emissions such as un burnt hydrocarbon (HC), carbon monoxide (CO), carbon dioxide (CO_2) etc. and the performance parameters are brake power (BP), indicated power (IP), frictional power (FP) and mechanical efficiency. The piston is modified by triangular shape on the crown, due to intensifying the air swirls for betterment of combustion. This configuration is compared to normal piston configuration, the experiments were conducted and compare the results values.*

***Keywords*—** *Combustion chamber, Piston crown configuration, Triangular shape.*

I. 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. Diesel engines, having the evident benefit of a higher thermal efficiency than all other engines, have served for both light - duty and heavy duty vehicles. This working condition may cause the fatigue damage of piston side wear, piston head/crown cracks and so on. The investigations indicate that the greatest stress appears on the upper end of the piston and stress concentration is one of the mainly reason fatigue failure.

To reduce the emission coming the engine exhaust, manufacturer try to design the best combustion chamber. The design of combustion chamber geometry is to reduce the emissions such as CO, CO_2, unburnt HC and O_2. In present scenario many technology are used to reduce the toxicity of exhaust gases EGR (exhaust gas recirculation) is one of them. therefore better understanding of fluid motion is critical for designing the engines with the most desirable operating and emission characteristics. Biogas is relatively cheap renewable source of energy that can be used to substitute the use of fossil fuels [1]. Due to the low flame velocity combustion period is long which affect the performance of the engine. Then the performance can be improved by three parameters such as piston crown, cylinder head and inlet manifold. This investigation is modified to triangular piston crown by comparing the conventional piston of the four stroke single cylinder diesel engine. Turbulence is created in the engine cylinder by the cutting grooves [5]. A good swirl promotes fast combustion to improve the efficiency [13]. Modifying the piston bowl geometry to improve the performance and emissions.

II. METHODOLOGY

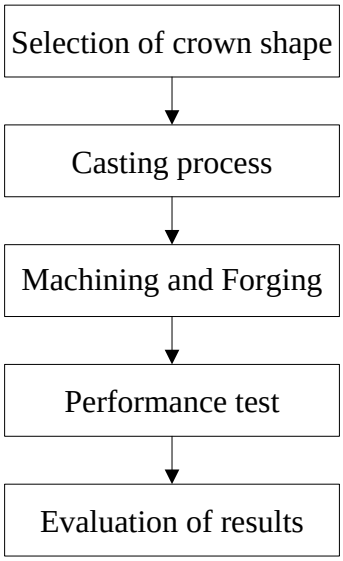

Fig. 1. Flowchart

III. EXPERIMENTAL WORK

In the present work the effects of air swirls in the combustion chamber are experimentally studied on the performance of single cylinder light duty direct injection diesel engine. The experiments are conducted on the single cylinder kirloskar diesel engine. In this engine piston is modified and tests the result. The piston crown is modified by following different process.

- Casting process
- Turning process (Machining)
- Press forging

The general specifications of engine and piston are tabulated below.

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TABLE I. Engine Specification

Engine Details	Description
Model	Kirloskar AV1
Fuel	Diesel
No. of cylinders	Single Cylinder
Power	5 HP
Engine Speed	1500
Compression ratio	17.5:1
Cylinder Bore	80 mm

TABLE II. Piston specification

Piston Details	Description
Bore	80 mm
Stroke length	110 mm
Power	5 HP
Engine Speed	1500

IV. CONFIGURATION OF PISTON

Fig. 2. Triangular Piston Crown

V. EXPERIMENTAL PROCEDURE

Experiments were performed on single cylinder diesel engine. In this different piston configuration of piston crown geometry were investigated for evaluation of performance and emissions. The performance test had been performed at different loads. The performance parameter are (i) Brake power (KW) (ii) Indicated power (iii) Total fuel consumption (TFC) and Mechanical Efficiency. The emission parameter are unburnt HC, CO, CO_2 and O_2

VI. TESTING PROCEDURE

Performance Testing

During testing the different set of readings are taken in diesel engine at different loads on a conventional piston crown. The values are given below

TABLE III. Results of performance normal piston

Load Kg	TFC	BP KW	FP KW	IP KW	η_{mech} (%)
10	0.62	0.75	0.11	0.86	87.22
15	0.80	1.47	0.22	1.69	87.01
20	0.93	2.07	0.31	2.38	86.90

Then the same load conditions, the modified piston were tested and the performance were calculated.

TABLE IV. Result of performance on triangular crown piston

Load Kg	TFC	BP KW	FP KW	IP KW	η_{mech} (%)
10	0.73	0.77	0.08	0.85	90.58
15	0.93	1.49	0.17	1.66	89.75
20	1.11	2.16	0.26	2.42	89.24

At the same time the emissions of different pistons were tested and the readings are given below

TABLE V. Results of emissions

Piston	CO%	HC (PPM)	CO_2%	O_2 %
Conventional shape	0.05	13.20	1.42	18.66
Triangular shape	0.04	13.18	1.40	18.65

VII. RESULT AND DISCUSSIONS

The comparison between the performance and exhaust emissions of different piston configuration. The results were noted and based on tabulation and graphs for comparing the parameters. The graphs are given below.

(1) Load Vs TFC

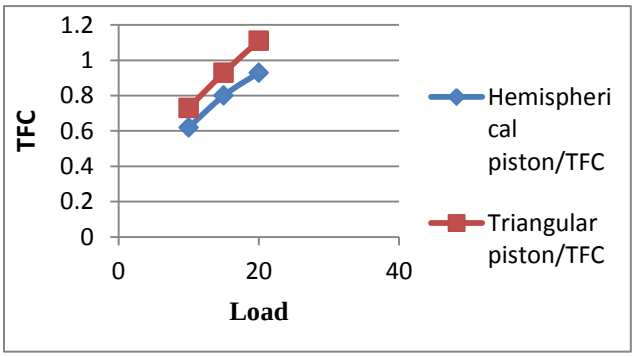

Fig. 3. Comparison of TFC Vs Load

The variations of fuel consumptions with different load with various configurations of piston are shown in fig. 3. As the load increases fuel consumptions also increases. It is observed in the triangular crown piston is increase by 0.11%. This is because of complete combustion in a combustion chamber.

(2) Load Vs BP

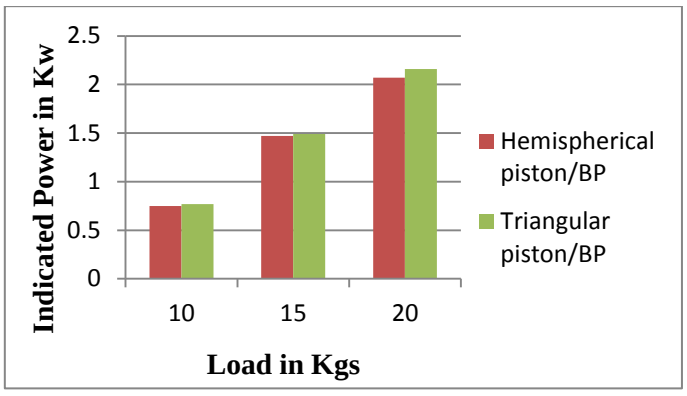

Fig. 4. Comparison of BP

The variation of brake power at different loads with various configuration of piston are shown in fig. 4. As the load increases BP also gradually increases. The BP is gain at the rated load condition 0.09 KW.

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(3) Load Vs FP

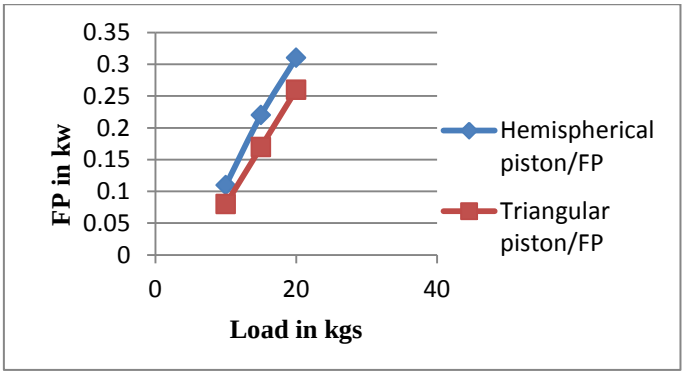

Fig. 5. Comparison of FP

The variations of the FP at the different load with various configuration of piston shown in fig. 5. This frictional power is decreases by increases the speed of the engine. It is decreases about the 0.05KW.

(4) Load Vs IP

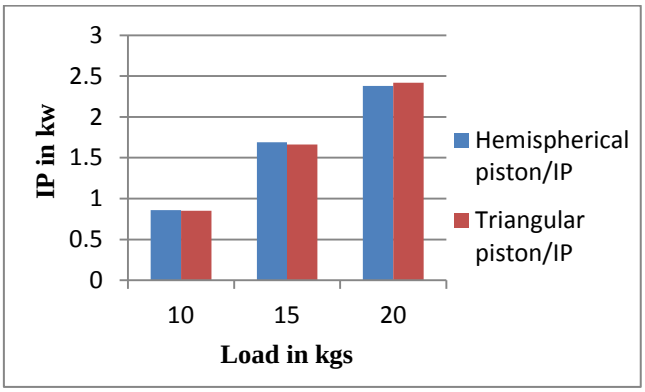

Fig. 6 Comparison of IP

The variations of the IP at the different load with various configuration of piston shown in fig. 6. Then the indicated power is observed by the increase of rated load. It is increased by the 0.04%.

(5) Load Vs Efficiency

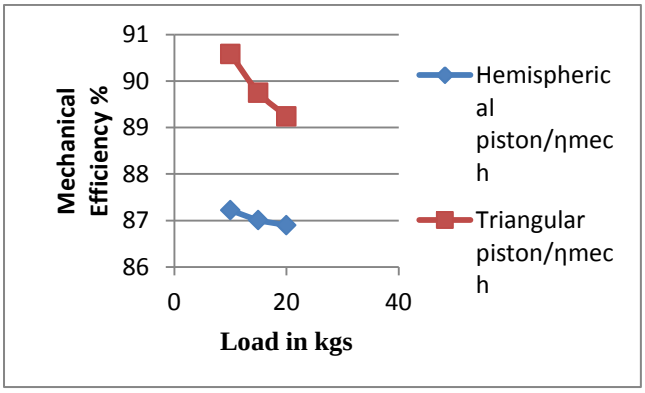

Fig. 7. Comparison of Mechanical efficiency

The variations of the Mechanical efficiency at the different load with various configuration of piston shown in fig. 7. In the triangular piston configuration were increases about 2.34%. The performance level is increased in the triangular crown piston.

(6) Hydrocarbon emissions

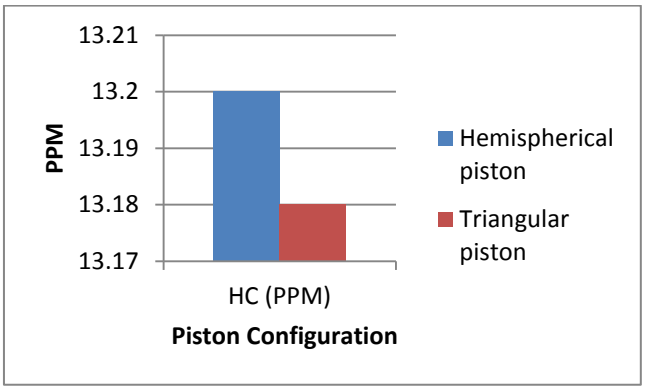

Fig. 8. Comparison of HC

The variations of the HC in the different configuration of the piston is shown in fig. 8. Unburnt HC is reduced due to the complete combustion of fuel and air. It reduced by the 0.02PPM.

(7) CO emissions

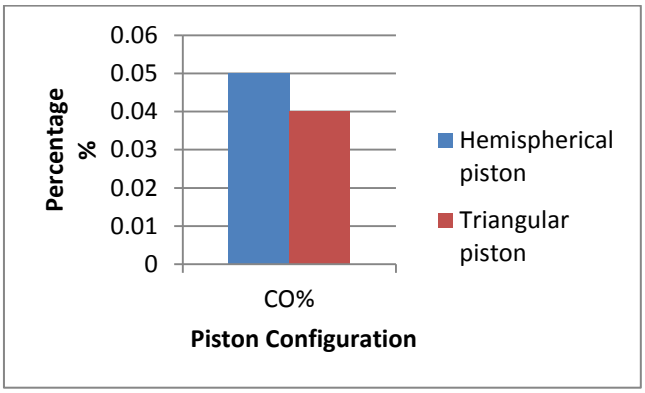

Fig. 9 Comparison of CO

The variations of the CO in the different configurations of the piston are shown in fig. 9. The CO emissions are reduced with the higher turbulence and temperatures in combustion chamber. It is reduced upto 0.01%.

(8) CO_2 emissions

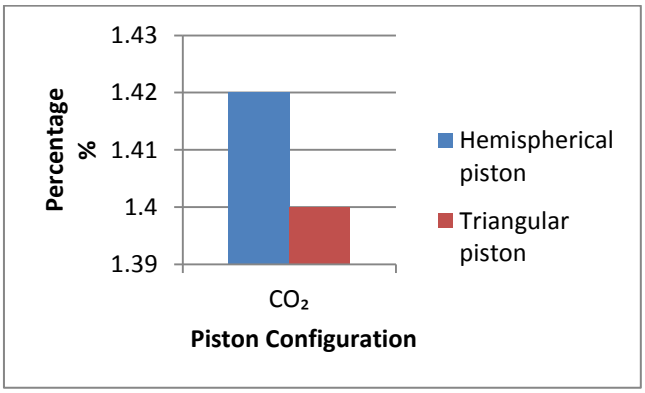

Fig. 10. comparison of CO_2

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The variations of the CO_2 in the different configurations of the piston are shown in fig.9. The CO_2 emissions is reduced by modifying piston crown. It is reduced by 0.02%.

(8) O_2 emissions

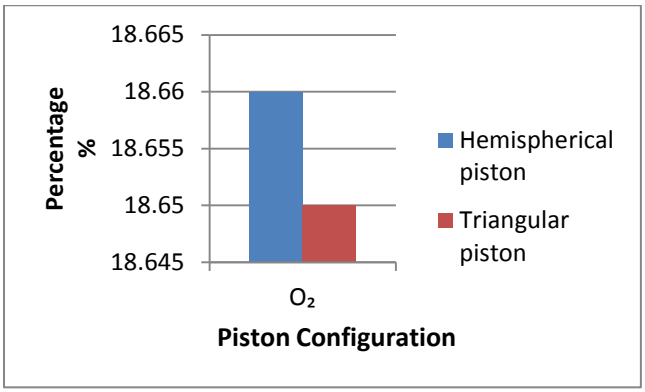

Fig. 11. comparison of O_2

The variations of the O_2 in the different configuration of the piston are shown in fig.10. The oxygen emission also reduces along with other emissions. It is reduced upto 0.03%.

VIII. CONCLUSIONS

The geometry of the piston is modified to induce the turbulence by means of swirl motion. Based on the experimental work of the single cylinder diesel engine of different configuration of piston conclusion were drawn below.

- At a rated load brake power is increases up to 0.1kw increases on the triangular shape piston crown.
- At maximum load total fuel consumption are also increases because of complete combustion chamber due to the enhancement of air swirl. The total fuel consumption are increases up to 0.172kg/hr respectively.
- Frictional power is increased up to 0.05kw respectively.
- As increasing of load indicated power also increases gradually, the indicated power is increased up to 0.04kw respectively.
- Mechanical efficiency of the triangular piston is increases up to 2.34% respectively.
- Hydrocarbon emission is decreased up to 0.02PPM in the triangular piston crown.
- Carbon monoxide emission is decreased in a triangular shape crown 0.01% respectively.
- Carbon dioxide emission is decreased 0.02% respectively.
- Oxygen emission also decreased up to 0.01% respectively.

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