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PERFORMANCE IMPROVISATION OF PULSAR ENGINE USING SUPERCHARGER-REVIEW STUDY

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[1,2,3,4,5] Mechanical Engineering, ITM Universe.

Abstarct – The improvement in performance of IC engine by implementing a supercharger. Moreover, there are several modification made in the design of the supercharger to obtain optimum performance by varying the parameters which can improve the performance. Supercharging provides better combustion condition, torque as well as it also decreases the consuption of fuel as well as exhaust. Inlet pressure is the parameter that is focused upon as it will increase the compression ratio and eventually the efficiency. In existing supercharger there is problem of loss of power and rpm is reduced if it is directly mounted to engine crankshaft. The project aims to modify existing supercharger by using gear pinion arrangement between compressor and crankshaft to overcome powerloss.

Keywords – Supercharger, Naturally Aspirated Engine, Inlet Pressure, Power Output, Performance

I. INTRODUCTION

Nowadays there is a great increment in the industrialization and the use of vehicles as motorization of the world. This leads the world to an abrupt rise in the demand for petroleum products which are stored under the surface of the earth. As in the current stage, we have limited reserves of these stored fuels and it is very difficult to replace. These finite and limited resources of petroleum are highly available in certain regions of the world. So it has given rise in fluctuations and uncertainties in its price as well as supply. In the current year, substantial research for the development of supercharger is made with various kinds of supercharger technology with the aim to obtain a higher output performance of vehicle engines. The development of supercharger technology is led due to the decisive role of its characteristics, producing an outstanding increase in power of the engine and mean effective pressure. A supercharger is a device to increases the density or pressure of air which is supplied to an internal combustion engine.

II. DIFFERENT TYPES OF SUPERCHARGER

A. Centrifugal supercharger

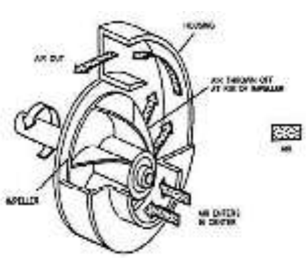

Fig. 1 Centrifugal Supercharger

A centrifugal type supercharger is the best elementary and most common used supercharger. A centrifugal supercharger works a lot similar to a centrifugal blower fan, having an inlet port, a scroll, an impeller and a discharge port. The air comes in the inlet port of supercharger and is knocked out by an impeller. The impeller needs to rotate at the speeds of 4000 - 6000 rotations per minute in order to generate boost. At idle speeds, the impeller does not rotate with sufficient speed to gain any boost. The impeller consumes centrifugal forces in order to yield boost.

B. Roots Supercharger

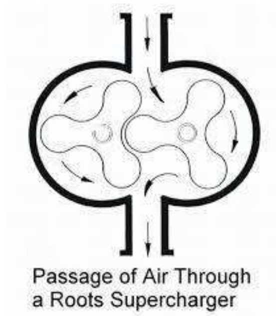

Fig. 2 Roots Supercharger

The roots type supercharger is consist of two counter-rotating interlocked lobed rotors. The two rotors setup air, in the openings between rotors and push it in contradiction of the compressor housing as they rotate in the direction of the outlet/discharge port. As with all positive displacement blowers, boost is openly connected to the speed of the lobes. The roots supercharger is mainly used for low-rpm boost. The roots blower is highly suitable pressure ratio of 1.2 to 2 as it is simple in construction, low cost and higher mechanical efficiency. The volumetric efficiency decreases rapidly with an increase in pressure ratio. The roots superchargers are suitable for low and medium speed engine as well as for stationary and marine engines.

C. Vane Supercharger

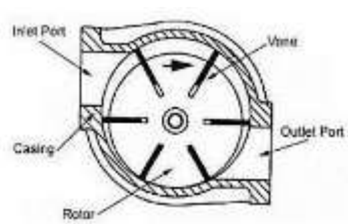

Fig. 3 Vane Supercharger

Vane type supercharger is a positive displacement rotary type supercharger. This consists of a rotor which revolves inside a large cylindrical casing. The rotor has four slots which is connected with the casing at least at one point all the time. The axis of the rotor is mounted eccentrically and blades slide radially in and out of the slots of the rotor. As it moves, the air is trapped in between two immediate vanes and as the rotor rotates, the volume of air goes on reducing and so on increasing the pressure. The vane supercharger is very rarely used on cars, yet its design displays in other requests.

D. Screw Supercharger

Fig. 4 Screw Supercharger

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A twin-screw supercharger works by drawing air through a pair of meshing lobes that look like a set of worm gears. Like the Roots supercharger, the air inside a twin-screw supercharger is trapped in pockets generated by the rotor lobes. But a twin-screw supercharger compresses the air inside the rotor case. Because of that, the rotors have a pointed taper, which means the air pockets reduction in size as air moves from the fill side to the release side. As the air pockets shrink, the air is compressed into a smaller space.

E. Axial flow supercharger

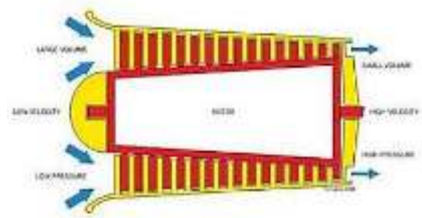

Fig. 5 Axial flow Supercharger

An axial flow compressor compresses a large volume of low-pressure air at low velocity into a small volume of high-velocity air at high pressure. The rotating blades draw air into the compressor. These rotating blades induce a velocity, also known as kinetic energy. When the air contacts the stators, which is in the compressor assembly, it reduces the velocity and converts part of the kinetic energy into static pressure and heat. The mass airflow is then directed to the next set of rotating blades. This process is then repeated through each stage until the desired pressure is obtained. In the axial flow compressor, high pressure is generated. Output pressure is increased by divergence in each static inter stage section.

III. PURPOSE OF SUPERCHARGER

Supercharging is a process which helps to increase the suction pressure of IC Engines above the atmospheric pressure. The main objective of supercharging is to increase the amount of air per cycle. Due to access amount of air in charge , permits the better combustion of fuel compare to aspirate. Thus the power output of the engine is increased. Purpose of supercharging is to raise the volumetric efficiency above that which can be obtained by normal configuration. The engine is an air pump. Increasing the air consumption permits grater quantity of fuel to be added and results in a greater potential output. The produced indicated power is almost directly proportional to the air consumption of engine. While break power is not so closely related to air consumption. However, it is dependent upon the mass of air consumed. It is desirable that the more amount of mass of air is being consumed by the engine.

It is preferred to fulfill the following requirements:

1. To reduce the weight of engine per kW
2. To increase the power of an existing when the greater power demand occurs
3. To overcome effects of high altitude
4. Reduction in HC and CO emission
5. Increased volumetric efficiency and load carrying capacity.

IV. LITERATURE REVIEW

1. "EXPERIMENTAL ANALYSIS OF SPARK IGNITION ENGINE (BELOW 100 CC) WITH SUPERCHARGER USING E10 FUEL"

Rahul Kumar Sharma, Manoj Sharma, Sumeet Singh, Ashish Jain had done the study of the supercharger in Suzuki Max 100.

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The engine specification of the bike is given below.

Table 1. Technical specifications of the engine

Item	Technical Data
Type	Two stroke single Cylinder
Model	Suzuki
Make	Max 100
Bore x stroke	50 mm x 50 mm
Compression ratio	6.7:1
Max Power	7.8 bhp@5500 rpm
Intake system	Reed valve
Lubrication	Suzuki CCI
Ignition type	PEI (Electronic)
Method of cooling	Air

This paper gives information about the problems faced when a supercharger is introduced in a light weight engine and the problems are eradicated by blending ethanol. The increase in mechanical efficiency of the engine with respect to rpm can be clearly seen in the graph shown in Fig. 6.

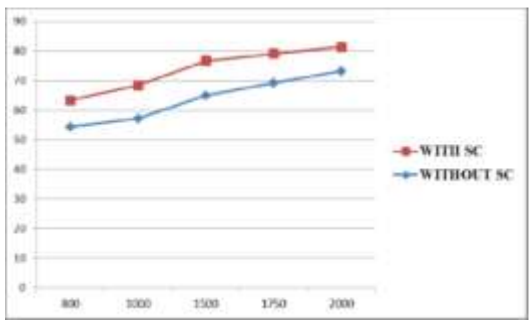

Fig. 6 mechanical efficiency vs rpm

The mechanical efficiency increases by 11.2-19.5% with supercharged engine. Knocking will be noticed at higher speed which can be reduced by adding ethanol, by using heat exchanger, air cooling, some modification in naturally aspirated engine. Moreover, there is a loss of mechanical power to drive the supercharger at low speed.

2. "PERFORMANCE ANALYSIS OF SUPERCHARGING A SINGLE CYLINDER SI ENGINE"

This Project had done by Pasala Venkata Satish, Samanthla Naveen, Hepsiba Seeli, Sri Harsha Dorapudi for the engine having capacity of 125 cc. The bike they had choosen having specification as below.

Table 2. Technical specifications of the engine

Engine Displacement	124.6cc
Engine Type	Air cooled, Four Stroke
Number Of Cylinders	1
Valve Per Cylinder	2
Max Power	11.0 PS@8000 rpm
Max Torque	10.8 Nm@5500 rpm
Bore x Stroke	57.0 x 59.0 mm
Fuel Type	Petrol

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Supercharger which is used in experimental setup is 50 ccs supercharger and its specification along with its dimensions are detailed below.

Table 3. compressor specification

Compressor	Vane type
Weight	2.9 kg
Working rpm range	500 to 10000
Max rpm (cont)	10000
Max rpm (inst)	12500
Max boost pressure	1.2 bar

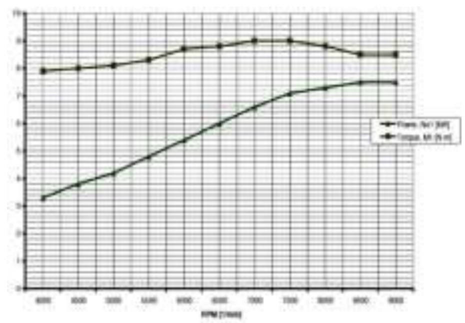

Fig. 7 Power and torque characteristics of the modified engine

The figure 3.2shows that the power de-veloped at the 4000 rpm is more than 3.5KW and it increases as the rpm of the engine increases and it will becomes maxi-mum at 9000 rpm about 7.4 KW. The torque of the engine starts from 7.9 Nmat 4000 rpm and it will becomes maximum about 9 Nm at 7200 rpm. Now from figure 3.2it 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 developedby the modified en-gine shows the value of 11.48 Nm at 4000 rpm and gives high-est 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.

3. "PERFORMANCE ANALYSIS OF SUPERCHARGING OF TWO WHEELERS"

Yashvir Singh, Nishant Kr. Singh, Rakesh Prasad and Hemant Kr. Nayak had done the study of the centrifugal supercharger in LML freedom 125cc bike.

The engine specification of the bike is given below.

Table 4. Technical specifications of the engine

Items	**Technical data**
Type	4 stroke single cylinder
Make Model	LML Freedom
Compression ratio	9:1
Max power	8.5bhp@ 7750rpm
Max torque	8.6nm@ 5000rpm
Lubrication	Wet sump
Oil pump type	Trochoidal
Method of cooling	Air

Here from this literature we can see that the Power and torque characteristic of the engine, for both the condition of the vehicle with & without a supercharger, is represented in graphical form.

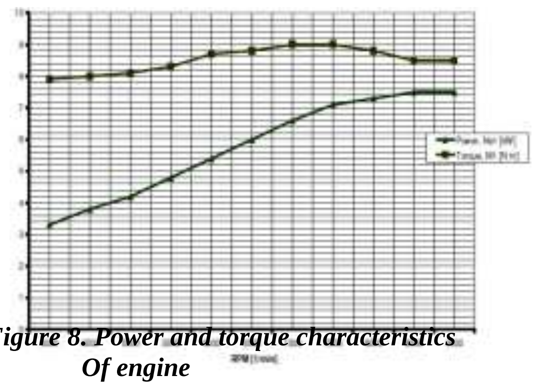

Figure 8. Power and torque characteristics Of engine

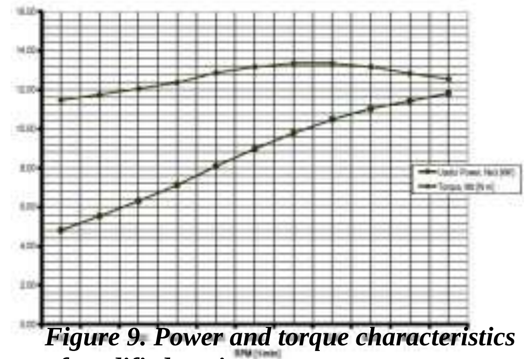

Figure 9. Power and torque characteristics of modified engine

It is seen that from the first graph the power developed at 4000 rpm is more than 3.3 KW and increases as the rpm of the engine increases and becomes maximum at 9000 rpm about 7.5 KW. The torque of the engine starts from 7.9 Nm at 4000 rpm and becomes maximum about 9 Nm at 7000 rpm.

Now from the second graph, 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 a supercharger. Also, the torque developed by the modified engine shows the value of 11.48 Nm at 4000 rpm and gives the highest value of about 13.35 Nm at 7000 rpm. This increase in power and torque of the engine is due to the more air consumption by the engine. It can be seen the torque of the modified engine is highest at 7000 rpm and after that, there is decrement of torque due to the fast opening and closing of valves of the engine.

4. "Supercharging of Luna Super engine for increase in power output"

This project had done by Galani Kaushik N. for the engine having a capacity of less than 100cc.The moped they had chosen having specification as given below.

Table 5. Technical specifications of the engine

Items	Technical Data
Displacement	59.57cc
Engine	2-stroke single cylinder engine
Cooling system	Air cooled
Maximum power	2.2+(0.1)KW @ 6000rpm
Maximum torque	4.2 Nm @ 4000rpm
Compression ratio	8.8:1(±0.2)

In this literature, certain parameters were considered to check the difference between an aspirated engine and supercharged engine by applying specific load condition.

Effect of load on brake thermal efficiency

The graph shows the brake thermal efficiency of applying 4 kg load. It is seen that the brake thermal efficiency of supercharged engine at 4kg load decreased by 4.43% compared without a supercharged engine at 1500 rpm. The brake thermal efficiency at 14 kg load it is decreased by 11.05% compared without a supercharged engine at 1500rpm

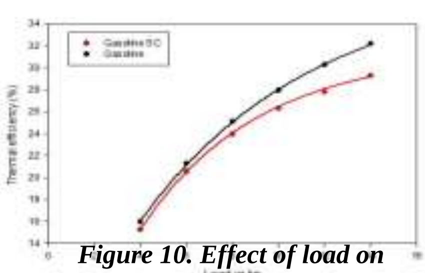

Figure 10. Effect of load on Thermal efficiency at 1500 rpm

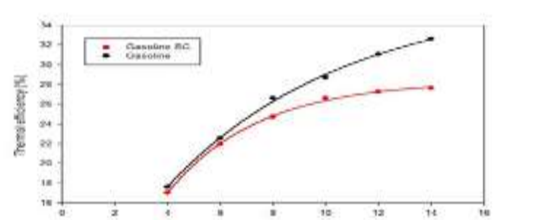

Figure 11. Effect of load on Thermal efficiency at 1700rpm

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Now for the same load condition and for 1700 rpm, the brake thermal efficiency graph is shown as below.

The brake thermal efficiency of the supercharged engine at 4kg load decreased by 2.63% compared without a supercharged engine at 1700rpm. TE at 14 kg load it is decreased by 9.88% compared without a supercharged engine at 1700rpm.

Effect of load on volumetric efficiency

By supercharging the density of air increases and pressure will also rise. Volumetric efficiency increases due to supercharging.

The graph shows the volumetric efficiency for 4kg load consideration and speed of 1500 rpm.

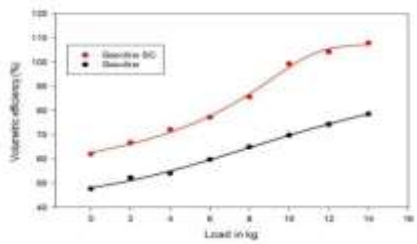

Figure 12. Effect of load on volumetric efficiency at 1500 rpm

Volumetric Efficiency for the supercharged engine at 4kg load increased by 10.27% compared without a supercharged engine at 1700rpm. Volumetric Efficiency at 14 kg load it is increased by 19.22% compared without a supercharged engine at 1700rpm.

The thermal efficiency of the system decreased because more amount of air insert into the cylinder which increases the temperature of the combustion chamber and also has a tendency of knocking which reduces the thermal efficiency.

The volumetric efficiency of the system increases for supercharged engine around 71% in comparison to the naturally aspirated engine.

5. "Performance analysis of supercharging process in SI engine & CI engine and application of supercharger"

Prakash Kumar Sen, Rohit Jaiswal, Shailendra Kumar Bohidar had done the research on this.

In the supercharging pressurized air is passed through the carburetor, which further moves to the engine cylinder.

Otto cycle for both the, with a supercharged & without a supercharged engine is graphically presented below.

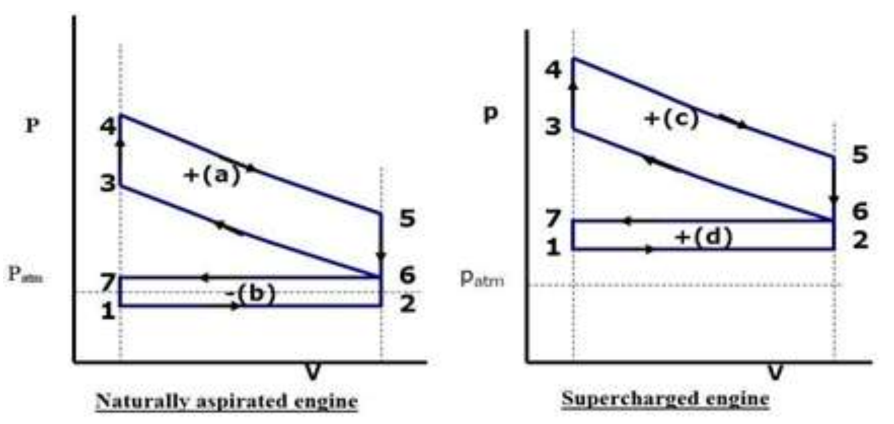

Figure 13. PV diagram

The gain in the output of a supercharged engine is mainly due to increase in the amount of air inducted for the same swept volume. More amount of air leads to a better mixture of the charge. Also, it will help to scavenge residue gasses & unburnt particles in the cylinder.

The fuel consumption will be more in highly supercharged spark ignition engines because to minimize the effect of knocking which will occur in the cylinder.The knock limit is dependent upon the type of fuel, mixture ratio, spark advance and the design features of the engine, the valve timing, and cooling system. The supercharged engine uses the very rich mixture to avoid knocking tendency.Hence specific fuel consumption will be higher.

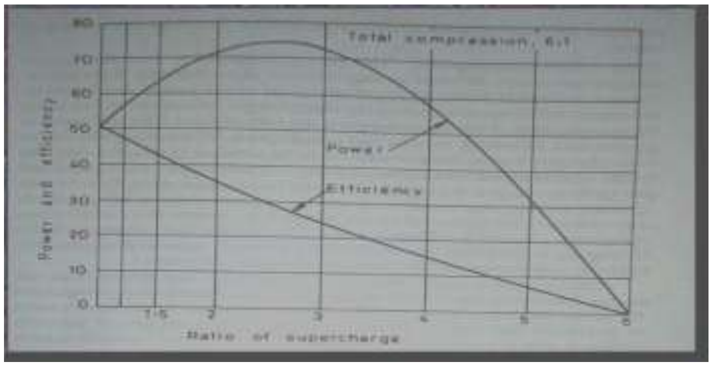

Figure 14. Effect of supercharging ratio on power and efficiency

Above graph shows the power and mechanical efficiency of the supercharged engine having the compression ratio of 6:1.for the supercharged engine, mechanical efficiency will be higher than the naturally aspirated engine.

V. CONCLUSION

After studied all literature reviews it can be seen that it is possible to install supercharger for a commercial two wheelers which increases their horsepower on an average about 150% more than original engine and mechanical efficiency increases 11.2% to 19.5% with supercharged engine. The supercharged engine performance is mainly dependent on the mechanical loss to drive the supercharger at low speed. In addition, at high speed the supercharged engine performance was more influenced by the compression ratio than mechanical loss. However, limit of supercharging is imposed due to maximum permissible pressure and temperature and thermal stress in cylinder. Brake specific fuel consumption with supercharged engine increases by 28% with increase in rpm.

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