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Design and Development of Turbo-Charger for Two Stroke Engine

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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 application of such a mechanical device enables automotive manufacturers to adopt smaller displacement engines, commonly known as "engine downsizing". Historically, turbochargers were often used to increase the potential of an already powerful IC engine. 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 aim of this work is to provide a review on the techniques used in turbocharging to increase the engine output and reduce the exhaust emission levels.

Keywords: Turbo-charger, Emission, IC Engine, Automotive Industry.

I. INTRODUCTION

An attempt has been made in this work by which the exhaust gas is made utilized to rotate the turbine with a turbocharger arrangement. This exhaust gas gets impact with high pressure on the turbine blades in turn driving the compressor and this compressed air is given to the input supply. The ultimate innovation is that this setup is implemented in two wheeler engine having a low velocity of exhaust gas.

In two stroke engine due to the cycles limitations fuel will not properly burn. By considering this drawback here decided to make a work which will help to increase the average or performance of engine in two stroke engine. In stroke engine the air fuel ratio is 14:1 or 16:1 but in actual practice the ratio is less because of insufficient air fuel ratio, so decided to get that air fuel ratio by adding a new concept of turbocharger to the vehicle.

The progress of automobiles for transportation has been intimately associated with the progress of civilization. The automobile of today is the result of the accumulation of many years of pioneering research and development. An attempt has been made in this work; the exhaust gas is used to rotate the turbine with blower arrangement. Exhaust gas is used to rotate the blower and this air is given to the ignition input supply. The foremost aim in selecting this work is to use efficiency turbo charging. It is also good with regard to economic considerations and engine efficiency.

The meaning of turbo charger is to provide pressurized air to the engine without mounting any component to run of engine power. The turbo charger means a fan assembled unit. It means an air fan which rotates on the power of wind.This powered wind is supplied by the exhaust manifold, is used to driveout the burnt gas in the atmosphere. The velocity of gas coming out from the engine is very high & it contains two types of energies. These are:

1. Pressure energy.
2. Heat energy.

Due to the pressure & heat energy the air in the manifold gets preheated or it is very hot vapour this air contains high power. This power is wasted by the exhaust gas in the form of pressure, is about approx. 30% .the efficiency of the pressure energy can be utilized. The energy means to find a component in the silencer or the manifold. It is done in mostly for four wheeler vehicles. It is a system to give pressurized air to carburetor. The carburetor adjusts the regulator valve according to the air need & the use of petrol (fuel) will be decreased. This will increase the average by minimizing the fuel to be supplied by increasing the air fuel ratio.

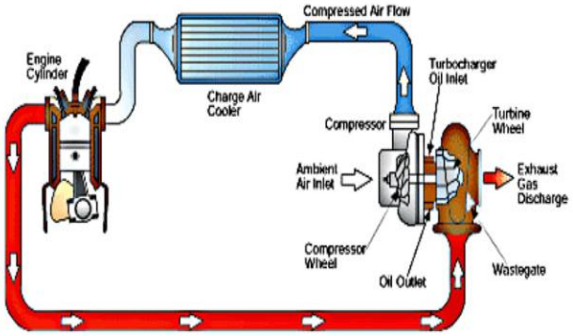

Fig.1.1 Working principle of Turbocharger

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Fig.1.1 shows the working principle of turbocharger in the automobile. By implementing the turbocharger in the two-wheeler engine, volumetric efficiency can be increased making use of the kinetic energy of the exhaust gas. This may reduce the fuel consumption and increases the performance of the engine in all naturally aspirated engines. Because the turbocharger increases the pressure at the point where air is entering the cylinder, a greater mass of air (oxygen) will be forced in as the inlet manifold pressure increases. The additional oxygen makes it possible to add more fuel, increasing the power and torque output of the engine. Even though this work is economical, proper design of turbocharger should be made specially to improve the efficiency further.

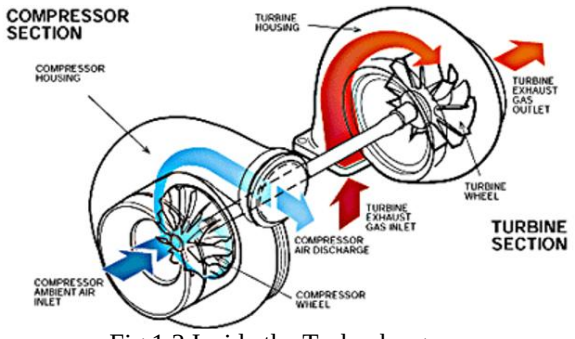

Fig.1.2 Inside the Turbocharger

Fig.1.2 shows the inside view of turbocharger. The compressor wheel and turbine are mounted on the same shaft. The exhaust gases from the engine strikes on the turbine blades causes to rotate the turbine at high speed. As the turbine rotates, the compressor start to rotate with the speed of turbine. The Fresh air from the atmosphere get sucked insude the compressor and further that air supplied to the carburettor causing increased air-fuel ratio.

II. DESIGN OF TURBOCHARGER

2.1 Design Procedure And Information

2.1.1 Design of Ventury Meter:

Ventury meter is an apparatus used for finding out the discharge in the pipe if consist of following three types. There are three types of ventury meter they are as follows.
Convergent cone:- It is a short pipe, which converges from the pipe diameter To throttle diameter the slope of convergent side, is kept between in four or In five.
Throat: It is circular pipe having diameter equal to half or one third of pipe.
Divergent cone: It is diverging pipe 5 to 4 times longer then the convergent cone connects through diameter with the pipe dimensions. It is also known as outlet of ventury meter.

Diameter of convergent =35mm
Flow through the air =3.5m/s
By formula for calculation of Q = discharge through silencer.

$Q = a_i \times v_i$
$= \pi/4 \times d^2 \times 3.5$
$= \pi/4 \times (35/1000)^2 \times 3.5$
$Q = 1.54 \times 10^{-4}\ m^3/s$
The discharge of the exhaust gas is $1.54 \times 10^{-4}\ m^3/s$.
Obtained from design assuming
$V_1 = 3.5$ m/s
$V_2 = 7$ as d_2 is ½ times of d_1
By formula of energy theorem at that point we get

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

As $Z_1 = Z_2$

$$P_1 - P_2 = \frac{V_2^2 - V_1^2}{2g}$$

$$P_1 - P_2 = \frac{7^2 - 3.5^2}{20}$$

$P_1 - P_2 = 2.45 - 0.6175$
$P_1 - P_2 = 1.833$. But
P_1 = 2 times P_2
$P_1 - 2P_1 = 1.833$.
$P_1 = 1.833\ N/m^2$.
The pressure released from the ventury meter at the outlet fan is **1.83** N/m^2.

2.1.2 Design of Driving Fan:

The outer radius of fan is 50mm the fan is made in such a way that the fan has 6 wing of dimension [4 ×4.5] cut at development of each fan the fan is designed in such a way that when the gas flowing through the ventury meter is dashed on the fans tins it most rotates faster.
Design of driving fan
Assumption made in design of driving fan

- The weight of the fan is 70 grams.
- The air traction has min force =0
- The force exerted by silencer is uniform.
- There is no bearing resistance considered in fan motion.
- There is no thermal expansion considered.

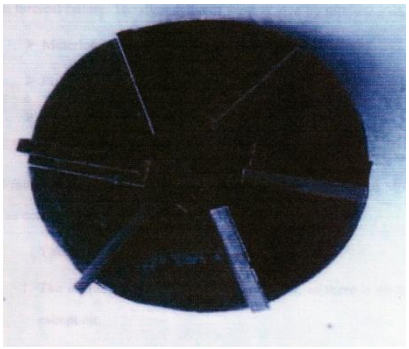
Fig.2.1 Turbine Fan

Design procedure for fan:
The CG of circle is r hence it is at 5.5 at the center.
The moment of inertia of the circle is $\pi/64\ (d)^2$
The MI of the circle is at center = $\pi/64\ (100)^4$
MI = 490.87 mm4
Design of wings
For designing of wing the CG is calculated by the formula.
X axis X/2 = 40/2 = 20.

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Y axis Y/2 = 35/2 =17.5.
The CG of the wings of fan are (20,17.5) respectively.
As the figure is symmetrical, hence the CG is at the center
Calculate MI
To Calculate MI the formula is

$= 1/12bd^3$.
$=1/12 \times 40 \times 35^3$.
$= 142916.66\ mm^4$.
$= 143 \times 10^3$.
$I_{PQ} = I\ xx + Ah^2$.
$= 143 \times 10^3 + 1400 \times 3$.
$=143 \times 10^3 \times 4200$.
$=147200$.

Therefore the pressure exerted on each fan is about area of fan x
pressure of air.
$=1400 \times 3.67$
$=5138$ N.

Due to this force the fan moves, as the force exerted is symmetric the force is unidirectional and the CG & MI is equal to the center.

2.1.3 Design of Shaft:

The shaft is designed in such a way that the shaft should not fail in farcical failure. The dimension of shaft is given by following ways.

- Material: M.S.
- Fatigue strength = 40 N/mm.

Selection of material: -
The shaft is designed in such way to avoid failure plus the M.S is a good conductor of heat. The fatigue strength of MS is good as compared to other materials.

The assumption made in the shaft is as follows.

- The torque transmitted power of one KN, as there is no force expects air.
- The thermal expansion is not considered.
- The bearing failure is not considered.
- The crushing failure of shaft at bearing is not considered.
- The pitch of a screw are at inch and done by trial and error method.

Design of shaft :

$T = \pi/16\ fs\ d^3$.
$T = \pi/16 \times 40 \times (6)^3$.
$T =1996$ N- mm

As it is more than assumed data.
The design is safe.

2.1.4 Design of Hub:

The hub is the most important component it contains the entire assembly in it. The main function of the hub is to support the entire mechanism.

- Material: M.S.
- Diameter: 110mm.
- F centrifugal = 70 N/mm^2

The assumption made in the hub is as follows.

- The pressure exerted by exhaust is equal throughout the body.
- The heat disappeared by the engine is distributed uniformly.
- The thermal expansion by the body is negligible.
- There is no effect of temperature on body.

Selection of material: -

- The mild steel is good conductor of heat.
- It dissipates heat at a large quantity.
- The metal can resist high temperature.
- It is easily malleable.

The design of hub has following procedure:-
Design for longitudinal stress

$\sigma_t = Pd/4$
$= 3.67 \times 110/4 \times 1$.
$\sigma_t = 100.9\ N/mm^2$.

The design is safe.
Design for circumferential stress:

$\sigma_c = Pd/2t$.
$= 3.67 \times 110/2 \times 1$.
$\sigma_c = 201.8\ N/mm^2$.

The design is safe.

2.1.5 Bearing Selection:

Bearing is one of the important components in turbo charger because the bearing the component in which the rotation of smooth fan takes place the bearing used in the project is of SKF company. This company is well know at the manufacturing of bearing.

- Material: - carbon steel.
- Bearing No : - 627 no.
- Size : - outer diameter 19mm.
  Inner diameter 6mm.

2.1.6 Selection of Bush:

The bush is also such of that type that the outer diameter of the bush must be of 19mm and the inner dia must be of 7mm. the bush helps to prevent bearing from dust.

- Material :- rubber bus

2.1.7 Desgin of a Circular Rib for Fixing Bearing and Bush:

Rib is also made of mild steel to the following reasons.

- Good conductor of heat.
- Easy to machining.
- The finishing is good.
- Good for welding purpose.

Design of rib:
The assumption made for fan:

- There are no forces on rib.
- The rib holds only the bearing and bush.
- It is made only because the thickness of hub is not so much to have grip in bearing and bushes it is done to support it.

The thickness of rib is assumed as 5mm. without any calculation.

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2.1.8 Design of Compression Fan:

The fan is designed to compress the air in the hub it is just like a air blower the basic principle of fan is to compress air it work on the principle of air blower.

- Material: - M.S.
- Diameter :- 90mm.
- The fan like L shape.

Selection of material: -

- Good conductor of heat.
- Good malleable or machinablity.
- Soft to mold.
- Good strength.
- No variation due to temperature.

The calculation of CG on both sides:
The dimension of fan diameter is 90mm
The CG of circle is at made at d/2.

CG = d/2 = 90/2= 45.

As the plate, CG is at center.

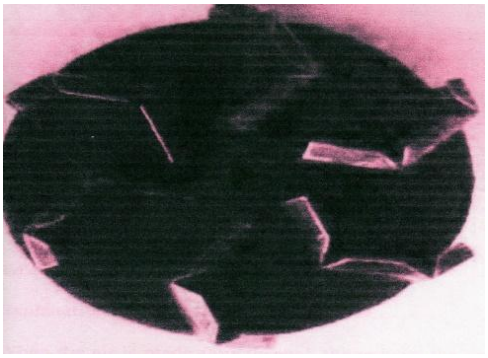

Fig.2.2 Compressor Fan

Design of fan wing:
As per assumption, the wing is considered of L section. The design dimension are as follows:

(50 x 40) as 10mm is welding the dimension are (50, 30)

25/2 = 12.5.

$$Y = \frac{a_1Y_1+a_2Y_2}{a_1+a_2}.$$

$$Y = \frac{750\times12.5+750\times0.5}{1500}.$$

$$Y = 6.5$$

X =(0.5, 12.5)

$$X = \frac{a_1X_1+a_2X_2}{a_1+a_2}.$$

$$X = \frac{750\times0.5+750\times12.5}{1500}. \quad = \quad 6.5$$

The CG of each fan is at (6.5, 6.5)
But the figure and MI is same on both side the CG of both wings comes on center.

2.1.9 Design of Inermediate Cooler:

The intermediate cooler is designed in such way that when the pressurized air is brought out to the pipe during that time the air is heated and the heated air density is always less to increase the density of a air the intermediate cooler is present.

Fig.2.3 Intercooler

III.CONSTRUCTION AND WORKING OF TURBOCHARGER

3.1 Construction

For this work, the existing silencer of a motorcycle is modified with the assembly of turbocharger. It consist of shaft which is fitted with bearing. On the shaft, the compression fan is fitted on one end and turbine fan on the other end. The function of turbine fan is to rotate compression fan with the help of exhaust gas at the bottom of silencer. The filter is provided to suck the atmospheric air from the atmosphere.

Fig.3.1 Modified Silencer with Turbocharger

The intercooler is fitted for cooling of the superheated air. The intercooler and silencer port is joined by pipe. The sucked air is passes through intercooler to carburetor. The original silencer of the vehicle is replaced by modified Silencer.

Fig.3.2 Assembly on Bike

In this assembly the arrangement consist of the turbine wheel, blower and the bush, bearing. The outlet of the turbocharger is attached to the intercooler and the intercooler outlet attached to the carburetor of the engine through the pipes.

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3.2 Working

The fresh air flows through the following methods of turbo charger.

From atmosphere

↓

To the compression fan.

↓

Flow through pipe.

↓

To intermediate cooler.

↓

To the carburetor.

The fresh air from the atmosphere is sucked by the compressor fan. Due to low pressure the air flow in the chamber and the gas is made to flow in the pipe. This flexible pipe is attached to intermediate cooler.

When the air flows through the compression chamber, at that time the temperature of silencer and the fan temperature makes the density of air less. To increase this density the intermediate cooler is provided. In this, the fresh charged air is brought in contact with the oil and cooled it the air is cooled and supplied to the silencer.

3.3 Effect of Turbo Charger On the Engine

As the turbocharger is selected to two wheeler two stroke engine the effect is very much like the four wheeler turbo engine. When the pressurized air is supplied to carburetor the adjustment of throttle valve changes due to speed of engine. When the throttle valve adjusts, the required pressure air and fuel flow through the capillary will be less. It will work in the same condition as the engine running at steady state. Due to this, the O_2 content increases in combustion chamber and due to this fuel burns efficiently and the output i.e the efficiency increases and the power or average increases.

IV. OBSERVATION,TESTING AND RESULT

4.1 Testing of Vehicle:

Readings are taken as the sample testing 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.

Table No. 1

Sr. No	Fuel quantity ml	Trial no	Without turbo charger km	With turbo charger km	Increase in average km	Result Km
1.	50	1	2.50	2.85	0.35	0.35
		2	2.52	2.90	0.38	
		3	2.49	2.82	0.33	
2.	100	1	4.80	5.48	0.68	0.71
		2	4.90	5.62	0.72	
		3	5.00	5.74	0.74	
3.	500	1	25	28.50	3.50	3.50
4.	1000	1	50	57	7	7

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

4.2 Percentage of Carbon Monoxide and Hydrocarbon:

➢ Without using the turbocharger:

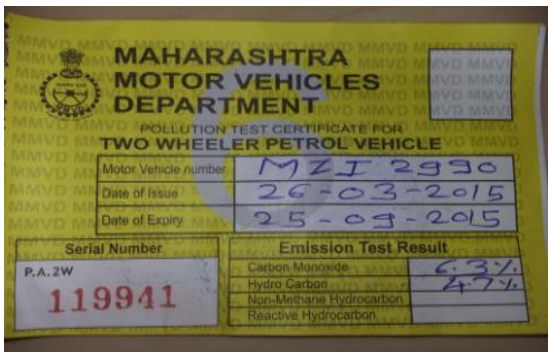

Fig.4.1 % CO & HC Without Turbocharger

➢ With using the turbocharger:

Fig.4.2 % CO & HC With Turbocharger

Table No.2

Sr. No	Fuel Quantity ml	Increase in Milage kmpl
1.	50	0.35
2.	100	0.71
3.	500	3.50
4.	1000	7

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4.3 Result

As the testing of vehicle carried out with and without turbocharger the results obtained are as follows. Hence from the result table it shows that the average of the vehicle is increased by 7 km/liter

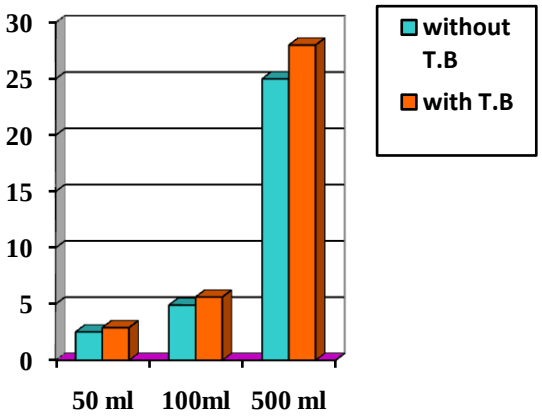

Fig.4.3 Comparision of Fuel Efficiency

The above graph shows the comparison between the vehicle used with and without turbocharger at the above reading. The graph shows the efficiency of vehicle.

V. CONCLUSION

From the above work the designed and fabricated prototype of the Turbocharger was implemented in Two-wheeler, in which the efficiency of the Engine is increased. Thus by using turbocharger in two stroke engine the efficiency of the engine can be increased and at the same time, the Emissions from the engine can be control. It is also good with regard to economical considerations and engine efficiency.

REFERENCES

1. Heywood JB. "Internal Combustion Engines". USA: McGraw-Hill, 1988.
2. Mr. Ayaz Afsar, Mr. Prafulla V. Pawar, Mr. Prathik Dahule, Mr. S. Papinwar. "Experimental investigation of direct air injection scavenged two stroke engine".2009 International symposium on computing, communication and control (ISCCC). Proc. Of CSIT vol.1 (2001). PP. 21-24.
3. Colin R. Ferguson, Allan T. Kirkpatrick. "Internal combustion engines, Applied Thermosciences". John Wiley & Sons (Asia) Pte Ltd, Singapore. 2004.
4. Amjad Shaik, N Shenbaga Vinayaga Moorthi and R rudramoorthy. "Variable compression ratio engine: A future power plant for automobiles- An overview". Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering September 1, 2007 vol. 221 no. 9. pp1159-1168.
5. N. Seshaiah. "Efficiency and exhaust gas analysis of variable compression ratio spark ignition engine fuelled with alternative fuels". International journal of energy and environment. Vol.1, Issue 5, 2010. pp 861-870.
6. Yashvir Singh, Nishant Kr. Singh, Rakesh Prasad and Hemant Kr. Nayak, "Performance Analysis of Supercharging of Two Wheelers" International Journal of Mechanical Engineering."
7. Internal combustion engine by V.GANESHAN.