

# Performance Analysis of Swirl Chamber Type Induction System for a Four Stroke Petrol Engine

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**Abstract**— Internal combustion engines in now a days is the best available reliable source of power for all domestic, large scale industrial and transportation applications. The major issue arises at the efficiency of these engines. Every attempt made to improve these engines tends to attain the maximum efficiency. Here a single cylinder four stroke petrol engine is used for study. In this present work a study about influence of the air swirl upon the performance and emission of a single cylinder four stroke petrol engine is presented. In order to achieve the swirl, diverter tube is used between carburetor and engine to intensify the swirl for better mixing of fuel and air and their effects on the performance and emission are recorded. In particular the performance parameters of engine speed, torque, brake power, volumetric efficiency, brake specific fuel consumption, brake thermal efficiency are examined. In additional the noise and emission parameters percentage of CO and HC has been measured.

**IndexTerms**— Induction System, Manifold, Swirl Chamber

## I. INTRODUCTION

In today's world, major objectives of engine designers are to achieve the twin goals of best performance and lowest possible emission levels. Excellent engine performance requires the simultaneous combination of good combustion and good engine breathing. The Performance of an internal combustion engine, be it power, fuel economy or emissions, is strongly influenced by the combustion of the air and fuel inside an engine cylinder. This combustion process is strongly affected by the in-cylinder 'support flow' that results from the transport of the air and fuel through the induction system. The understanding of the effect of the induction geometry on the support flow is therefore essential for internal combustion engine development.

Among the many design goals of combustion engines, the mixing process of fuel and oxygen occupies an important place. If a good mixture can be achieved, the resulting combustion is both clean and efficient, with all the fuel burned and minimal exhaust remaining. In turn, the mixing process strongly depends on the inflow of the fuel and air components into the combustion chamber or cylinder.

## II. EXPERIMENTAL SET UP

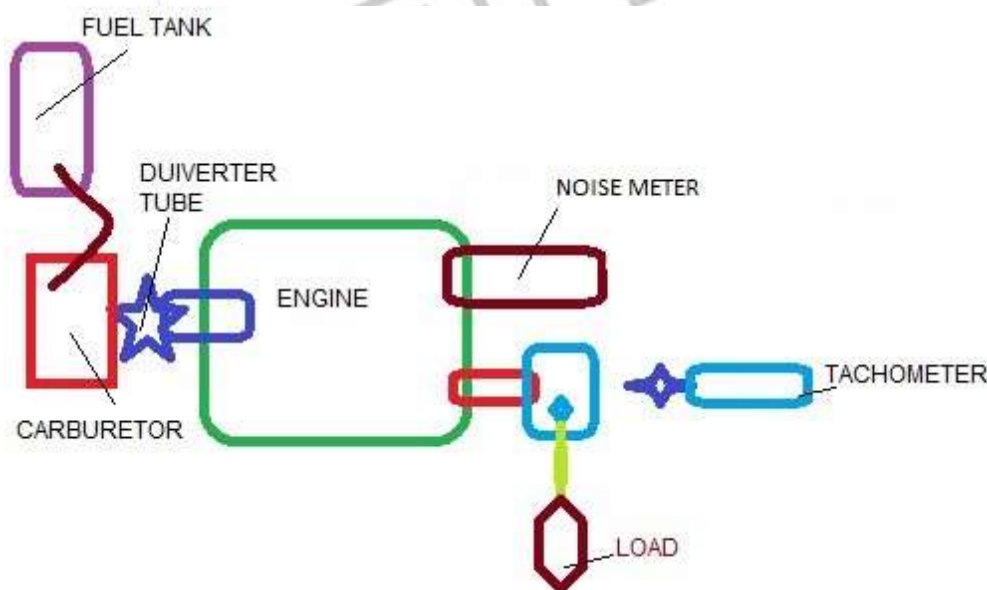


Fig. 1: Schematic of the Test Rig

The engine thereby has to be tested by mounting it in appropriate test rig which is equipped with fuel consumption rate measurement apparatus along with brake dynamometer setup for loading arrangement. Thus the Performance test rig is an essential set up so as to determine the utility of the given engine and decide the application it is suitable for.



Fig. 2: Photograph of the Experimental Setup

We have used four stroke single cylinder petrol engine for experimental setup. Specifications of test engine are given in table 1.

Table 1: Test Engine Specifications

Engine	
Type	Air Cooled, 4 Stroke Single Cylinder
Bore	50.0 mm
Stroke	49.5 mm
Piston Displacement	97.2
Carburetor	Side Draft , Variable Venturi Type with TCIS
Compression ratio	9.9:1
Transmission	
Clutch	Multiplate wet
Transmission	4 Speed Constant Mesh
Gear shift pattern	All Down, heel-toe shift
Performance	
Max. horsepower	6.15kW (8.36 Ps) @8000 rpm
Max. torque gear	0.82kg - m (8.05 N-m) @5000 rpm

#### ***Diverter Tube***

The diverter tube is encapsulated in the connector from the carburettor to the engine, with the provision of baffles and passage window so we ensure that the air is thoroughly mixed with fuel without creating a prominent pressure drop inside the intake chamber. The diverter tube is made of carbon fibre and the baffles are curved inside thereby allowing a streamline air flow inside the tube as well as the passage through the window cuts.

The intermixing of these streams of air fuel mixture will create turbulence in intake chamber and effective best mixing possible of the air and fuel.



Fig. 3: Diverter Tube

### III. ANALYSIS OF DIVERTER TUBE

Model was developed using UGNx8.0 and data transfer was done sing STEP203

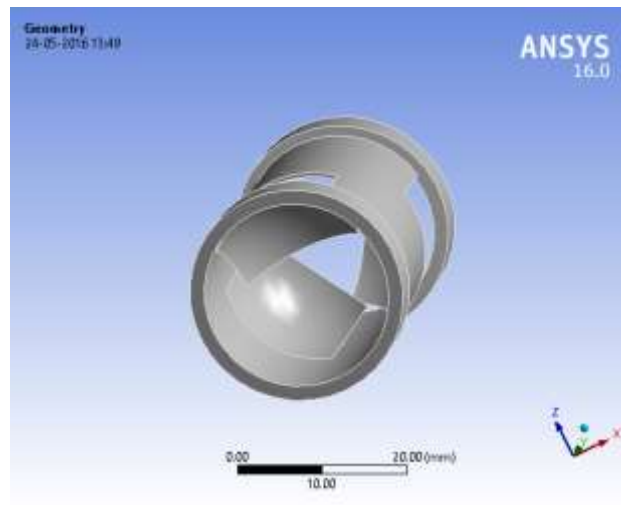


Fig. 4: Geometry of Diverter Tube

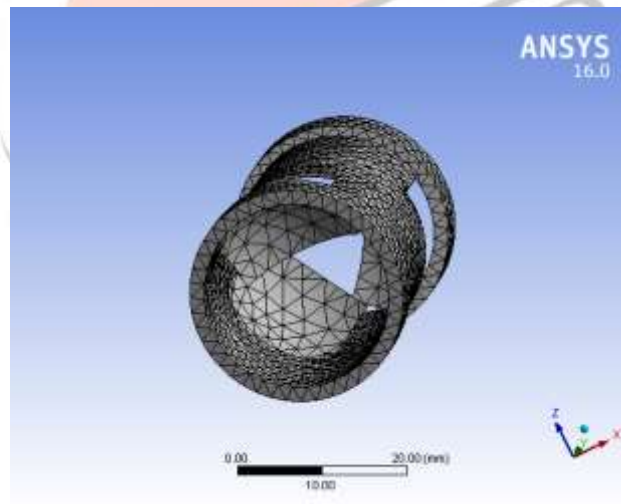


Fig. 5: Meshing of Diverter Tube

Statistics	
Nodes	13179
Elements	6325
Mesh Metric	None

Meshing type: Free mesh tetrahedron elements with following meshing parameters

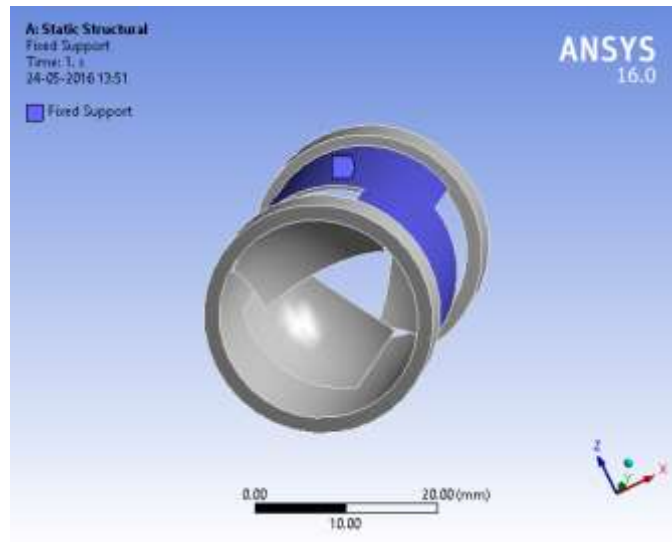


Fig. 6: Diverter Tube with Fixed Support

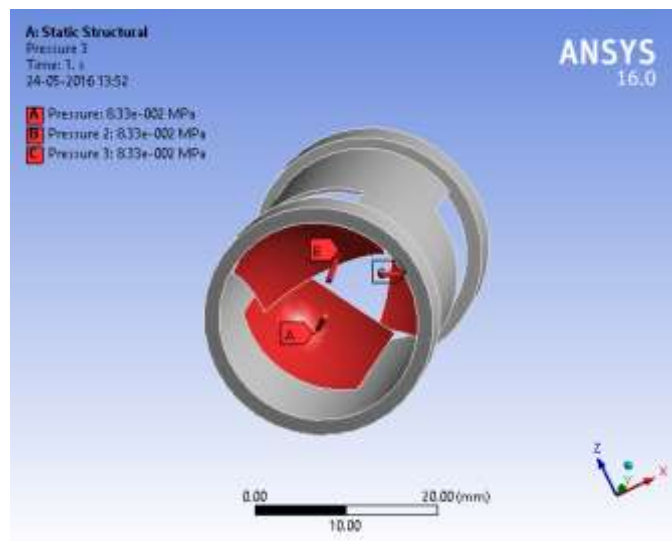


Fig. 7: Diverter Tube at Applied Pressures

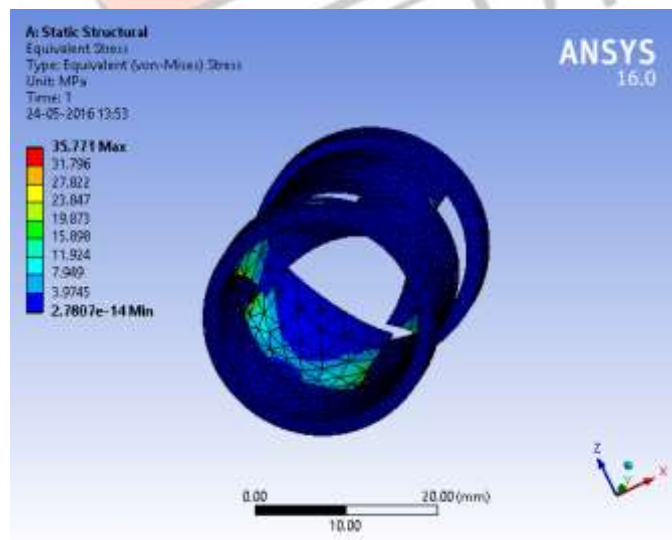


Fig. 8: Equivalent Stress

As the maximum stress induced  $35.711 \text{ N/mm}^2 < \text{Allowable Stress of } 133 \text{ N/mm}^2$  the diverter pipe is safe.

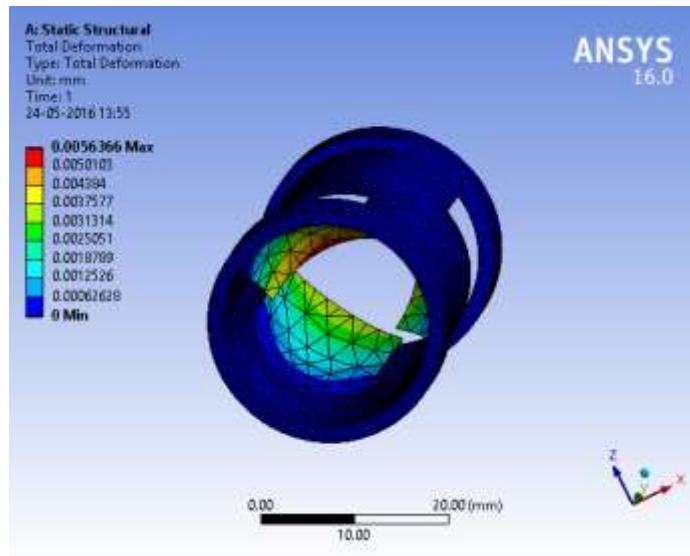


Fig. 9: Total Deformation of Diverter Tube

The maximum deformation shown is 0.005636 is negligible.

**IV. RESULTS AND DISCUSSION**

*Results of Performance Parameters of Engine*

Table 2: Readings with Conventional Intake Manifold

Load (Kg)	Speed (RPM)	Torque	Brake Power (Watts)	Volumetric Efficiency	BSFC	$\eta_{bt}$
4	2500	1.3734	359.6019	74.3812376	0.656976507	12.68437037
5	2500	1.71675	449.502375	75.30526356	0.688261102	15.1347601
6	2375	2.0601	512.4327075	80.22956627	0.7039034	16.87021259
7	2275	2.40345	572.6660258	82.75303688	0.735187995	18.05093856
8	2200	2.7468	632.899344	80.18663386	0.782114889	18.75257316
9	2090	3.09015	676.4111739	79.57966676	0.813399484	19.27097362

Table 3: Readings with Modified Intake Manifold

Load (Kg)	Speed (RPM)	Torque	Brake Power (Watts)	Volumetric Efficiency	BSFC	$\eta_{bt}$
4	2700	1.3734	388.370052	75.44496609	0.60831158	13.69912
5	2650	1.71675	476.4725175	77.6650416	0.637278798	16.04284571
6	2535	2.0601	546.9544899	85.22996879	0.651762407	18.00673218
7	2395	2.40345	602.8725854	89.37289587	0.680729625	19.00307598
8	2310	2.7468	664.5443112	86.32574779	0.724180453	19.69020181
9	2216	3.09015	717.1900294	83.91385108	0.753147671	20.43276437

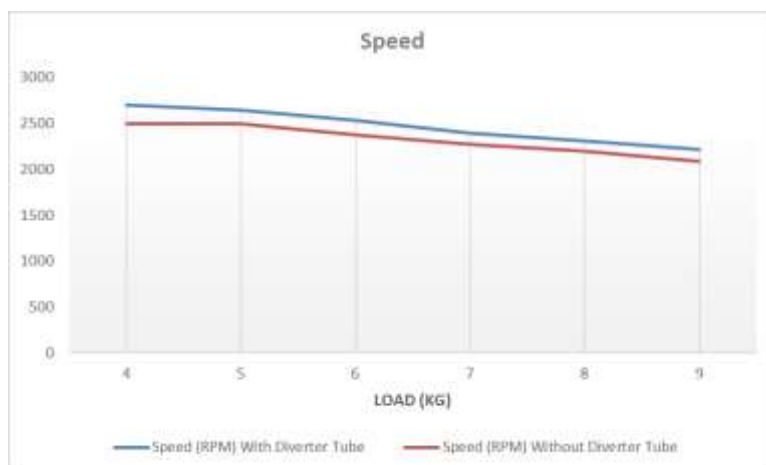


Fig. 10: Variation of Speed with Diverter Tube and Without Diverter Tube

Figure 10 shows the comparison of speed with load. It can be observed that speed decreases with increase in load. At the specific load, the speed with diverter tube is more as compared to speed without diverter tube.

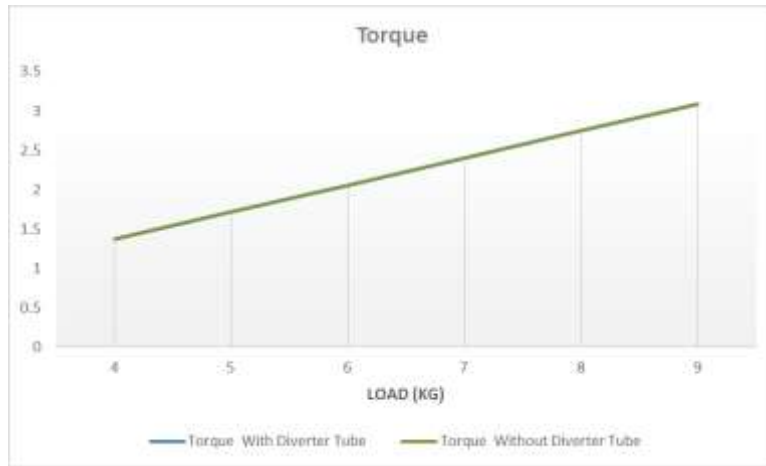


Fig. 11: Variation of Engine Torque

Figure shows the comparison of engine torque with load. It can be observed that torque increases with increase in load.

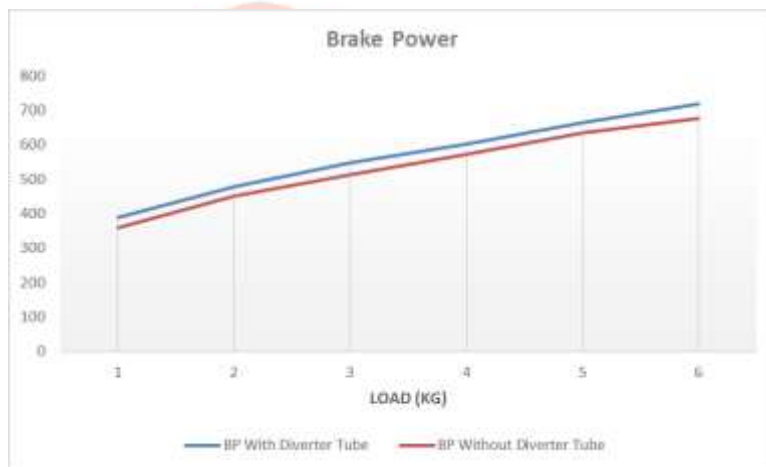


Fig. 12: Variation Brake Power with Diverter Tube and without Diverter Tube

Figure shows the comparison of brake power with load. It can be observed that brake power increases with increase in load. At the specific load, the brake power with diverter tube is more as compared to brake power without diverter tube.

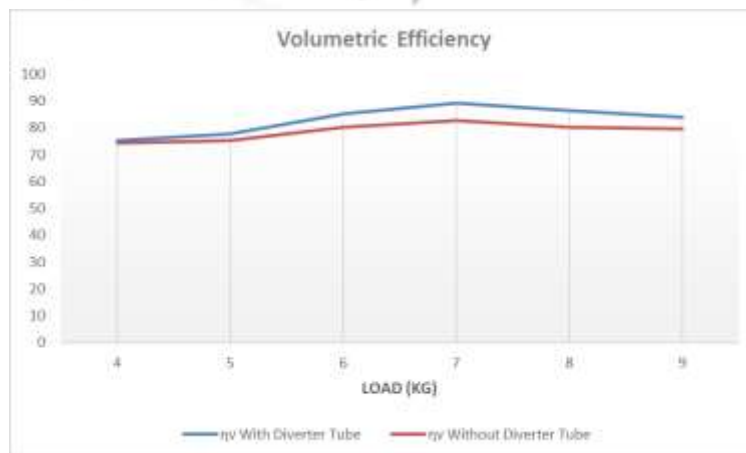


Fig. 13: Variation of Volumetric Efficiency with Diverter Tube and without Diverter Tube

Figure shows the comparison of volumetric efficiency with load. It can be observed that volumetric efficiency with diverter tube is more as compared to volumetric efficiency without diverter tube.



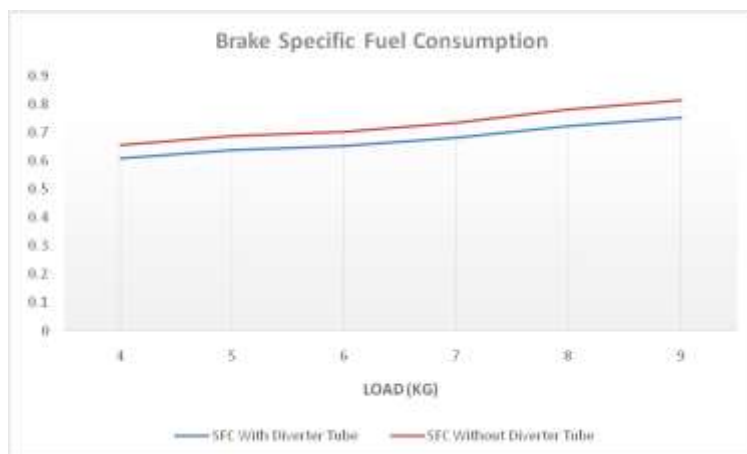


Fig. 14: Variation of Brake Specific Fuel Consumption with Diverter Tube and without Diverter Tube

Figure shows the comparison of brake specific fuel consumption with load. It can be observed that brake specific fuel consumption increases with increase in load. At the specific load, the brake specific fuel consumption with diverter tube is less as compared to brake specific fuel consumption without diverter tube.

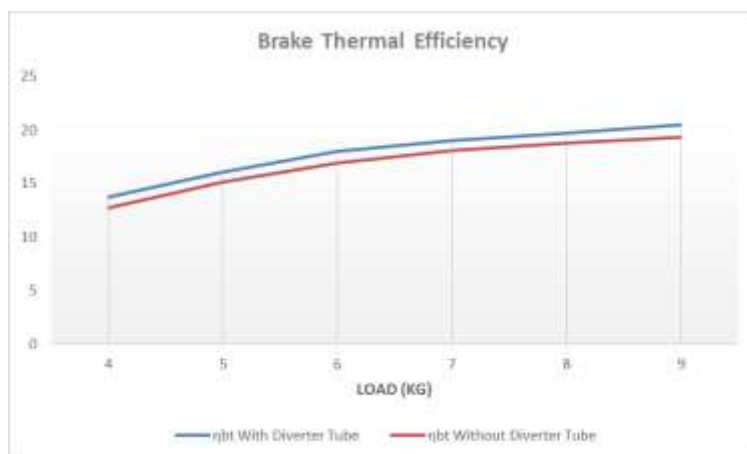


Fig. 15: Variation of Brake Thermal Efficiency with Diverter tube and without Diverter Tube

Figure shows the comparison of brake thermal efficiency with load. It can be observed that brake thermal efficiency increases with increase in load. At the specific load, the brake thermal efficiency with diverter tube is more as compared to brake thermal efficiency without diverter tube.

**Results of Noise and Emissions of Engine**

% CO - Percentage of Carbon monoxide in unit volume of exhaust gas - reference value below 4.5 % for 2/4 stroke engines in 2 wheeler vehicles.

HC (n-Hexane equivalent ppm) - reference value 9000 for 2/4 stroke engines in 2 wheeler vehicles.

Table 4: Readings with Conventional Intake Manifold

Load(Kg)	Speed (Rpm)	Noise (dBA)	% CO	HC
4	2500	111.3	0.96	450
5	2500	118.02	1.12	498
6	2375	129.57	1.36	532
7	2275	132.3	1.58	553
8	2200	134.4	1.76	573

Table 5: Readings with Modified Intake Manifold

Load(Kg)	Speed (Rpm)	Noise (dBA)	% CO	HC
4	2700	94.6	0.76	350
5	2650	96.25	0.88	398
6	2535	99.66	0.98	435
7	2395	102.74	1.11	456
8	2310	107.03	1.23	476

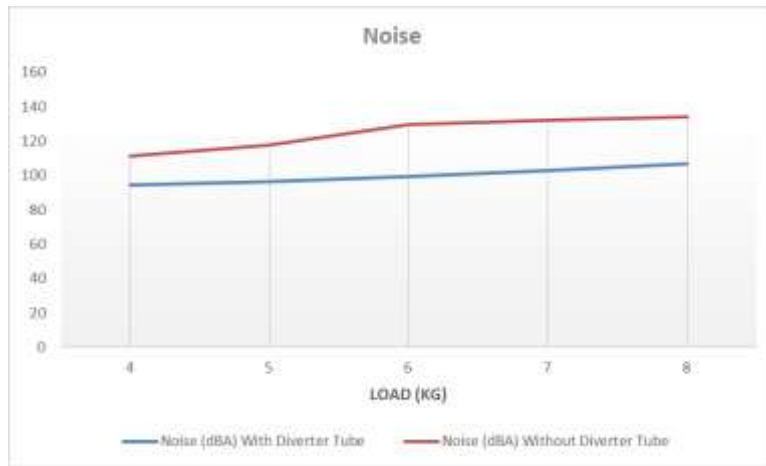


Fig. 16: Variation of noise with diverter tube and without diverter tube

Figure shows the comparison of noise with load. It can be observed that noise increases with increase in load. At the specific load, the noise with diverter tube is less as compared to noise without diverter tube.

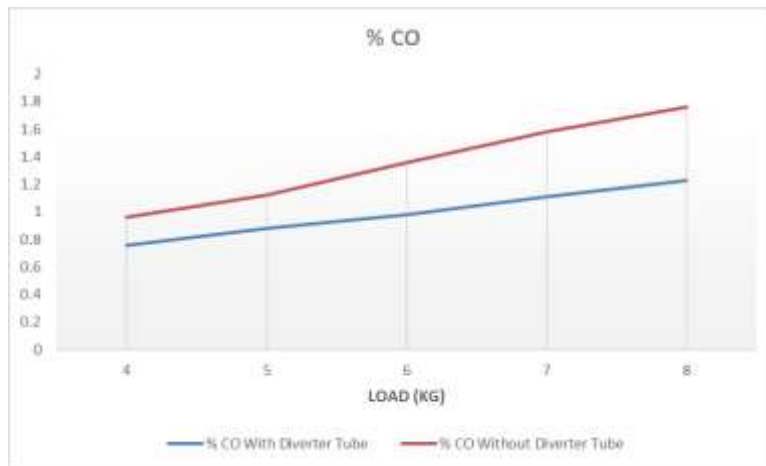


Fig. 17: Variation of % CO with Diverter Tube and Without Diverter Tube

Figure shows the comparison of % CO with load. It can be observed that % CO increases with increase in load. At the specific load, the % CO with diverter tube is less as compared to % CO without diverter tube.

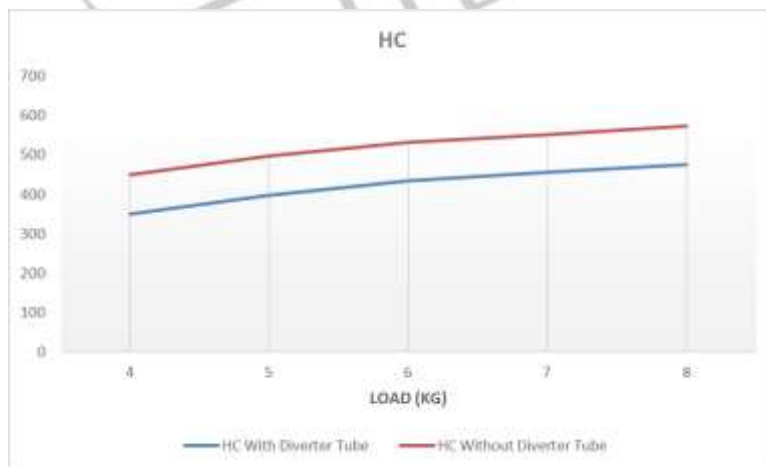


Fig. 18: Variation of HC with Diverter Tube and Without Diverter Tube

Figure shows the comparison of HC with load. It can be observed that HC increases with increase in load. At the specific load, the HC with diverter tube is less as compared to HC without diverter tube.



## V. CONCLUSION

The main objective of the intake manifold is to supply evenly distribution of the air fuel combustion mixture to intake port in the cylinder heads. Even distribution is important to optimize the efficiency and performance of the engine. If the distribution is uneven, it leads to decrease in volumetric efficiency.

The objective of this project is to increase the efficiency of engine. This work has presented a powerful method of enhancement of four stroke petrol engine by designing the swirl chamber. Due to the swirl chamber the mixture of air fuel from the carburetor to engine is properly mixed and due to this the proper combustion of fuel take place and exhaust of engine is reduces. Performance of engine is increased as well as emission also reduced. In particular the performance parameters of engine speed, torque, brake power, volumetric efficiency, brake thermal efficiency are increased while brake specific fuel consumption reduced. In additional the noise and emission parameters percentage of CO and HC are also reduced. The main problem of SI engine i.e. improper supply of air and fuel mixture to the engine is reduced due to the swirl chamber.

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