Analysis of I.C. Engine to Improve Performance due to Grooves on Engine Cylinder Head

V.R.Deshmukh[1], A.B.Atpadkar[2]

[1]Student, M-Tech-Mechanical Engineering, Mechanical Engineering Department, YSPM, YTC, Satara, Maharashtra, India.
[2]Professor, Mechanical Engineering Department, YSPM, YTC, Satara, Maharashtra, India.

---***---

Abstract - *The in-cylinder air motion 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 petrol engines.*

In this present work the experimental investigation of air swirl in the cylinder upon the performance and emission of a single cylinder petrol engine is presented. This intensification of the swirl is done by the formation of grooves on the engine cylinder head of the combustion chamber, by different configurations. Experiments are carried out on a petrol engine which is a four stroke single cylinder air cooled engine using modified different configurations of grooves on cylinder head. Performance parameters such as brake power, specific fuel consumption and brake thermal efficiency are calculated based on experimental analysis of the engine. Emissions such as carbon monoxide, carbon dioxide and unburnt hydrocarbons are measured.

Key Words: I.C. Engine, Turbulence, Swirl, Squish, Tumble Break Power, Break Specific Fuel Combustion.

1. INTRODUCTION

In the year2001, Somender Singh did the experimental investigation carried on a 4-S single cylinder air cooled petrol engine with different configurations of grooves and compared results with conventional engine. And he stated that there is a considerable enhancement in the performance of IC engine. He says that grooved engine have better fuel economy, higher torque and power, better combustion, less pollution, and engine runs cooler compare to conventional. He carried out experimentation by using three different configuration of grooves.

Instead of making grooves, John Lipinski, carried out experimentation in 2010 on internal combustion engine consisting of modified piston profile. He stated that, an upper end of the piston cylinder within the combustion can be contoured to increase turbulence in the combustion chamber and the cylinder head should comprise comprises one or more grooves in the combustion chamber. In order to analyze the effect of modification in the cylinder head geometry following experimentation is carried out.

The primary goal to select this topic is due to we know about there are lots of inventions are going on continually on I.C. Engine but there is no any method which improves overall efficiency of engine. Also all of us knows about the fuel cost and its availability in market also how the exhaust gases from engine affects on environment. That's why I am going to find found the some modifications in engine which reduce above mentioned problems.

Modifications in-cylinder head inside internal combustion engines is one of the most important factors controlling the combustion process. It governs the fuel-air mixing and burning rates in engines. In this project I am going to analyze the effect of grooves on performance of internal combustion engine is improved or not.

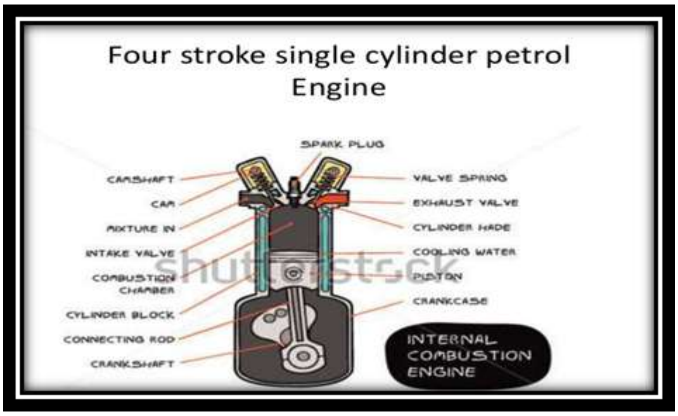


Fig.(1) Working Principle of Four Stroke Single Cylinder

2. EXPERIMENTATION

The following procedure is adopted for the experimentation:

1. To accomplish the desired tests, the engine was configured with both the normal and modified configurations.
2. The cylinder head modification (Singh Groove) was performed as instructed by Somender Singh.
3. The cylinder heads were configured for each test. The first was a conventional SI engine with specifications.

4. The second and third were a modified cylinder head, with same specifications and then had the “groove” modification added.
5. All the heads were then checked for combustion chamber volume and made sure they were nearly identical so that differences in combustion could not be attributed to an increase or decrease in compression ratio.
6. Modified cylinder head was rebuilt with resurfaced valves and new seals, after which the Singh modification was added.
7. Perform each cylinder head with Hero Honda Super splendor bike on two wheeler chassis dynamometer.
8. Simultaneously noted each required results from computer which is interfaced with test rig.
9. Noted results of exhaust emission gases from bike.
10. Above procedure is followed for all modified cylinder heads.

Fig. (2) Actual Grooved Engine Cylinder Head

2. EXPERIEMENTATION CALCULATIONS

1. Brake Power = $2 \times \pi \times N \times T$
2. Mechanical Efficiency = $BP \div IP$
3. Brake Mean Effective Pressure = $BP \times L \times A \times N \times K$
4. Specific Fuel Consumption = BSFC=$mf \div BP$
5. Specific air Consumption = BSAC= $ma \div BP$

3. RESULT & DISSCUSSION

Experimental investigation were carried out for performance and exhaust emission of the conventional SI engine and modified grooved engine. The test results obtained from the comprehensive experimental investigations are analyzed and described below.

3.1. Tests carried Out on I.C. Engine

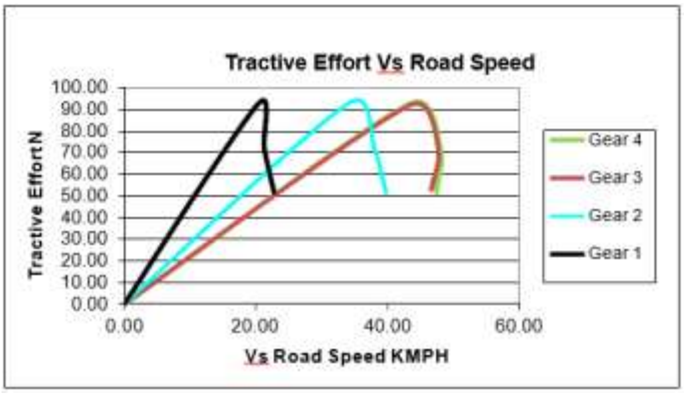
3.1.1. Normal Performance Test

The testing of the performance of an internal combustion engine is a huge task. However there are several simple tests that can be carried out to approximate the engine performance. One such test is normal performance test. The results obtained from the normal performance test are in terms of wheel power (Wheel- bhp) and tractive effort (N).

1st Gear Test

T (N-m)	RPM-Dyno	Vs.	P-dyno (BHP)	Pv-Roll (BHP)	P-wheel (BHP)	F-Tractive Effort
3.1	488	27.23	0.22	0.32	0.54	52.46
6	465	25.95	0.40	0.31	0.71	72.05
9.1	431	24.05	0.56	0.29	0.84	93.00

Table -1: Normal Average Performance



Graph-1: Tractive Efforts vs. Road Wheel

3.1.2. Fuel Average Performance Test

The fuel economy of an automobile is the fuel efficiency relationship between the distance traveled and the amount of fuel consumed by the vehicle. Consumption can be expressed in terms of volume of fuel to travel a distance, or the distance travelled per unit volume of fuel consumed. The test was carried out by running the engine for fuel quantity of 50cc and measuring the distance travelled by it.

Fuel Average Performance			
Road Speed KMPH	Dist. Covered 'm'	Fuel Consumed CC	Average KMPL
40 - 50	3644	50	72.88

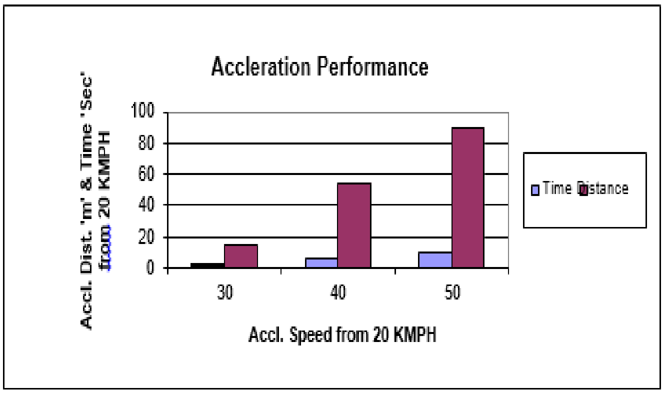
Table - (2) Fuel Average Performance

3.1.3. Acceleration Performance test

An engine that can accelerate in a short amount of time is considered to be eye candy for anyone with a taste in vehicles. The faster a engine can accelerate to a high velocity is crucial to its performance and handling .Acceleration performance is commonly reported as the time needed to accelerate a vehicle between two speeds at wide-open throttle.

Acceleration Performance			
Accl. Speed Low	Accl. Speed High	Accl. Time 'S'	Accl. Distance 'M'
20	30	2.2	15
20	40	6.3	54
20	50	9.1	90

Table – (3) Acceleration Performance Test



Graph-2: Acceleration Performance

3.1.4. Emission Test

The purpose of having an emission test on engine is to see the amount of pollutants it produces. With these tests, it can help to lower the pollutants your vehicle releases and can help the air quality of the environment. The emission test has repeatable and comparable measurements of exhaust emissions for different engines and vehicles. These tests are done in cycles, which can specify a set of very specific conditions that the engine is operating at. It was carried out by connecting the exhaust pipe of engine to the gas analyzer so that percentage of various gases exhausted to the atmosphere can be determined.

Single Groove					
Time [s]	CO corrected [%vol]	CO_2 [% vol]	HC corrected [ppm]	O_2 [%vol]	NO [ppm]
1	0.55	6.1	1287	11.49	73
2	0.54	6.11	1285	11.4	73
3	0.53	6.24	1201	11.14	73
4	0.52	6.38	1116	10.92	74
5	0.5	6.73	1011	10.75	74
6	0.5	6.73	937	10.7	73
7	0.52	6.42	1126	10.95	73
8	0.55	6.01	1363	11.39	71
9	0.58	5.68	1505	11.65	69
10	0.58	5.67	1622	11.96	68
11	0.58	5.67	1625	11.95	66
12	0.55	5.73	1606	11.8	67
Avrg.	0.541666667	6.1225	1307	11.341667	71.1666667
Normal Engine					
Time [s]	CO corrected [%vol]	CO_2 [%vol]	HC corrected [ppm]	O_2 [%vol]	NO [ppm]
1	0.85	4.81	2544	13.35	63
2	0.84	4.91	2495	13.15	65
3	0.84	4.91	2452	13.08	67
4	0.83	4.95	2367	12.89	66
5	0.83	4.95	2279	12.81	68
6	0.83	4.95	2178	12.93	66
7	0.83	4.95	2187	12.96	67
8	0.83	4.95	2273	13	68
9	0.81	5.07	2225	12.86	69
10	0.81	5.1	2210	12.63	71
11	0.8	5.16	2147	12.49	73
12	0.8	5.16	2053	12.56	72
Avrg.	0.825	4.989166667	2284.166667	12.8925	67.9166667

Table – (4) Emission Test

By analyzing the above observation table we can say that for recorded values for shorter time duration NO emission is comparatively higher in case of the grooved engine.

To comment accurately on emission effect more number of observations for longer duration test are required to carried out.

4. NOMENCLATURE

T = Torque in N-m

N = Rotational speed in rps

Pbm = Brake Mean Effective Pressure, N/m2

L = Length of the stroke, m

A = Area of the piston, m2

K = 1, for two stroke engine,

K=1/2, for four stroke engine.

3. CONCLUSIONS

In the present research work tests are carried out on SI engine with conventional cylinder head and modified cylinder head. From results it is observed that grooved engine, groove modification, requires less fuel for same distance travel as compared to engine with normal cylinder head. As the fuel economy of the grooved engine is more than normal engine, it is observed that brake specific fuel consumption of the grooved engine is less as compared to regular SI engine.

By analyzing emission results we can say that, by modifying cylinder head geometry it is possible to reduce the emission of harmful pollutants. From present results it is not feasible to comment on emission rate of any particular pollutant. To comment on that it is require to carry out number of emission tests on same setup.

The conclusions deriving from present experimental investigation which is conducted on 4- stroke, single cylinder, air cooled petrol engine by using two different configurations of grooves on cylinder head and a regular cylinder head is that, from the first set of results it can be conclude that the groove configuration has given the better performance in the sense of Brake specific fuel consumption and emission parameters. While the groove configuration gives the better performance in the sense of brake specific fuel consumption and acceleration performance.

REFERENCES

[1] Somender Singh, "Design to Improve Turbulence in combustion chamber", US 6,237,579 B1, May 29 2011

[2] A.Vamshikrishna Reddy, T. Sharathkumar, D. K. Tharunkumar, B. Dinesh, Y.V.S. saisantosh, International journal of technology enhancements and emerging engineering research, vol2, issue 6issn2347-4289.

[3] J Paul Rufus Babu, B. MadhuBabu, T. DaDakhalandar and P. S. Bharadwaj, "experimental investigation of rhombus shaped grooves on piston crown of a single cylinder 4-stroke DI diesel engine", International Research of Mechanical Engineering and Robotics Research, ISSN 2278 – 0149 Vol. 4, No. 1, January 2015

[4] Rodney J. Tabaczynski, "Turbulence and Turbulent Combustion in Spark-Ignition Engines", Energy Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA, Prog. Energy Combust, Sci., Vol. ~, pp, 143 165, 1976.

[5] Pavan Chandra P V, Siva Chaitanya A, "Design and Analysis of the Effect of a Modified Valve with Helical Guide ways on Combustion Performance of an I.C Engine", ISSN: 2248-9622, Vol. 5, Issue 8, (Part - 4) August 2015, pp.33-42

[6] M. L. Mathur, and R.P. Sharma, (1994), A Course in Internal Combustion Engines, DhanpatRai and Sons, NewDelhi.

[7] J.C.Jessin1, P.Maheswaran, M.Syed Abuthahir , K.Vijayan, "Design and Analysis of an IC Engine Piston Head to Increase the Torque on Crankshaft", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5, May 2016.

[8] Poulos, S. and Heywood, J., "The Effect of Chamber Geometry on Spark-Ignition Engine Combustion," SAE Technical Paper 830334, 1983, doi: 10.4271/830334.

[9] Freudenhammer, D., Peterson, B., Ding, C., Boehm, B. et al., "The Influence of Cylinder Head Geometry Variations on the Volumetric Intake Flow Captured by Magnetic Resonance Velocimetry," SAE Int. J. Engines8(4):1826-1836, 2015, doi:10.4271/2015-01-1697.

[10] Dr.VVPrathibha Bharathi , VV Naga Depthi , Dr.R.Ramachandra , Prof. V Pandurangadu , Prof. K Govindarajulu "Enhancement of Engine Performance and Reduction of Emissions by changing Piston Geometry", Volume 6 Issue No. 11

[11] Millo, F., Luisi, S., Stroppiana, A., and Borean, F., "Effects of Different Geometries of the Cylinder Head on the Combustion Characteristics of a VVA Gasoline Engine," SAE Technical Paper 2013-24-0057, 2013, doi:10.4271/2013-24-0057.

[12] 12. Vaz, M., Amorim, F., Ribeiro, J., Huebner, R. et al., "Numerical Analysis of the Piston Crown Geometry Influence on the Tumble and Squish in a Single Cylinder Engine," SAE Technical Paper 2014-36-0300, 2014, doi: 10.4271/2014-36-0300.

BIOGRAPHY

Vishal Rajaram Deshmukh

Student, M-Tech Mechanical Engineering, YSPM, YTC, Satara (Under BATU University, Lonere)