

Mileage Enhancement and Emission Control in Bikes using Turbochargers

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Abstract - A turbocharger, colloquially turbo, is a turbine-driven forced induction device that increases an internal combustion engine's efficiency and power output by forcing extra air into the combustion chamber. Turbochargers are commonly used on truck, car, train, aircraft, and construction equipment engines. Turbochargers are widely used in car and commercial vehicles because they allow smaller-capacity engines to have improved fuel economy, reduced emissions, higher power and considerably higher torque. In this work a turbocharger of a 4 wheeler has been innovatively fixed to the exhaust of a bike and its effect on mileage and emission control are studied.

Key Words: Turbo charger, Combustion Chamber, Fuel Economy, Exhaust, Mileage

1. INTRODUCTION

1.1 Turbocharger

In naturally aspirated piston engines, intake gases are drawn or "pushed" into the engine by atmospheric pressure filling the volumetric void caused by the downward stroke of the piston (which creates a low-pressure area), similar to drawing liquid using a syringe. The amount of air actually inspired, compared with the theoretical amount if the engine could maintain atmospheric pressure, is called volumetric efficiency. The objective of a turbocharger is to improve an engine's volumetric efficiency by increasing density of the intake gas (usually air) allowing more power per engine cycle.

The turbocharger's compressor draws in ambient air and compresses it before it enters into the intake manifold at increased pressure. This results in a greater mass of air entering the cylinders on each intake stroke. The power needed to spin the centrifugal compressor is derived from the kinetic energy of the engine's exhaust gases. A turbocharger may also be used to increase fuel efficiency without increasing power. This is achieved 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 burned before being vented at the start of the exhaust stage. The increased temperature from the higher pressure gives a higher Carnot efficiency.

The turbocharger has three main components:

1. The turbine, which is almost always a radial inflow turbine (but is almost always a single-stage axial inflow turbine in large Diesel engines)
2. The compressor, which is almost always a centrifugal compressor
3. The centre housing/hub rotating assembly

Many turbocharger installations use additional technologies, such as waste gates, intercooling and blow-off valves.

1.2 Model Selected for Study

The Yamaha Crux is a 106 cc, single-cylinder four-stroke motorcycle made by India Yamaha Motor. The Crux is designed for Indian markets. It was launched in 2001 replacing RX 100, as 2-Stroke engines were not able to meet government's emission norms. A different version of Crux known as Crux R and Crux S were introduced with the same specifications but rectangular headlights. But after it could not make a considerable sale, the production was halted. User and owner claimed mileage and top speed is 55kmpl and 95kmph respectively.

2. TESTS CONDUCTED ON THE MODEL

2.1 Emission Test

The turbo charger was initially placed at the exit valve of the engine in between the silencer and the engine exhaust valve. It was welded to outlet and further connected to inlet using a connection setup. It utilizes exhaust gases for charging the intake. Waste gases from the turbocharger were expelled through silencer at the last.



Fig-1: Engine without modification



Fig-2: Engine with turbocharger



Fig-3: Turbocharger connected to exhaust

An emission test cycle is a protocol contained in an emission standard to allow repeatable and comparable measurement of exhaust emissions for different engines or vehicles. Test cycles specify the specific conditions under which the engine or vehicle is operated during the emission test. At first emission test was conducted on the original model without turbocharger. After that turbocharger was fixed and emission test was again performed. Readings obtained during both tests are tabulated below.

Table-1: Emission Results without Turbocharger

Exhaust Gas Contents	Regulation (%)	Actual Reading	
CO	3.5	2.121	% Vol
HC	4500	107	PPM
CO ₂		1.41	% Vol
O ₂		18	% Vol

Table-2: Emission Results with Turbocharger

Exhaust Gas Contents	Regulation (%)	Actual Reading	
CO	3.5	3.669	% Vol
HC	4500	186	PPM
CO ₂		2.36	% Vol
O ₂		15.26	% Vol

It can be seen from the tabulated readings that exhaust gas contents such as HC, CO has been considerably reduced. It shows that fuel burning efficiency of the engine has been increased after fixing the turbocharger so that only small amount of harmful exhaust gases is expelled to atmosphere.

2.2 Mileage Test

Mileage test was conducted on the model for comparable measurements to obtain the various outputs with and without the turbocharger under specified conditions with help of mileage test tube and stop watch. The specific time taken to consume 30 ml of petrol was duly noted with the help of the stopwatch. The model was ensured to be working at a specified and constant rate. For this experiment, the bike was maintained at 6000 rpm constantly to ensure the most accurate values. Given below are the experimental values obtained in seconds for the combustion of 30 ml of fuel at a constant speed of 6000 rpm:



Figure-4: Mileage Test

Table-3: Results of Mileage Test

Trial No	With Turbocharger	Without Turbocharger
1	2.52s	2.24s
2	2.56s	2.29s
3	2.49s	2.22s

It is clear from the tabulated readings after mileage test that engine with turbocharger has given a better performance in terms of mileage. 3 trials were done and in all of the results mileage of turbocharger fitted engine outperformed the original one.

3. CONCLUSIONS

Turbochargers are basically used to increase power of the specimen specifically sacrificing the mileage and other properties concentrating solely on the power increase and performance. In this particular project we have incorporated a turbocharger used on a Scorpio Turbo 2.6 L vehicle on the specimen, Yamaha Crux R, a 106cc bike. Certain modifications were done to the design of the engine and the detailed study of the turbocharger was conducted. Performing the specified test under the specific conditions,

we have come to a conclusion that by using the turbocharger under the specific condition where power is kept constant there is a noticeable change in mileage.

Furthermore, turbocharger forces more air into the engine inlet which results in the complete combustion of the fuel used thereby reducing the portions of unwanted pollutants caused due to the incomplete combustion of the fuel. This result in an improved condition of the exhaust gas expelled through the silencer. Futuristic scope of the project lies in the designing of a new turbocharger specifically for the usage on 125cc –150 cc bikes. By doing so we can implement the design based on performance and power in the Indian market and production can be done based on the user's need for mileage or performance. Further, we can implement this turbocharger for all vehicles having engine capacity of less than 200cc.

We can design the turbocharger as per the user needs, specially focusing on the Indian market. Certain users might prefer mileage over power whereas others might prefer power over mileage. Hence by designing a turbocharger for the common 150cc bikes, we can deliver the required need by bring about the alterations in the design as per the user need.

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