Performance Analysis of Supercharging a Single Cylinder SI Engine

Pasala Venkata Satish, Samanthula Naveen, Hepsiba Seeli, Sri Harsha Dorapudi

Abstract— The recent developments in motorcycle engines a huge power gives an element of fun for riding and hence the demand for the faster bikes increased but in order to make it available for an economical price is the challenge so installing a supercharger is the best suggestion. However there are so many problems that had to be furthertly resolved with respect to the application of the supercharger.

The most important parameter of the engine is the size and shape because the twin cylinder v shaped engines have a great attractive look, if that was changed because of installing a supercharger it may degrade the look of the automobile.

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So the main objective of this project is to increase the torque and power of the two wheeler by supercharging the SI engine. For this purpose Bajaj discover 125 cc is analyzed for the work and certain parameters like torque, power, and specific fuel consumption vs rpm are calculated. This calculated data is used in software Engine Analyzer for analysis purpose together with the data of supercharger. It can be seen that power and torque of the engine increases from 7 to 11 KW and 9 to 13 NM at 7500 and 9000 RPM respectively.

Index Terms— Engine, power, supercharger, specific fuel consumption, Torque, Mean effective pressure

1 INTRODUCTION

A supercharger is a device which is used for supercharging the engine. It consists of two main components they are air compressor and an electric motor. The compressor is driven by motor and the source for the electric motor is the automotive battery. Depending upon the performance requirements there are many types of superchargers are available in the market. But in this performance test we are equipping the experimental setup with the vane type supercharger. Generally superchargers are used for multi-cylinder engine but furtherly some modifications are done on superchargers which allowed us a chance to do a performance test on the single-cylinder SI engine.

The supercharger gives boosts to the engine, Boost is measured in Manifold Pressure (MAP). The boost increases with the increase in the density of the air charge. Which allows the engine to burn more air and fuel hence it generates more horsepower. Different researchers working on increasing the performance of the superchargers. But only very few did research on the supercharging of two wheelers. As we knew that racing bikes are equipped with superchargers. But commercial two wheelers do not come with superchargers. So, in this work the author's tries to increase the power and torque characteristics of the 125 cc engine of the Bajaj Discover equipped with vane compressor

2 EXPERIMENATL SETUP

A single cylinder 4-stroke air-cooled petrol engine which develops a power output of 3.7 kW is used in this experimental setup. Engine specifications are mentioned in the Table (1.). A rope brake dynamometer is used for loading the engine. Computerized monitoring system helped in observing and noticing different parameters related to the performance of the engine with respect to RPM

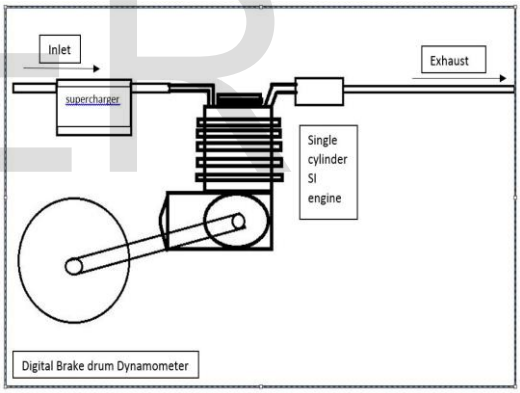

Fig: 2.1 BLOCK DIAGRAM OF EXPERIMENT SETUP

Engine Displacement	124.6 cc
Engine Type	Air cooled , 4 stroke
Number Of Cylinders	1
Valve Per Cylinders	2
Max power	11.0 PS @8000 rpm
Max Torque	10.8 Nm @5500 rpm
Bore x Stroke	57.0 x 49.0 mm

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Fuel Type	Petrol

Table 2.1 TECHNICAL SPECIFICATIONS OF THE ENGINE

Technical Data Type 4 stroke single cylinder Model **Bajaj Discover 125** Bore x Stroke 57 mm x 49.0 mm Compression ratio 9:1 Max. Power 11PS@8000 rpm Max. Torque 10.8 NM@5500 rpm.

2.2 Supercharger specifications

The supercharger which is used in the experimental setup is 50ccs supercharger and its specifications along with its dimensions are detailed below.
This supercharger is driven by a belt and pulley system which makes it easy to install and uninstall very less in cost. This

Compressor	Vane type
Weight	2.9 kg
Working rpm range	500 to 10,000
Max rpm(cont)	10,000
Max rpm (inst)	12,500
Max boost pressure	1.2 bar

TABLE 2.2 COMPRESSOR SPECIFICATION

This type of vane type compressors have a great advantage in

Fig: 2.2 Supercharger

Using it with other bike engines and it makes less noise when Compared to other superchargers.

The whole engine is dismantled from the bike and it is fixed rigidly with the experimental stand, the stand have an arrangement similar to the bike to hold the engine rigidly without producing any vibrations.

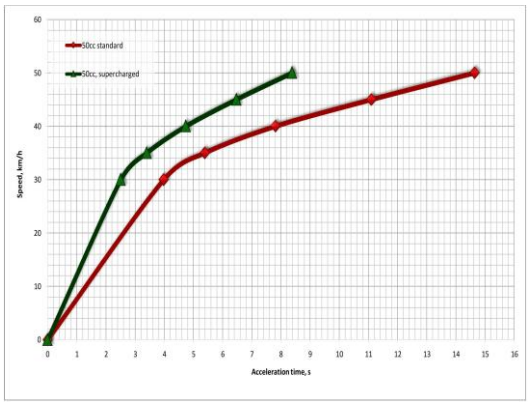

Fig: 2.3 Acceleration vs Speed, km/h

. The engine inlet valve is initially connected to a carburetor outlet but in the experimental setup up we have to change its configuration we must place a supercharger before it and now we attach the inlet of the engine to the outlet of the supercharger.

The supercharger is also placed rigidly to further avoid the unnecessary vibrations now it is powered by battery of the supercharger. Now after arranging the engine and supercharger with the experiment stand the other components like a fuel tank and an accelerator and a brake type dynamometer with digital meter is arranged to the engine.

Now the fuel tank is filled and it is ready to run experiment on it. First we run some basic diagnostics on the engine to test whether the engine is running correctly and smoothly then the performance tests are run on it.

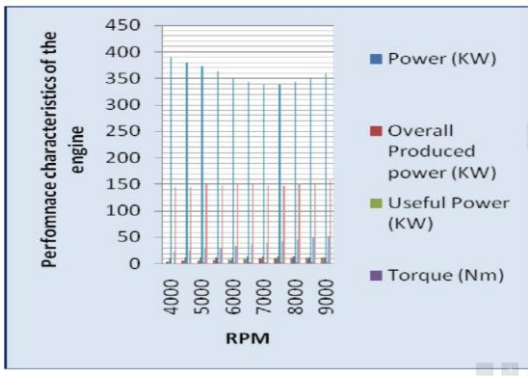

Fig: 2.4 Performance characteristics of the SI engine

Experiments were performed at ranging from 4000 rpm to 9000 rpm. At constant intervals of 1000 RPM performance characteristics of the engine are evaluated and the results are shown in figure 2.4. After evaluating the data of the engine without supercharger, it is compared with the performance

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values of the engine with supercharger and their values are mentioned in the graphical format which are shown below.

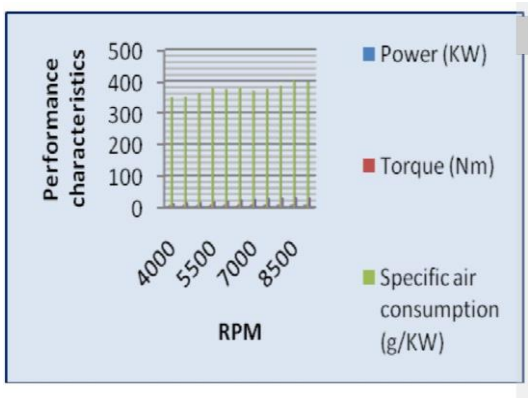

Fig 2.5 Performance characteristics of the SI engine with supercharger

From the above graph we can say that the performance of the engine increases after supercharging and the overall power produced by the engine is greatly increased when it is compared with the unmodified engine the overall produced power is reached to 150 KW at the 9000 rpm. The total power produced after modification is also increased

3 Results and Discussions

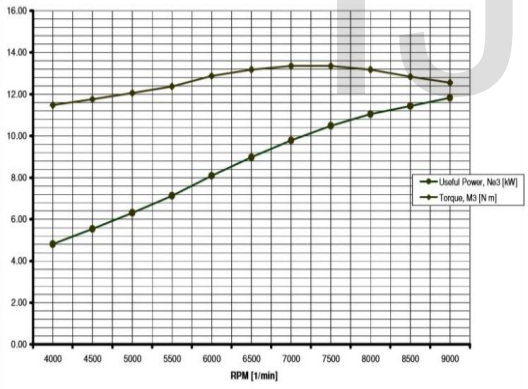

Fig: 3.1 Power and torque characteristics of the engine

This data shows that the power and torque of the engine without modification and modified engine in the figures 3.1 and 3.2 respectively. The figure 3.2 shows that the power developed at the 4000 rpm is more than 3.5 KW and it increases as the rpm of the engine increases and it will becomes maximum at 9000 rpm about 7.4 KW. The torque of the engine starts from 7.9 Nm at 4000 rpm and it will becomes maximum about 9 Nm at 7200 rpm. Now from figure 3.2 it can be seen that the useful power developed at 4000 rpm is more than 300 KW which is much more than the power developed without supercharger. Also, the torque developed by the modified engine shows the value of 11.48 Nm at 4000 rpm and gives highest value of about 13.58 Nm at 7000 rpm. This increase in power and torque of the engine is due to the more air consumption by the engine.

Useful Power, Ne3 [kW]
Torque, M3 [N m]

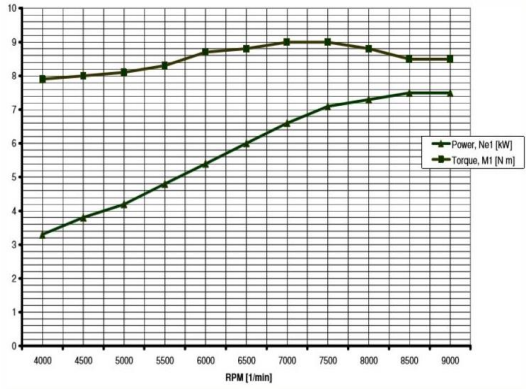

Fig: 3.2 Power and torque characteristics of the modified engine

Mean Effective Pressure, Pe3 [Mpa]
Mean Effective Pressure, Pe1 [Mpa]

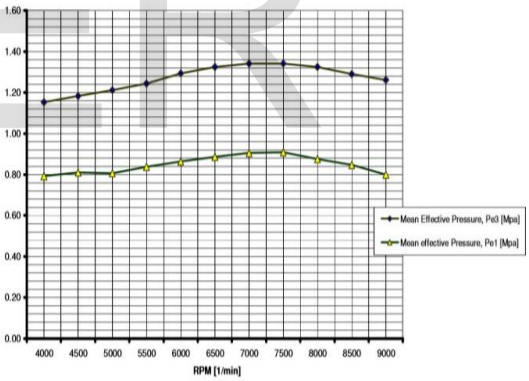

Fig: 3.3 Comparison of the mean effective pressure of the given engine and modified engine

The Figure 3.3 indicates that mean effective pressure (MEP) of the modified engine is much greater than the original engine's mean effective pressure (MEP). The modified engine gives 1.35 Mpa of mean effective pressure as compared to 0.80 Mpa in case of original engine. From the figure 3.4 it can be seen that the specific fuel consumption of the modified engine increases due to supercharging. Figure 3.5 shows the air consumption of the modified engine and the give engine. It can be concluded from the figure that the hourly air consumption in case of supercharged is more which increases the power of the engine

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RPM [1/min]
Specific Fuel Comsumption, ge1 [g/kW h]
Specific Fuel Consumption, ge3 [g/kW h]

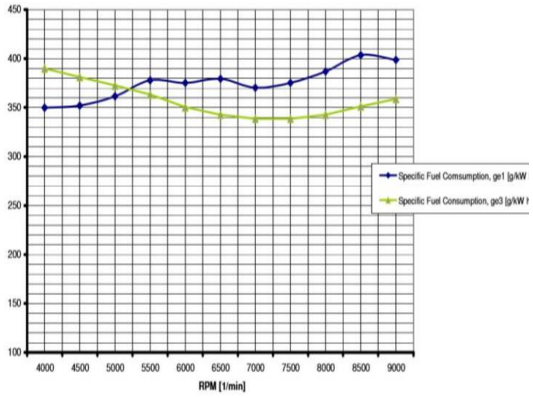

Fig: 3.4 Comparison of the specific fuel consumption of the given engine and modified engine

RPM [1/min]
Volumetric Air Consumption, V
Ve 1 [m3/h]
Volumetric Air Consumption, V
Ve 3 [m3/h]

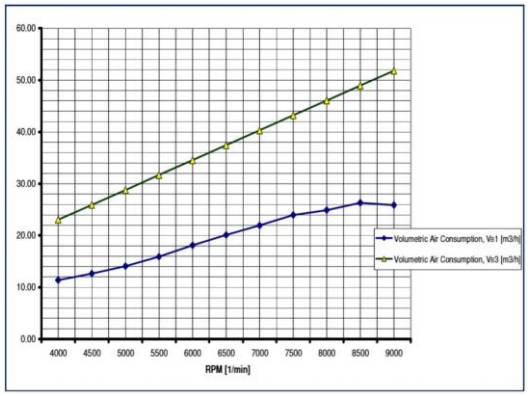

Figure 3.5 Comparison of the hourly air consumption of the given engine and modified engine

4 Conclusion

It is concluded that it is possible to install a supercharger for a commercial two wheelers which increases their horsepower on an average about 150 % more than the original engine. So, supercharging can be an alternative for engines where more power and torque is desired on the verge of more fuel consumption. The graph below shows the power and torque characteristics of the given engine and the modified engine. It showed that the torque of the modified engine is highest at 7000 rpm and after that torque is declined due to the rapid and fast opening and closing of valves of the engine.

RPM [1/min]
Overall Produced Power, N= Ne3 +Nek [kW]
Useful Power, Ne3 [kW]
Torque, M3 [N m], Original Torque, M1 [N m]

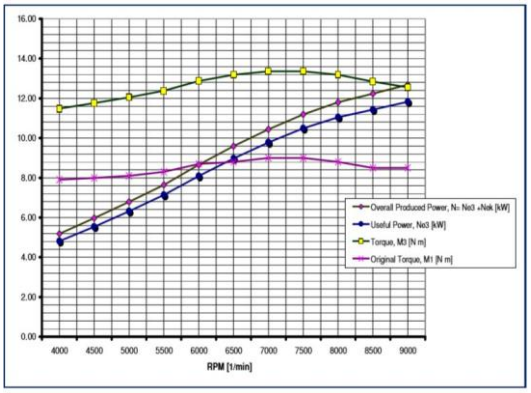

Fig: 4.1 Final result

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