A Study on Compression Ratio for Petrol Engine in India

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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 at. (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. LITERATURE REVIEW

The ever increasing demand for the petroleum based fuels and their scare availability has lead to extensive research on Diesel fuelled engines. A better design of the engine can significantly improve the combustion quality and in turn will lead to better brake thermal efficiencies and hence savings in fuel..(M.K.G. Babu et.al, 2008) The potential of Diethyl ether (DEE) as a supplementary oxygenated fuel in a compression ignition engine has been identified through an experimental investigation.

In this study the tests were conducted on a single cylinder DI diesel engine fueled with neat diesel fuel and addition of 2, 5, and 10% DEE in diesel fuel to find out the optimal blend on the basis of performance and emission characteristics India though rich in coal abundantly and endowed with renewable energy in the form of solar, wind, hydro and bio-energy has a very small hydro carbon reserves (0.4%of the world's reserve) [2]. India is a net importer of energy. Nearly 25% of its energy needs are met through imports mainly in the form of crude oil and natural gas (Kapilan N et.al 2008).The rising oil bill has been the focus of serious concerns due to the pressure it has placed on scarce foreign exchange resources and is also largely responsible for energy supply shortages. The sub-optimal consumption of commercial energy adversely affects the productive sectors, which in turn hampers economic growth. [4].The present work deals with finding the better compression ratio for the Diesel fuelled C.I engine at variable load and constant speed operation. The compression ratio of an internal combustion engine or external combustion engine is a value that represents the ratio of the volume of its combustion chamber from its largest capacity to its smallest capacity. It is a fundamental specification for many common combustion engines.

Experimental results showed that there is a slight increase in brake specific fuel consumption, brake power and brake thermal efficiency as compared to diesel fuel. In addition, it was found that there is a decrease in smoke, oxides of nitrogen, unburned hydrocarbon, carbon monoxide and ignition delay along with increase in carbon dioxide. (Ashok M.P et.al 2007).The performance of the diesel engine is increased with the addition of oxygenates to the fuel prior to the combustion. This paper presents the effect of blending of Diethyl ether (DEE) with diesel at various proportions (5%,7.5% and 10%)on the performance of diesel engine. The experimental results indicated that with the increase in the concentration of DEE to diesel increases the brake thermal efficiency, mechanical efficiency and decreases the specific fuel consumption.

The performance of diesel engine at different compression ratios (18, 16 and 14) for diesel with 5% DEE blend was also evaluated in this work. (Subramanian K.A. et.al 2002).The data obtained from experimentation is presented analyzed in this paper .To find out the Optimum Compression Ratio of the Computerized Variable Compression Ratio (VCR) Single Cylinder Four Stroke Diesel Engine using Experimentation analysis. Various parameters defining the performance of V.C.R diesel engine are calculated and they are used as means for obtaining optimum compression ratio. By plotting performance graphs of different loads and different compression ratios from that optimum compression ratio obtained.

Mjad Shaik El At [2001] reviews the geometric approaches and solutions used to Achieve VCR, consider the results of prior research, and forecasts what benefits, if any, a VCR would bring to present engine design.

Martyn Roberts [2003] studied Potential benefits of Variable Compression Ratio (VCR) spark ignition engines are presented, based on an examination of the relationship between Compression Ratio, BMEP and spark advance at light load and full load. Alternative methods of implementing VCR are Illustrated and critically examined.

Tadeusz J. Rychter el at [2004] introduced the state-of-art knowledge about the progress in the investigations of the VR/LE concept of the variable compression ratio engine .reviewed Engine kinematics, thermodynamic analysis, research engine design and application of the concept to the turbocharged diesel engine A variable compression ratio concept has also been evaluated by means of the simulation of a turbocharged diesel engine.

GVNSR Ratnakara Rao [2004] carried out experiments on a single cylinder four stroke variable compression ratio diesel engine to find out optimum compression ratio. Tests were carried out at compression ratios of 13.2, 13.9, 14.8, 15.7, 16.9, 18.1 and 20.2 results on thermal efficiency due to varying compression ratio are plotted on graph.

Aina T. [2005] performs experimental and theoretical investigation of the influence of the compression ratio on the brake power, Brake thermal efficiency, brake mean effective pressure and specific fuel consumption of the Ricardo variable compression ratio spark ignition engine. Compression ratios of 5, 6, 7, 8 and 9, and engine speeds of 1100 to 1600rpm, in increments of 100 rpm, were utilized. The results are shown that as the compression ratio increases, the actual fuel consumption decreases averagely by 7.75%, brake thermal efficiency improves by 8.49 % and brake power also improves by 1.34%.

Charles Mendler [2006] gives brief technology overview to vary compression ratio. Initial approaches are given by him .Piggy back the VCR hydraulic actuator system off of the transmission hydraulic circuit to minimize hardware cost and to minimize additional oil pump power consumption.
Implement a new intermittently high-pressure circuit to step-up the transmission oil pressure for powering the VCR & shows Major Finding and New Approach Found after his testing of his VCR engine.

Nitin Wankhade [2007] comparatively investigate VCR diesel engine for different types of vibration .to analyze the vibration in diesel engine cylinder liner considering combustion gas forces and cylinder liner temperature using finite element software ANSYS. By comparing the analytical results, the validity of the proposed analysis has been tested & evaluated the vibration of different materials along with increase in thickness.

Prof. N.P. Doshi [2008] performs modeling of connecting rod used in light commercial vehicle of Tata motors had recently been launched in the market using PRO-E wildfire 4.0software & analysis its design in ANSYS 11 software. They found out the stresses developed in connecting rod under static loading with different loading conditions of compression and tension at crank end and pin end of connecting rod. They have also designed the connecting rod by machine design approach.

Anthony Crawford [2009] studied & reviews ways to mitigate knock in VCR engine. Find various benefits of VCR in SI engine shows various VCR systems.

Hong- Wook Lee [2010] Developed a concept of Variable Compression Ratio Engine Using TRIZ In this study, TRIZ is applied to develop new concept of VCR engine. Various tools of TRIZ have been used in this study: “Function analysis” is applied to analyze previous VCR models, and “Trimming” to make new contradiction, then “ARIZ” to solve this problem. When the more power of engine is needed during high load, the compression ratio is decreased, and when the higher efficiency is needed during low load, the compression ratio is increased. This is one of good examples of “Separation in Time” in TRIZ. VCR engine with turbo charger improves 20~30% of fuel consumption in comparison with the same power of naturally-aspired engine

Biogas as Alternate Fuel in Diesel Engines: A Literature Review

Current energy situation throughout the world and the fact that main resources of energy, such as crude oil, natural gas, coal and nuclear fuel are not renewable give importance to other sources of energy, like hydro energy, solar energy, energy of wind and biogas. Mentioned sources of energy are all renewable, but biogas is particularly significant because of possibility of use in internal combustion engines, which are the main power source for transport vehicles and also commonly used for powering of generators of electrical energy. This possibility of use is justified by biogas properties, which make it convenient for IC engines. India is largest cattle breeding country; there is abundance of raw material for producing biogas. Also municipal sewage & kitchen wastes can be used for this purpose. The use of methane separated from biogas as a fuel will substantially reduce harmful engine emission and will help to keep the environment clean. Biogas consists of approximately 50-70 % methane. It is economical and slurry can be used as organic manure. In 1981 an effort has been made to use biogas in a converted diesel engine to SI engine by D. J. Hickson. He experienced 35% less power compared to diesel and 40% less compared to gasoline fuel. In that year another research was done by S. Neyeloff and W. W. Cunkel. They used a CFR engine and ran it with simulated biogas in different compression ratios. They reached to compression ratio of 15:1 for optimal solution. The lower heating value, corrosive composition and difficulties in transportation of the fuel were main challenges for biogas. In 1983, R.H. Thring concluded that biogas would be attractive just where it is close to production site and he suggested converting gaseous fuels like biogas or natural gas to liquid fuels such as methanol or gasoline.

Bio fuels derived from biomass are considered as good alternative to petroleum fuels. Biogas, a biomass derived fuel can be used in internal combustion (IC) engines, because of its better mixing ability with air and clean burning nature. Biogas is produced by anaerobic digestion of various organic substances such as kitchen wastes, agricultural wastes, municipal solid wastes, cow dung etc., which offers low cost and low emissions than any other secondary fuels. It can be a supplemented to liquefied petroleum gas (LPG) and compressed natural gas (CNG), if it is used in compressed form in cylinders.

III. MATERIALS AND METHODS

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 1: Test engine specifications

Type	4 Stroke, Spark ignition, Forced Air-cooled BS-III
No. of cylinder	One
Displacement	125 cc
Power (Hp @ rpm)	8-9 Hp @ 7000 rpm
Torque (Nm @ rpm)	9.8 Nm @ 5000 rpm
Bore (mm) X Stroke (mm)	52 X 58.6
Compression Ratio	10:01
Idling Speed (rpm)	1000-1300
Ignition System	Electronic
Fuel Efficiency	62 Km / Lit. at ARAI
Starter	Electric starter motor & Kick
Transmission	CVT

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.

Fig.1: Vespa 125cc engine test rig

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 × (Radius of Bore)2 × 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
= 3.1416 × (Radius of bore)2 × Deck clearance
G.V. = Gasket Volume
= 3.1416 × (Radius of bore)2 × gasket thickness .

E.D.V = Effective piston dome volume

IV. 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.

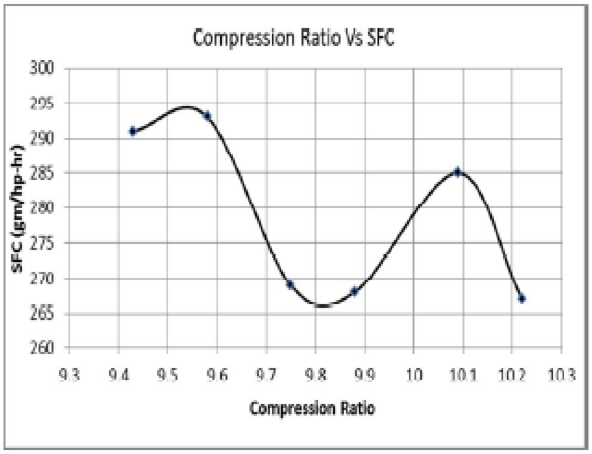

Fig.2: Variation in specific fuel consumption with different compression ratios.

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.

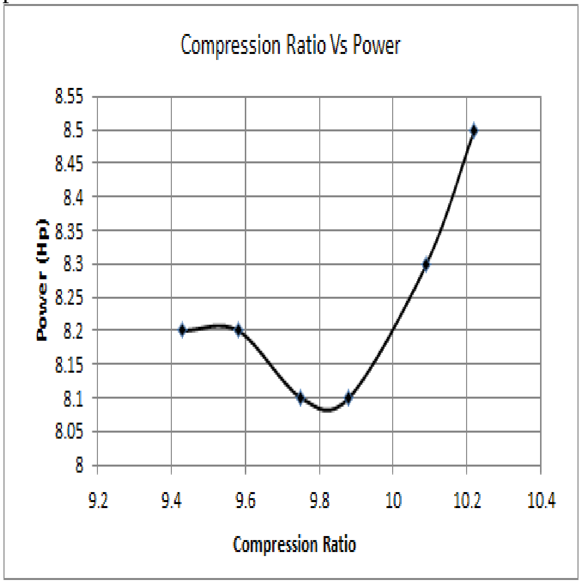

Fig.3: Variation in engine power with different compression ratios

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.

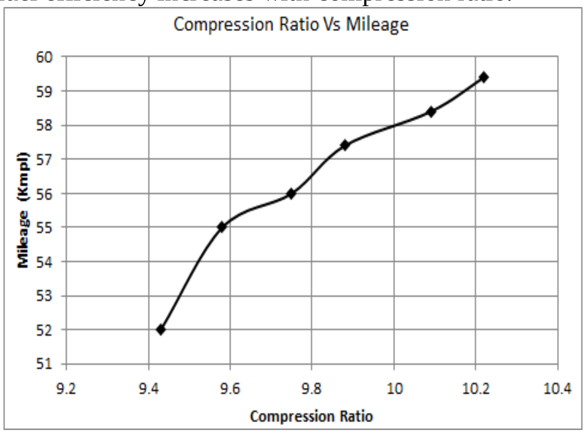

Fig.4: variation in fuel efficiency with different compression ratio

V. 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.

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