THE EFFECT OF COMPRESSION RATIO ON PERFORMANCE OF 4-STROKE SPARK IGNITION ENGINE

1MALI ANUP D., 2YADAV SANJAY D.

1M.Tech. Student, Automobile Department, R.I.T., Sangli, Maharashtra, India, 2Associate professor, Automobile Department, R.I.T., Sangli, Maharashtra, India.
E-mail: anup.mali44@gmail.com, sanjay.yadav@ritindia.edu

Abstract- Petrol engines are very popular from the time of their invention; most of the automobiles are run by these engines. Mainly because of its simplicity and easy operations they are the choices for a number of researches but due to lack of crude oil reserves and increasing price of petrol alternative fuels are coming to picture. In this present investigation a novel method of changing the compression ratio is proposed, applied, studied and analyzed. The clearance volume of the engine is altered by changing the cavity volume of cylinder head and also piston height. This modification permitted to have different values of clearance volume. Increase in compression ratio improves fuel efficiency and power output. The novelty in this work is to permit 4-stroke spark ignition engine manufacturer to change the compression ratio.

Keywords- Four Stroke Engine, Spark Ignition, Compression Ratio And Fuel Efficiency Etc.

I. INTRODUCTION

Worldwide pressure to reduce automotive fuel consumption and exhaust emissions is leading to the introduction of various new technologies for the petrol engine as it fights for market share with the diesel. Compression ratio is the technology to adjust internal combustion engine cylinder compression ratio. In four stroke spark ignition engine high compression ratio is employed for greater efficiency and low load operation, and low compression ratio is employed at full load allowing to work without problem of detonation. The compression ratio could provide the key to enable exceptional efficiency at light loads without loss of full load performance. A study on the efficiency and exhaust gas analysis of variable compression ratio spark ignition engine fuelled with alternative fuels reveals that the brake thermal efficiency and volumetric efficiency improved with higher compression ratio. Traditionally, every mechanical element in the power conversion system has been considered as a means to achieve variable compression ratio.

Different methods to obtain different compression ratios are changing the cylinder head cavity volume, variation of combustion chamber height and variation of piston height.

1. Cylinder head cavity volume
The cylinder head cavity volume is plays major role in variation of compression ratio. This cylinder head cavity volume is measured separately for calculating the clearance volume. If cylinder head cavity volume is at higher side then compression ratio is at lower side and when cylinder head cavity volume is at lower side then compression ratio is at higher side. So every researcher aims to that keep compression ratio at higher side for better engine performance by using lower cavity volume cylinder head.

2. Top dead center volume
The top dead center volume is also important parameter which affecting on variation of compression ratio. This volume is measured when piston is rest at top dead center and this volume measured for calculating the clearance volume with the addition of cylinder head cavity volume. If TDC volume is at higher side then compression ratio is at lower side and when TDC volume is at lower side then compression ratio is at higher side. This top dead center volume always keeps at lower side for better engine performance.

3. Head gasket thickness
Head gasket thickness is little affecting on the variation in compression ratio. This gasket thickness measured for the calculating the clearance volume with the addition of cylinder head cavity volume and top dead center volume. For better engine performance the gasket thickness keep at lower side.

4. Piston Height from piston pin to crown
The piston height is little affecting on the variation in compression ratio. This piston height from piston pin to piston crown is helpful for the lowering clearance volume. If piston height is at higher side the TDC volume is at lower side and when piston height is lower side the TDC volume is higher side. For better engine performance keep piston height at higher side.

The following researchers worked on effect of variable compression ratio such as, Yuh and Tohru (2005) conducted a research on the effect of higher...
compression ratios in two-stroke engines. The results show that the actual fuel consumption improved by 1-3% for each unit increase in the compression ratio range of 6.6 to 13.6. It was concluded that the rate of improvement was smaller as compared to the theoretical values. The discrepancies were mainly due to increased mechanical and cooling losses, short-circuiting at low loads and increased time losses at heavy loads. Power output also improved, but the maximum compression ratio was limited due to knock and the increase in thermal load. In addition, the investigation covered the implementation of higher compression ratio in practical engines by retarding the full-load ignition timing.

Asif et al. (2008) conducted a research on performance evaluation of a single cylinder four stroke petrol engine. In the research, the actual size of the engine parameters like the bore, stroke, swept volume, clearance volume, compression ratio and engine speed were recorded and computed. Based on the actual size of the engine parameters, the indicated horse power, brake power, and friction horse power were determined and were found to be 1.54, 1.29 and 0.25 respectively. The mechanical efficiency and the thermal efficiency were also calculated and were found to be 83% and 20.5% respectively. The fuel consumption per hour was found to be 0.8 litre/hour while the fuel consumption per distance traveled was found to be 60 km/litre.

II. MATERIALS AND METHOD

In the present work is carried out on forced air cooled, 4-stroke spark ignition engine operating for different compression ratio. The specifications of engine are given in following table 1.

<table>
<thead>
<tr>
<th>Table 1: Test engine specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>No. of cylinder</td>
</tr>
<tr>
<td>Displacement</td>
</tr>
<tr>
<td>Power (Hp @ rpm)</td>
</tr>
<tr>
<td>Torque (Nm @ rpm)</td>
</tr>
<tr>
<td>Bore (mm) X Stroke (mm)</td>
</tr>
<tr>
<td>Compression Ratio</td>
</tr>
<tr>
<td>Idling Speed (rpm)</td>
</tr>
<tr>
<td>Ignition System</td>
</tr>
<tr>
<td>Fuel Efficiency</td>
</tr>
<tr>
<td>Starter</td>
</tr>
<tr>
<td>Transmission</td>
</tr>
</tbody>
</table>

Six variations in the compression ratio are obtainable within the proposed work. The original compression ratio given by the manufacturer cannot be altered at the piston end. However by machining the piston crown it is possible to increase the clearance volume. This machining is restricted by the piston design limitation. The investigation in this line of study has to consider the factor of safety before going for machining. Six collars are made to get six compression ratios apart from existing compression ratio. The compression ratios obtained are 9.43, 9.58, 9.75, 9.88, 10.09 and 10.22. A drum is mounted on the output shaft and is loaded with a brake dynamometer as shown in the test rig in Figure.

The engine is coupled to an eddy current dynamometer to measure power. The fuel consumption was measured on mass consumption basis. The clearance volume is found by measuring the length of the pin projected into the combustion chamber. The experiments are carried out at different compression ratios 9.43, 9.58, 9.75, 9.88, 10.09 and 10.22 of The load is varied from no load to full load for each compression ratio at constant speed of 1700 rpm of the engine. The variation of total fuel consumption, engine power and the mileage of engine is studied at constant speed of the engine.

Formulae for calculating the compression ratio

\[
C.R. = \frac{S.V. + C.V.}{C.V.}
\]

Where,
S.V. = Swept volume = 3.1416 \times (\text{Radius of Bore})^2 \times \text{Stroke}
C.V. = Clearance volume = H.V. + D.C.V. + G.V. – E.D.V.

Where,
H.V. = Head Volume
D.C.V. = Deck Clearance Volume
G.V. = Gasket Volume

= 3.1416 \times (\text{Radius of bore})^2 \times \text{Deck clearance}
= 3.1416 \times (\text{Radius of bore})^2 \times \text{gasket thickness}.
E.D.V = Effective piston dome volume

III. RESULT AND DISCUSSION

Figures 2 to 5 are the experimentally obtained graphs for the specific fuel consumption, power and mileage of four stroke spark ignition engine. The various compression ratios of 9.43, 9.58, 9.75, 9.88, 10.09 and 10.22 for each of the compression ratio have different performance characteristics. The graphs presented for the comparisons are for an engine speed of 1700 rpm. The variation of total fuel consumption at different compression ratios is shown in the fig. The total fuel consumption increased with all the compression ratios. The total fuel consumption increased up to a compression ratio of 9.4. The improvement in the fuel consumption is considered to be a result of the reduced specific heat ratio of the working gases and increased mechanical loss, cooling loss and time loss.

The variation of power at different compression ratios is shown in the fig.3. The power increased with increasing the compression ratios. The power increased up to 8.5 at the compression ratio 10.22.

The variation in fuel efficiency (On road mileage) at different compression ratios is shown in the fig 4. The results show that the fuel efficiency increases with compression ratio.

CONCLUSIONS

The significant conclusions from the present work are summarized as follows.
1. The compression ratio is varied by using a simple.
2. The total fuel consumption increased with the compression ratio.
3. The specific fuel consumption reduced with compression ratio.
4. The power of an engine increased with the compression ratio.
4. The fuel efficiency increased with compression ratio.

ACKNOWLEDGMENT

The authors gratefully acknowledge the help of Piaggio vehicles pvt. ltd. and library facilities from Rajarambapu Institute of Technology, Rajaramnagar.

REFERENCES


