International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Impact of Piston Geometry on Diesel Engine Performance, Emissions and Combustion

LakshmiSrinivas Sastra Ummaleti, Jamuna Rani Ganipineni, Srinivasa Rao Konuru

Abstract**: *Motor execution improvement and fumes discharges decrease are two most significant issues to build up an increasingly productive motor with less natural effect. For diesel motor, cylinder geometry is one of the real parameter that influences the motor performance and emissions. In this present research work, engine performance improvement and exhaust emission characteristics reduction was reducing with the help of some modification in piston geometry by using 3 different types of piston geometries. Horizontal, Toroidal and Re-entered pistons. These can be tested on single cylinder water cooled ci motor. Varying Different type's pistons were analyzed and emissions HC, CO, CO2, O2 and NOx were studied with 5-gas exhaust gas analyzer. The toroidal cylinder gives the best performance and lower emissions at all load conditions.***

Index Terms**: *Combustion Chamber,* Diesel engine, *Emissions, Performance, Piston geometry***

I. INTRODUCTION

Pistons are planned which perform explicit in motor activity. The chamber head or crown gets into greater part of fundamental weight and power achieved by the start procedure. The cylinder stick region is displayed to a great deal of power because of speedy directional changes. It is furthermore presented to warm expansion about the trading the head to a body of cylinder. The cylinder stick zone is expose a more warm augmentation than different areas of the chamber.

In-chamber smooth motion in inside ignition engines is a champion among a huge components controlling the consuming procedure. It administrates air-fuel mixing and expending rates in diesel motors. The fluid stream going before consuming in an internal ignition motor is made acceptance procedure and weight stroke. In this way, a superior comprehension of smooth motion during the enlistment procedure is essential for make a motor structure with the most alluring working and outflow qualities.

Dr. S.L.V.Prasad [1] et al. 2013 He investigates the technique to improve the air swirl to accomplish achieve progression in engine execution and outflow in an immediate infusion (DI) single-chamber diesel motor. So as to accomplish the distinctive whirl powers in chamber, three plan parameters have chosen: the chamber head, cylinder crown, and bay complex. To investigate the uplifting of swirl in chamber, the plan of analyses is directed by making straight notches in the chamber head. In this work, three unmistakable arrangements of chamber heads are 1, 3, 6, used to swirl for better blending of fuel and air to improve the exhibition the engine. An endeavor is made in this work with an alternate number of channels on the chamber leader of the diesel motor. Different channels of size 16x3x2 mm are orchestrated on the chamber head and depend upon the locally open innovation.

B.V.V.S.U.Prasad [2] et al. 2010 He concerns the effect of whirl prompted by re-participant cylinder bowl geometries on emanations in a diesel motor, and unequivocally fixates around on a solitary chamber, 7.5 kW enduring velocity engine. The emanation test outcomes of two arrangements of the chose motor are accounted for. The second arrangement which has a marginally re-contestant consuming chamber and a sac-less injector was found to yield lower discharges. In order to understand the re-participant and injector change on discharges, point by point, three-reproductions of the in-chamber procedures were directed. The piston geometry and injector change was inspected using unfired and terminated recreations. Reenactment of the shut valve part of the cycle in the two arrangements uncovered that ordinary whirl and disturbance levels around TDC of weight were higher for standard case than for the changed geometry. Extended surface zone, nearness of an enormous focal projection and lacking re-contestant were perceived as the explanations behind the altered geometry yielding poor outcomes.

Dr. G .Prasanthi [3] et al Learned about the impact of the air twirl in the chamber upon the introduction and transmission of a singular chamber diesel direct implantation engine by utilizing diesel on volume premise exhibited. The expansion of the whirl is done by cutting scores on the crown of the chamber. In this work, three particular structures of the chamber for instance solicitation of various miseries 6,9,12 are used the swirl for better mixing of air and fuel and their outcomes on the show and spread are recorded.

From the examination, unmistakably out of all cylinders arrangements the single-chamber D.I diesel motor, the cylinder with nine depressions, for example, GP2 gives better execution in perspectives. The accompanying finishes are drawn reliant on the effect of air swirl in the chamber at 3/4 of the assessed burden when contrasted with the ordinary motor.

I.J.Patel [4] et al 2014 probed the cylinder bowl by cutting three twisting scores on the inner surface of the hemispherical bowl and slight growing in bowl estimation. The winding indents increase air limit and somewhat diminish the weight proportion similarly to make a homogeneous blend of fuel and air.

Revised Manuscript Received on 30 July 2019.

* Correspondence Author

LakshmiSrinivas Sastra Ummaleti*, PG Scholar, Department of Mechanical Engineering, VRSEC Vijayawada, Andhra Pradesh, India. .

Jamuna Rani Ganipineni, Assistant Professor, Department of Mechanical Engineering, VRSEC, Vijayawada, Andhra Pradesh, India.

Srinivasa Rao Konuru, Assistant Professor, Department of Mechanical Engineering, Vidya Jyothi Institute of Technology, Hyderabad, TS, India

This examination is done on Kirloskar AV1 water-cooled, regular suctioned direct imbuement diesel engine with unadulterated diesel. In examination, it watched the fuel use and NOx declined by 0.1Kg every hour 8.82% independently.

II. PROCEDURE AND METHODS

A. Hemispherical piston:

A cylinder head expansion part extends downwardly into the hemispherical ignition chamber in order to involve a volume there of as necessary to increase compression ratio to a desired value. At the point When the hemispherical burning chamber is shaped in the piston crown, the cylinder crown is verified to however disperse to separate from the piston head in order to protect piston crown from the piston head.

Fig A. Hemispherical piston

B. Toroidal piston:

The toroidal cylinder a sort of inside burning motor where the cylinders move in a round development inside a ring-shaped "chamber", drawing nearer and further from each other to give weight and extension. By two arrangements of cylinders are used, prepared to move in a fixed relationship as they turn around the chamber. In specific versions, the cylinders falter around a fixed centre, rather than pivoting around the motor. The structure has furthermore been alluded to as swaying cylinder motor, the vibratory motor when the cylinders waver as opposed to turn or toroidal motor reliant on cylinder.

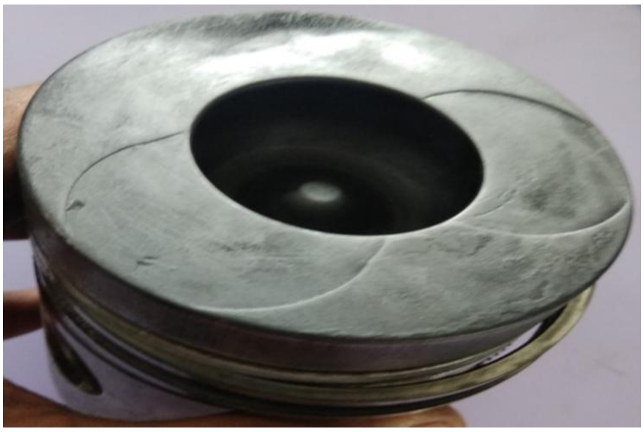

Fig B. Toroidal piston

C. Re-entrant piston:

A re-entrant bowl is utilized to advance increasingly quick air fuel mixing in the bowl. Convectional bowl is swirling air enters to the bowl and streams down to base of the bowl then internal and upward in toroidal movement. Re-entrant bowl is swirling air enters the bowel and spreads downwards and outwards into the undercut locale and partitions into stream rising up the bowl sides and stream flowing along the bowl base.

Fig C. Re-entrant piston

D. Experimental Setup:

An electronic device sole cylinder, four lash, continual speed, Water chilled, direct injection, variable solidity ratio diesel engine was utilized to study the presentation, combustion and emission analysis.

Fig D. Tested engine

Table 1. Engine Specifications

Ignition	Compressed ignition (4 Stroke)
Cylinders	1
Manufacturer	Kirloskar
Type	TV1
RPM	1500
Power	5.2 KW
Compression ratio	17.5
Bore diameter	87.5 mm
Stroke length	110 mm
Swept volume	661.45 cc
Connecting rod length	234 mm
Normal injection pressure	200 bar

III. RESULTS AND DISCUSSION

A. *Brake Thermal Efficiency:*

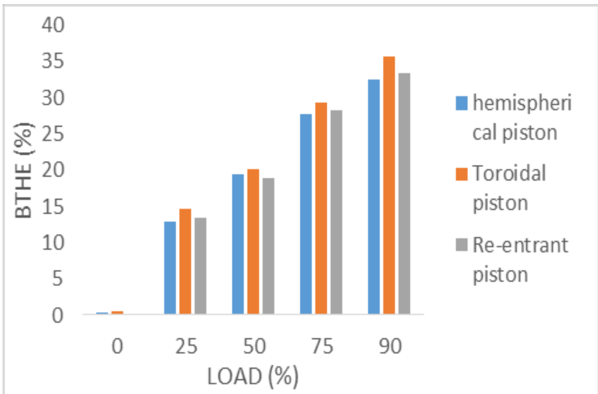

Fig E. LOAD Vs Brake Thermal Efficiency

Fig E. Shows the variation of Brake thermal efficiency with respect to load. The load is booked on the x-axis and efficiency is engaged on y-axis. The graph shows that changes in brake thermal efficiency with different loads. It can be seen that Toroidal piston Brake thermal efficiency is(35.6%) increased. When compared to hemispherical and re-entrant piston.

B. *Specific Fuel Consumption:*

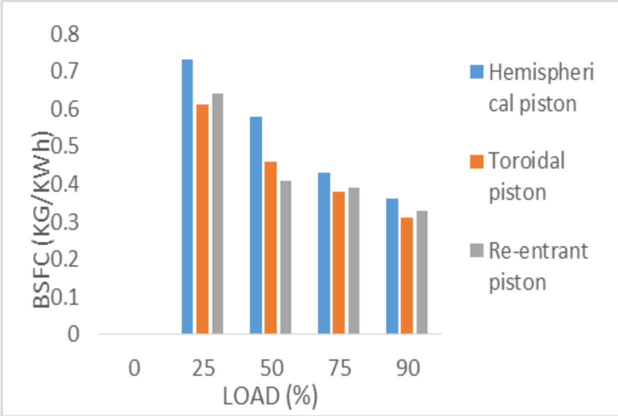

Fig F. LOAD Vs Specific Fuel Consumption

Fig F. Shows the variey of Brake specific fuel consumption with respect to load. The load is occupied on the x-axis and Brake specific fuel consumption is occupied on y-axis. It can be seen that Toroidal piston brake specific fuel consumption is decreases 0.31 kg/kwh. When compared to hemispherical and re-entrant piston.

C. *Carbon Monoxide Emissions*

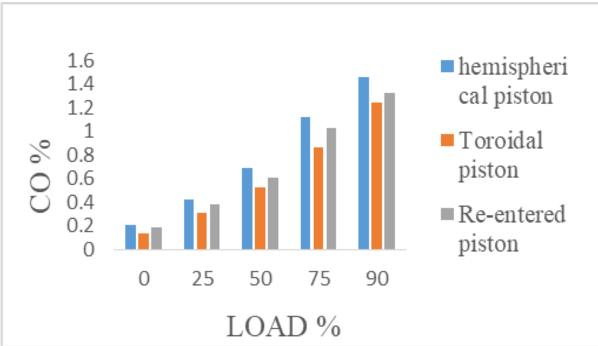

Fig G. LOAD Vs Carbon Monoxide Emissions

Fig G. Shows the variation of Carbon monoxide with respect to load. The load is taken on the x-axis and Carbon monoxide is taken on y-axis. It can be seen that toroidal piston showing the lowest carbon monoxide (1.24)% lower than the hemispherical and re-enterant piston.

The toroidal piston may cause complete combustion of fuel decrease the co emissions, the hemispherical and re-entrant pistons are increase when compare to toroidal because of an incomplete combustion of fuel.

D. *Hydro Carbon Emissions*

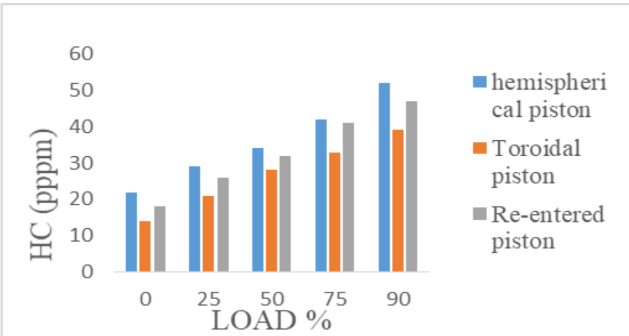

Fig H. LOAD Vs Hydro Carbon Emissions

Fig H. shows dissimilarity in hydrocarbons with respect to the load. The freight is booked on the x-axis and hydrocarbons are booked on y-axis. It can be seen that toroidal piston shows the lowest hydrocarbons 39 ppm when compared to the hemispherical and re-entrant piston.

E. *Nitrogen Oxide Emissions*

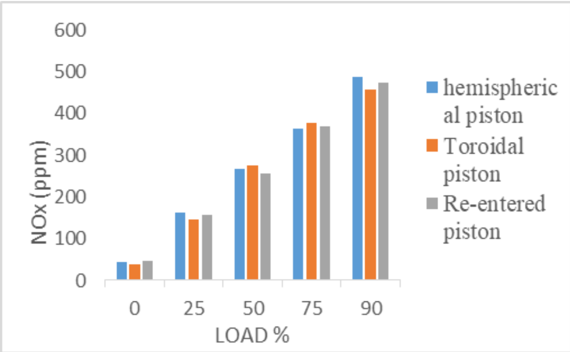

Fig I. LOAD Vs Nitrogen Oxide Emissions

Fig I. Expressions the dissimilarity of Nitrogen oxide with respect to load. The load is reversed on the X-axis and nitrogen oxide is taken on y-axis. It can be seen that toroidal piston shows in half load condition an slight increase in nitrogen oxide 378 ppm.

In full load condition the toroidal piston shows lowest nitrogen oxides 456 ppm. When compare to hemispherical and re-entrant piston.

F. *Heat Removal Rate*

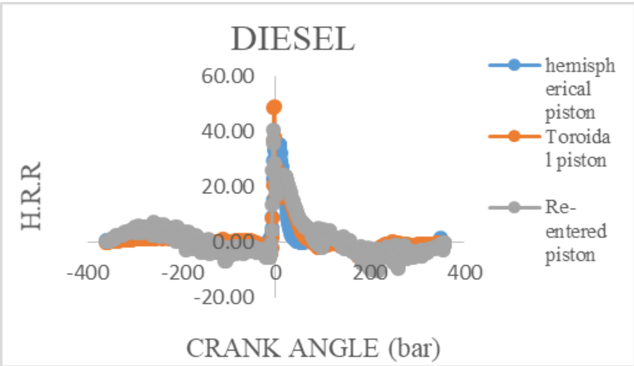

Fig J. Crank Angle Vs Heat Removal Rate

Fig J. shows variation of heat Removal Rate with respect to the Crank Angle. The Crank Angle is taken on the x-axis and Heat Removal rate is taken on y-axis. It can be seen that toroidal piston shows high heat removal rate. When compare to Hemispherical and Re-entrant piston.

G. *Cylinder Pressure*

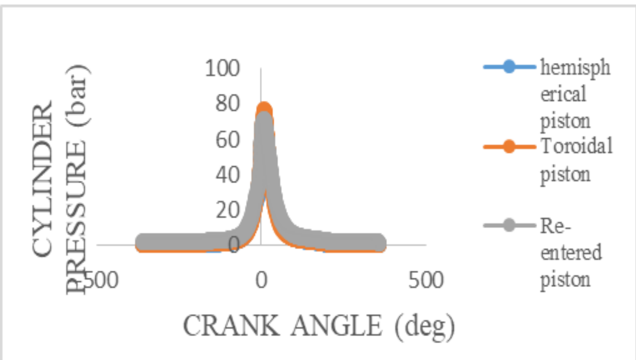

Fig k. Crank angle Vs Cylinder Pressure

Fig k. shows variation of Cylinder pressure with respect to the Crank Angle. The Crank Angle is taken on the x-axis and Cylinder pressure is taken on y-axis. It can be seen that toroidal piston shows the slight increment in Cylinder pressure. When compare to Hemispherical and Re-entrant piston.

IV. CONCLUSION

Better results are obtained by toroidal piston geometry on the diesel engine performance when it compare to hemispherical and re-entrant piston.

The toroidal piston will give better execution and lower in discharges however NOx somewhat expanded into equal parts burden condition when contrasted with the hemispherical and re-entrant cylinder.

The re-entrant piston has higher pinnacle weight and lesser start delay, decrease in HC, CO which is ascribed to improved air blending, the higher temperature in the chamber, and least warmth misfortunes contrast with hemispherical and Toroidal piston. There is an improvement in air movement in the hemispherical piston cause the expansion in brake warm productivity and decrease in brake explicit fuel utilization contrast the toroidal and re-entrant piston.

By using Toroidal piston geometry engine performance is improved and the emissions are reduced.

REFERENCES

1. Prasad, S. L. V., et al. "Upgrade of air twirl in a diesel motor with the scored chamber head." International Journal of Innovative Research in Science, Engineering and Technology 2 (2013): 3821-3825.
2. Prasad, B. V. V. S. U., et al. "High whirl actuating cylinder bowls in little diesel motors for emanation decrease." Applied vitality 88.7 (2011): 2355-2367.
3. Bharathi, V. V., and G. Prasanthi. "The Influence of air twirl on burning and outflows in a diesel motor." International Journal of Research in Mechanical Engineering and Technology 3.2 (2013): 14-16.
4. Pugazhvadivu, M., and S. Rajagopalan. "Examinations on a diesel motor fuelled with biodiesel mixes and diethyl ether as an added substance." Indian Journal of Science and Technology 2.5 (2009): 31-35.
5. Pugazhvadivu, M., and K. Jeyachandran. "Examinations on the presentation and fumes outflows of a diesel motor utilizing preheated waste browning oil as fuel." Renewable energy30.14 (2005): 2189-2202.
6. Peeraiah, M., M. Chandra Sekhar Reddy, and A. Venugopal. "Upgrade of Motor Performance and Reduction of Emissions by changing Piston Geometry."
7. Jaichandar, S., and K. Annamalai. "Joined effect of infusion weight and burning chamber geometry on the exhibition of a biodiesel-powered diesel motor." Energy 55 (2013): 330-339.
8. Jaichandar, S., P. Senthil Kumar, and K. Annamalai. "Joined impact of infusion timing and burning chamber geometry on the exhibition of a biodiesel-powered diesel motor." Energy 47.1 (2012): 388-394.
9. Li, J., et al. "Impacts of cylinder bowl geometry on burning and outflow qualities of biodiesel-powered diesel motors." Fuel 120 (2014): 66-73.
10. Kim, Hyung Jun, et al. "An investigation of shower methodologies on the progress of motor execution and outflows decrease attributes in a DME filled diesel motor." Energy 36.3 (2011): 1802-1813.
11. Shoji, Kianoosh, and Majid Mahdavian. "Adjustment of cylinder bowl geometry and infusion procedure, and examination of EGR piece for a DME-consuming direct infusion motor." (2017).
12. Aljaberi, Hassan An., A. Aziz Hairuddin, and Nuraini Abdul Aziz. "The utilization of various kinds of the cylinder in an HCCI motor: A survey." International Journal of Automotive and Mechanical Engineering 14 (2017): 4348-4348.

13. Sapit, Azwan, et al. "Correlation of Piston Bowl Shape Effect to Diesel Spray Development." IOP Conference Series: Materials Science and Engineering. Vol. 226. No. 1. IOP Publish, 2017.

AUTHORS PROFILE

First Author PG Scholar from VR Siddhartha Engineering College . Completed B.Tech from, JNTUK with first Class.

Second Author Have more than ten years of teaching experience. M. Tech Specialization is from Thermal Engineering Stream. Pursuing PhD from JNTUK Published more than ten technical papers inn different International journals and Conferences.

Third Author seven years of experience teaching. Pursuing Ph.D from JNTUK. Research areas of interest are CFD, Heat Transfer and Refrigeration and Air-conditioning.