Fabrication of Turbocharger For Two Wheeler

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Abstract- *Turbochargers are used throughout the automotive industry as they can enhance the output of an internal combustion (IC) engine without the need to increase its cylinder capacity. The emphasis today is to provide a feasible engineering solution to manufacturing economics and "greener" road vehicles. It is because of these reasons that turbochargers are now becoming more and more popular in automobile applications. The new turbocharger is coupled to an air-water intercooling system to decrease the inlet air temperatures. This project analyzed the intercooling system and tested the final design in the vehicle. The results show that the cooling system components purchased are adequate for this system. The aim of this paper is to provide are view on the techniques used in turbocharging used in two stroke single cylinder petrol engine by this to increase the engine output and reduce the exhaust emission levels. This paper is to analyze a turbocharger system in a twostroke petrol engine. The ideal turbocharger design would be smaller than the system purchased. The paper will also create speed sheets for use in calculating the necessary parameters for another turbocharger system, or to modify the currentsystem.*

Keywords- Intercooler, IC Engine, Turbocharger, Volumetric Efficiency.

I. INTRODUCTION

Turbo-charging, simply, is a method of increasing the output of the engine without increasing its size. The basic principle was simple and was already being used in big diesel engines. European car makers installed small turbines turned by the exhaust gases of the same engine. This turbine compressed the air that went on to the combustion chamber, thus ensuring a bigger explosion and an incremental boost in power. The fuel-injection system, on its part, made sure that only a definite quantity of fuel went into the combustion chamber.

A turbocharger or turbo is a forced induction device used to allow more power to be produced for an engine of a given size. The key difference between a turbocharger and a conventional supercharger is that the latter is mechanically driven from the engine often from a belt connected to the crankshaft, whereas a turbocharger is driven by the engine's exhaust gas turbine. A turbocharged engine can be more powerful and efficient than a naturally aspirated engine because the turbine forces more intake air, proportionately more fuel, into the combustion chamber than if atmospheric pressure alone is used.

1. What is turbo-charging

Turbo-charging, simply, is a method of increasing the output of the engine without increasing its size. The basic principle was simple and was already being used in big diesel engines. European car makers installed small turbines turned by the exhaust gases of the same engine. This turbine compressed the air that went on to the combustion chamber, thus ensuring a bigger explosion and an incremental boost in power. The fuel-injection system, on its part, made sure that only a definite quantity of fuel went into the combustion chamber.

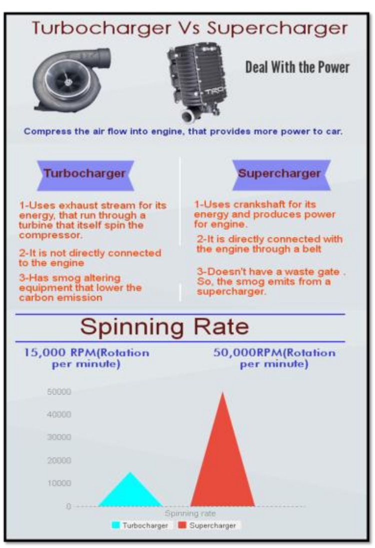
2. What the turbocharger does

What the turbo-charger was does is that it simply increases the volumetric efficiency of the engine. To give you an example: a 1,500cc engine that produced, say, 60 bhp when it was normally aspirated, benefited at times with a 10- to 20-per cent power boost depending on the kind of turbocharger used. Normally ,The manufacturer would have had to resort to a bigger displacement in the engine, or design and develop an all-new engine to get more power from the same unit.

Fig1 Turbocharger With Compressor

3. Super Charger-A supercharger is any device that pressurizes the air intake to above atmospheric pressure. Both superchargers and turbochargers do this. In fact, the term "turbocharger" is a shortened version of "turbo-supercharger," its official name.The difference between the two devices is their source of energy. Turbochargers are powered by the mass-flow of exhaust gases driving a turbine. Superchargers are powered mechanically by belt- or chain-drive from the engine's crankshaft. Another way to add power is to make a normal-sized engine more efficient. You can accomplish this by forcing more air into the combustion chamber.More air means more fuel can be added, and more fuel means a bigger explosion and greater horsepower. Adding a **supercharger** is a great way to achieve forced air induction. In this article, we'll explain what superchargers are, how they work and how they compare to turbochargers.

4. **Difference Between Turbocharger & Supercharger**



II. PROBLEM STATEMENT

2.1 Turbo Engine Setup

There are two types of choices in a carburetor turbo setup: “suck through” or “blow through”. The suck-through (or draw through) set up involves mounting the carburetor before the turbine inlet (usually in front of the impeller mouth). This means that both fuel and air are drawn into the turbo already mixed and then blown into the inlet manifold. This is by far the simplest way to setup a turbo as; the carburetor doesn’t need to be especially modified turning quit essay. The main disadvantage are that you can’t use any intercooling with such a setup, as it is dangerous to run air/fuel mixture through as an intercooler core. The reason for this is that fuel can condense inside the intercooler core and stay there- if you then have an engine back fire the intercooler can explode. As a result water injection is about the only option for cooling the charger air with this setup. This also corresponds to a blow-off valve because instead of just venting pressurized air, it would be releasing a fuel/air mixture which is very dangerous. The blow-through arrangement, logically enough, means the carburetor is mounted after the turbo compressor, so the turbo only draws in air and then blow it through the carburetor, which adds the fuel. The good things is than an intercooler and also a blow-off valve can be used with such setup.

2.2 Need Of Turbochager In Two Wheeles

All naturally aspirated Otto and diesel cycle engines rely on the downward stroke of a piston to create a low pressure area (less than atmospheric pressure) above the piston in order to draw air through the intake system. With the rare exception of tuned induction systems, most engines cannot inhale their full displacement of atmospheric density air. The measure of this loss or inefficiency in four stroke engines is called volumetric efficiency. If the density of the intake air above the piston is equal to atmospheric, then the engine would have 100% volumetric efficiency. Unfortunately, most engines fail to achieve this level of performance. This loss of potential power is often compounded by the loss of density seen with elevated altitudes. Thus, a natural use of the turbocharger is with aircraft engines. As an aircraft climbs to higher altitudes the pressure of the surrounding air quickly falls off. At 5,486 m (18,000 ft) the air is at half the pressure of sea level which means that the engine will produce less than halfpower at this altitude. A turbocharger may also be used to increase fuel efficiency without any attempt to increase power. It does this by recovering waste energy in the exhaust and feeding it back into the engine intake. By using this otherwise wasted energy to increase the mass of air it becomes easier to ensure that all fuel is burnt before being vented at the start of the exhaust stage. The increased temperature from the higher pressure gives a higher Carnot efficiency.

III. METHODOLOGY & MATERIALS

3. Main Components of a Turbocharger

1.Turbine
2.Compressor
3.Connecting Shaft
4.Center Housing / Rotating Assembly (CHRA)
5.Intercooler

3.1 TURBINE

The exhaust air is brought from high head reservoir through a penstock. At the end of penstock is a nozzle, which converts the available high head in high velocity jet. The jet strikes the blades, mounted on a runner and due to impulse action; the energy is transferred to runner. The jet itself is turned inside the blades and ultimately falls down in the tail race. For high efficiency, the jet should be compact and cylindrical and not broom shaped.The turbine wheel is responsible for converting heat and pressure into rotational force.

To understand how this process occurs, we would need to delve into some of the basic laws of thermodynamics, but within the scope of this article, understand that high pressure (from the exhaust manifold) will always seek low pressure and, within this process, the turbine wheel converts kinetic energy into rotation. As the turbine wheel rotates, it spins the turbine shaft, which in turn spins the compressor wheel. Often overlooked,

turbine wheel selection is critical to a properly built turbocharger system, as having too small of a turbine wheel will induce excessive backpressure and can choke the engine, making it lose power. On the other hand, selecting too large of a turbine will result in increased lag and can make it difficult to achieve specific target boost numbers. Of course, the turbine wheel doesn't act alone. It is part of the turbine housing, which is that giant, sometimes rusty looking piece of iron or steel you always see bolted to an exhaust manifold or merge collector on a turbo car. Because of the tremendous heat involved in collecting and moving pressurized exhaust gasses, the turbine housing is constructed from thick iron or steel and always consists of a turbine foot (the flange which connects to the exhaust manifold piping), an outlet connection (the large opening that connects to the downpipe), and a volute, which is the path the hot exhaust travels to get across the turbine wheel, from the turbine foot to the outlet. When someone calls a turbo a "T4 turbo," they are talking about this flange. Exhaust enters from the flange, rotates around the wheel inside the volute, and exits across the outlet connection, into a piece of exhaust that enthusiasts call the downpipe

3.1.1 Main Components of a Turbine

The main parts of this simple and efficient turbine are

1. Nozzle with regulating needle
2. Runner with blades
3. Casing
4. Blower

1.Nozzle

The exhaust pipe is jointed to the 1" pipe and this end is shaped to sharp to act as a nozzle. This pipe is provided with a bend near the turbine. This is done to accommodate regulating needle. The pipe at the end is provided with guide cross to ensure parallel flow. The nozzle is made of mild steel for small wheels and of cast steel for large turbines. The flow viscocity of hot gas is depends on this nozzle type.

2. Runner with Blades

Normally the runner wheels are mild steel in one piece with the blades and boss of special steel. The blade is the most important part of this project. It subjected to erosion due to impact of sandy air or chemically unsuitable gas. Depending upon head, stresses and quality of gas it is made of mild steel, cast steel or stainless steel. Cast iron is generally avoided, except for very small runners, due to its unsatisfactory welding characteristic.

3. Casing

The casing of a turbine has to carry housing for the bearing and it has also to support the nozzle and pipe bend. It is reinforced at this point to withstand reaction of jet. It is made of cast iron and is generally made in two parts so that erection and assembling is easy. The upper portion should fit tightly to prevent the air leading to runner and the lower portion has to be wide enough to prevent the water from reaching the runner again.

4. Blower

The fan (impeller) rotates inside the shell. The shell is so designed that the air is rushed out forcely. The blower consists of two main parts. They are

- Casing
- Impeller Blades(Fan

The turbine is directly coupled with Impeller blades through bearings. The gas is used to strike the turbine and the blower is rotated so that the air is rushed out force. This pressurized air from the turbocharger is then sent through a duct to an air-cooled intercooler, which lowers the temperature of the intake charge and thus increases its density. Exhaust enters from the flange, rotates around the wheel inside the volute, and exits across the outlet connection, into a piece of exhaust that enthusiasts call the downpipe The pipe at the end is provided with guide cross to ensure parallel flow. The nozzle is made of mild steel for small wheels and of cast steel for large turbines. The flow viscocity of hot gas is depends on this nozzle type.

Fig 3.1 Turbine

3.2 COMPRESSOR

It is driven by the turbine. It inhales the air from the atmosphere and compresses it at high pressure for the next suction stroke. The compressor increases the mass of intake air entering the combustion chamber. The compressor is made up of an impeller, a diffuser and volute housing. The operating range of a compressor is described by the "compressor map". Like the turbine, the compressor section is made up of two primary components: the compressor wheel and the compressor cover. The compressor's job is to, quite literally, compress fresh air and funnel it towards the throttle body. Since it is connected directly to the turbine wheel via the turbine shaft, the compressor wheel rotates at the same RPM as the turbine wheel and, as the engine and turbine wheel accelerate, so does the compressor wheel. This process creates pressure in the intake tract, which we call "boost" and is the reason anyone would install a turbocharger in the first place.

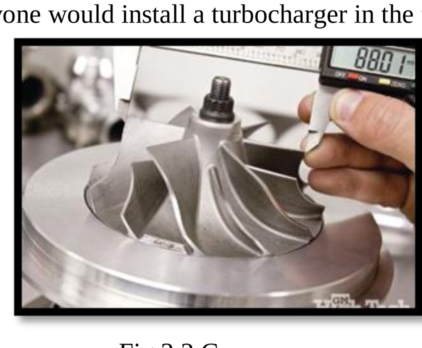


Fig 3.2 Compressor

3.3 Connecting Shaft

A turbocharger is effectively two little air fans sitting on the same metal shaft so that both spin around together. One of these fans, called the turbine, sits in the exhaust stream from the cylinders. As the cylinders blow hot gas past the fan blades, turbine blades ,they rotate and the shaft they're connected to compressor rotates as well. The second fan is called the compressor and, since it's sitting on the same shaft as the turbine, it spins too. It's mounted inside the air intake so, as it spins, it draws air in and forces it into the cylinders.

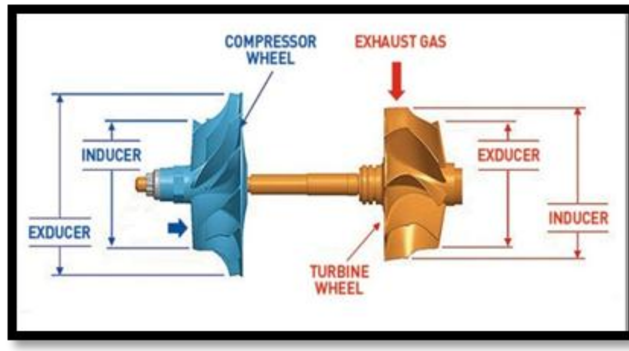


Fig 3.3 Compressor wheel & turbine wheel

3.4 Center Housing / Rotating Assembly (CHRA)

The CHRA may not get a lot of ink time, but it is one of the most critical parts of any turbocharger assembly. Practically, the CHRA serves as the mounting point for both housings and must be made of substantial material to handle the heat and stress of the turbine. Of course, holding the housings together is child's play compared to the real job of the CHRA, which is to support and lubricate the turbocharger's bearings.

Fig 3.4 Center Housing / Rotating Assembly (Chra)

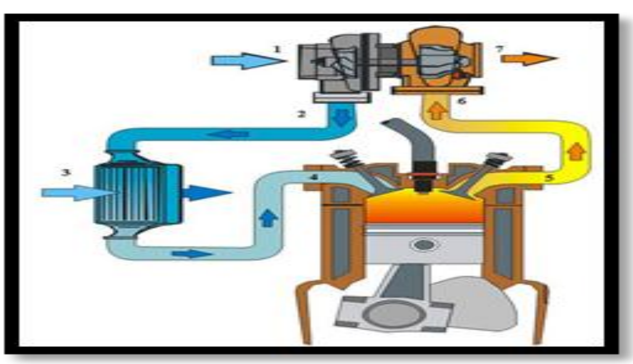
4.2.5 Intercooler

Understanding that a turbocharger works by compressing air, it is easy to see why an intercooler is important. Without jumping into too much math (we're talking about the ideal gas law again...), let's just say that as pressure increases within a fixed volume, heat is created. This is a law of thermodynamics and, no matter what anyone may argue, is present in any turbocharged engine application, even on "low boost" settings. Anyway, knowing that heat is present, we need a way to cool the incoming air charge before allowing it to enter the intake manifold, and for that we commonly use an intercooler.

Fig 3.5 Intercooler

IV. WORKING

The turbocharger consists of a single stage impulse turbine connected to a centrifugal impeller via a shaft. The turbine is driven by the engine exhaust gas, which enters via the gas inlet casing. The gas expands through a nozzle ring where the pressure energy of the gas is converted to kinetic energy. This high velocity gas is directed onto the turbine blades where it drives the turbine wheel, and thus the compressor at high speeds (10 -15000 rpm). The exhaust gas then passes through the outlet casing to the exhaust uptakes. On the air side air is drawn in through filters, and enters the compressor wheel axially where it is accelerated to high velocity. The air exits the impeller radially and passes through a diffuser, where some of the kinetic energy gets converted to pressure energy. The air passes to the volute casing where a further energy conversion takes place. The air is cooled before passing to the engine inlet manifold or scavenge air receiver.



(1) Compressor Inlet
(2) Compressor Discharge
(3) Charge air cooler
(4) Intake valve
(5) Exhaust valve
(6) Turbine inlet
(7) Turbine Discharge

The components that make up a typical turbocharger system are:

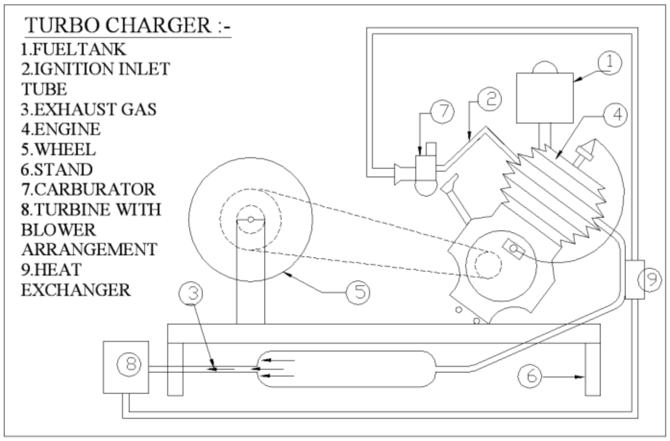
- The air filter (not shown) through which ambient air passes before entering the compressor (1)
- The air is then compressed which raises the air's density (mass / unit volume) (2)
- Many turbocharged engines have a charge air cooler (aka intercooler) (3) that cools the compressed air to
- further increase its density and to increase resistance to detonation
- After passing through the intake manifold (4), the air enters the engine's cylinders, which contain a fixed volume. Since the air is at elevated density, each cylinder can draw in an increased mass flow rate of air. Higher air mass flow rate allows a higher fuel flow rate (with similar air/fuel ratio). Combusting more fuel results in more power being produced for a given size or displacement
- After the fuel is burned in the cylinder it is exhausted during the cylinder's exhaust stroke in to the exhaust manifold (5)
- The high temperature gas then continues on to the turbine (6). The turbine creates backpressure on the engine which means engine exhaust pressure is higher than atmospheric pressure
- A pressure and temperature drop occurs (expansion) across the turbine (7), which harnesses the exhaust gas' energy to provide the power necessary to drive the compressor.

V. EXPERIMENTAL WORK

5.1 Specification of Two Stroke Petrol Engine:

Type	:	Two strokes
Cooling Syste	:	Air Cooled
Bore/Stroke	:	50 x 50 mm
Piston Displacement	:	9 8.2 cc
Compression Ratio	:	6.6: 1
Maximum Torque	:	0.98 kg-m at 5,500RPM

5.2 Construction and Components Used In a Model



5.3 Experiment Setup

1. Setup a rope brake dynamometer
2. Setup stand for the rope brake dynamometer
3. The pulley with rope is attached to the stand by the spring.
4. The engine is attached to the pulley by the shaft.
5. The carburettor and silencer is fixed to the engine and the engine is started.
6. The reading of exhaust temperature and pressure is taken when turbocharger is not connected and its efficiency is calculated and measured.
7. The turbocharger is connected to the silencer of the engine and then the readings should be taken and again the efficiency is calculated and measured.
8. The exhaust pressure and temperature of the engine is taken down.

5.4 Results and Discussions

Readings are taken as the sample tasting method. the process is carried out by taking different quantity of fuel and running the vehicle at steady state condition. The readings of performance are considered as the average of the vehicle.

SL No.	Fuel quality	Without turbocharger	With turbocharger	Increase in avg	Result
1.	50 ml	2.50 km	2.85	0.35	0.35
		2.52 km	2.90	0.38	
		2.49 km	2.82	0.33	
2.	100 ml	4.80 km	5.48	0.68	0.71
		4.90 km	5.62	0.72	
		5.00 km	5.74	0.74	
3.	500 ml	25 km	28	3	3

The testing shows the average of vehicle increased by adding turbocharger to the vehicle about 6 km to 7 km per liter of fuel.

As we are taking the testing of vehicle with and without turbocharger the above result is obtained. For taking the above observation we used the average tube. Hence from above result table it shows the average of the vehicle is increased by 7 km/liter.

5.5 ADVANTAGES:-

(1) More power compared to the same size naturally aspirated engine. Better thermal efficiency over naturally aspirated engine and supercharged engine because the engine exhaust is being used to do the useful work which otherwise would have been wasted.

(2) Better thermal efficiency over both naturally aspirated and supercharged engine when under full load (i.e. on boost). This is because the excess exhaust heat and pressure, which would normally be wasted, contributes some of the work required to compress the air.

(3) Weight/Packaging. Smaller and lighter than alternative forced induction systems and may be more easily fitted in an engine bay.

(4) Fuel Economy. Although adding a turbocharger itself does not save fuel, it will allow a vehicle to use a smaller engine while achieving power levels of a much larger engine, while attaining near normal fuel economy while off boost/cruising. This is because without boost, less fuel is used to create a proper air/fuel ratio.

5.6 DISADVANTAGES:-

(1) Lack of response called the Turbo Lag. If the turbo is too big, the boost will build up slowly because more exhaustpressure will be needed to overcome the rotational inertia on the larger turbine reducing throttle response but more peak power. If the turbo is too small the turbo lag won't be as big but the peak power would be lesser. So the turbocharger size is a very important consideration when deciding on it for a particular engine.

(2) Boost threshold- A turbocharger starts producing boost only above a certain rpm due to a lack of exhaust gas volume to overcome inertia of rest of the turbo propeller. This results in a rapid and nonlinear rise in torque, and will reduce the usable power band of the engine. The sudden surge of power couldoverwhelm the tires and result in loss of grip, which could lead to under steer/over steer, depending on the drive train and suspension setup of the vehicle. Lag can be disadvantageous in racing, if throttle is applied in a turn, power may unexpectedly

increase when the turbo spools up, which can cause excessive wheel spin.

(3) Cost- Turbocharger parts are costly to add to naturally aspirated engines.

VI. CONCLUSION

(1) This project is an attempt to reduce our dependency on foreign oil and reduce the tailpipe emission from automobiles and this was an attempt to design and implement this new technology that will drive us into the future.Use of production turbo charger will reduce smog-forming pollutants over the current national average.

(2) By the use of turbo charging in two wheelers the power can be enhanced.

(3) A properly tuned turbo engine can produce 20% + more power compared to stock, but expect an increase in fuel consumption.

(4) More power compared to the same size naturally aspirated engine.

(5) Better thermal efficiency over naturally aspirated engine and supercharged engine because the engine exhaust is being used to do the useful work which otherwise would have been wasted. After performing this project.

VII. ACKNOWLEDGMENT

I am privileged to thank Dr. SUNILKUMAR S. MANVI, Principal, RITM and our Head of the Department, Dr. K.S. NARAYANASWAMY, Mechanical Engineering, RITM, Bangalore for their constant support and help. I would also like to take this opportunity to extend my sincere thanks to all remaining staff of our department for their necessary help and co-operation.

It has been my great fortune to have Prof. MANJUNATH.C, Department of Mechanical Engineering, RITM, Bangalore as my Project Supervisor. In fact he has been the source of inspiration for me in and outside the classroom for the successful completion of my project.

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