A REVIEW ON TURBOCHARGER AND SUPERCHARGER

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ABSTRACT

As a demand of new efficient and eco friendly engines is incrementing new technologies are developing. Due to the rich air fuel mixture combustion emission will increase hence by turbocharging the engine more power can be obtained with low emission. In this paper review on various application of turbo charging and super charging technology is made. The behavior of IC engine with application of turbo/super charger and need of turbo/super charger installation is studied.

KEYPOINTS

Turbocharger, Supercharger, Exhaust gas recovery, Inter cooler.

INTRODUCTION

The present energy need of the world is met from fossil fuel. The automobiles mainly uses petrol and diesel as fuel. The population of automobile is increasing rapidly due to economic development of developing countries.

Due to this, the rate of fossil fuel depletion is increasing rapidly. Based on statistical report, if the current rate of depletion continues, the fossil fuel will get exhausted in a span of 10 to 30 years. To solve this problem electric automobiles is under development. Commercial proven electric automobiles will be available only after 15 years to 20 years. So we have to economize the use of petrol and diesel particularly in automobile sector. Till the commercialization of electric cars. We have to attempt economizing the consumption of petrol and diesel in automobile

sector. Under these circumstances we have to introduce systems like turbo charger and super charger to achieve the following.

1. Increase the efficiency of an IC engine by minimizing fuel consumption.

2. To reduce the carbon di oxide emission and pollution of atmosphere.

There are several models of turbo charger fit in automobile. The methodology adopted is to study and compare various types and advancements in turbocharger and super charger by analyzing various article, research paper & journals.

WORKING PRINCIPLE

Both the charger's mainly increase the air pressure with the help of compressor before it gets mixed with fuel. But when the air is compressed temperature increases due to adiabatic compression.

WORKING OF TURBOCHARGER

The turbocharger system comprises of three parts.

1. Compressor.

2. Cooling system.

3. Drive To The Compressor.

Compressor

It is a rotary compressor which is coupled to the exhaust turbine. It increases the pressure from 14 psi to 40 psi.

Cooling System

The heated compressed air is cooled by intercooler. An intercooler is another name for heat exchanger that is used to cool air that has been compressed by super charger or turbo charger. The inter cooler is placed some where in the path of air flow that flows from turbo/ super to motor. The intercooler is a must because of the physics of air described in the ideal gas law PV=nRT.

Drive system

Invariably the drive to the system is got from the exhaust. The turbine is rotated with the help of exhaust. The compressor which is coupled to the turbine is indeed rotated.

WORKING OF SUPERCHARGER

The super charger consists of three parts.

1. Compressor

2. Cooling system

3. Drive to the Super Charger

Both the Compressor and Cooling system are same as explained in Turbo Charger.

Drive to the Supercharger

Here in super charger the compressor is coupled to the crank shaft. So when the engine is switched on the compressor starts compressing.

LITERATURE REVIEW

The world's first functional supercharged engine was made my Dugald Clerk, which was used in two-stroke engine in 1878. Diamler received a German patent for supercharging an IC engine in 1885. In a supercharger the loss can be up to 15% of engine output. To reduce the loss of power, later on the compressor was driven by a turbine using the exhaust gas energy. Then this technology became popular by the name as Turbocharging during early 1980's.

Vidit Saxena et al [1] : There are many inventions aimed at increasing the performance of an Internal Combustion engines. When power increases, efficiency decreases. Presently, ethanol is prospective material for using in automobiles as an alternate fuels. The main reason for using ethanol is that it can be produced from natural products and waste materials, compared with gasoline, which is engendered from non renewable resources. Some methods and components are utilizable for incrementing performance of an IC engine. One such method is supercharging or turbo charging an IC engine.

Super charging

It is known fact that the potency output of an engine increases with an increase in amount of air or amalgamation in the cylinder at the commencement of compression stroke because it allows more quantity of fuel to burn. So in order to give in more air we are equipping the engines with a super charger.

Advantages of super charger.

1. Due to the lower volumetric displacement of supercharged engine, frictional and thermal losses are less.

2. Brake power will increase about 30-45 % because of increase in supercharged pressure as more amount of fuel will be burnt within the same period as the mass taken per stroke is increased.

3. The supercharged engine's installation space requisite is more small than that of naturally aspirated engine.

4. It is very simple for high speed engine.

Turbocharging

A turbocharged engine can be more efficient than an naturally aspirated engine because the turbine forces more intake of air, proportionately more fuel, into the combustion chamber. In turbo charging, the turbocharger is being driven by a gas turbine utilizing exhaust gases.

Advantages of turbocharger.

1. It produces more power than the same size naturally aspirated engine.

2. Better thermal efficiency than naturally aspirated and supercharged engine, because exhaust is being used to do the work which otherwise would have been wasted.

3. Better fuel economy.

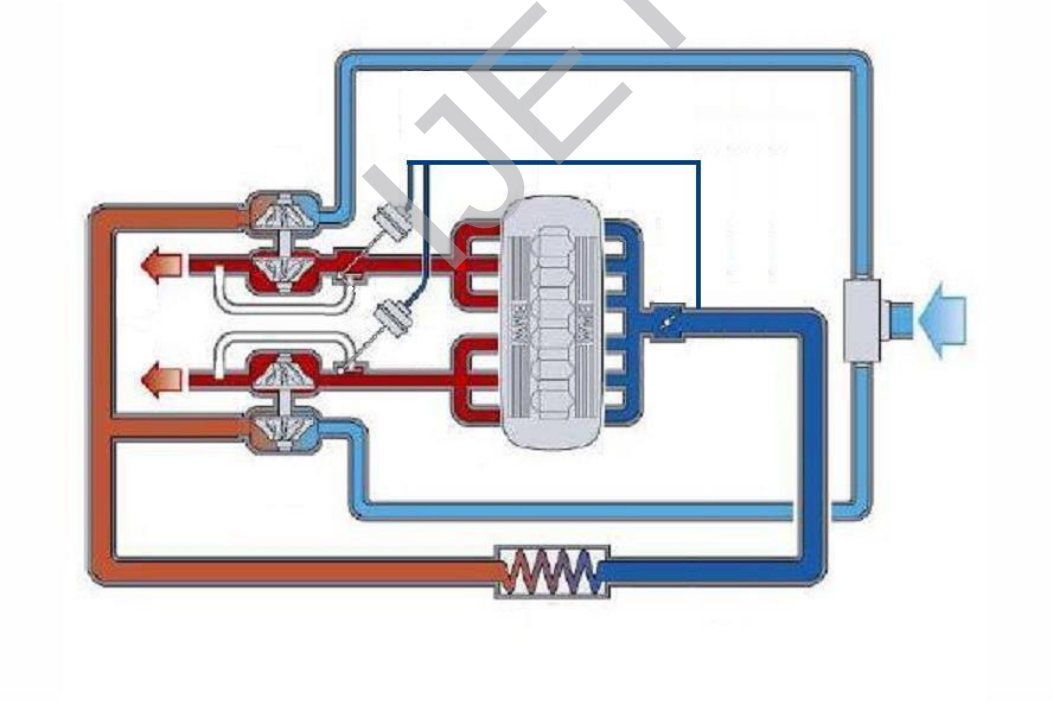
4. Better volumetric efficiency.

5. High speed obtained.

Anirudh H et al [2] : Over the years, raising man kind's standard of life has incremented the concentration of co2, one of the major contributors of green house effect, by 36% globally since the industrial revolution, which has emerged with wide usage of fossil fuel. The major contributors are automobiles. In this paper we will concentrate on reducing the number of cylinder and displacement what an engine uses, so as to lower the emission of co2. All these can be done by pressure boosting using a turbocharger or twin turbocharger.

Single stage Vs Dual stage

The most common problem associated with single stage turbo charged engine is that it has poor transient response. A recent development in single stage turbo charging is to look for an variable geometry turbine. Its main objective is to reduce the turbo lag. The variable geometry systems are useful in both petrol and diesel engines. Petrol engines having high exhaust temperature, variable geometry solution is not much suitable. If the single stage turbine has been replaced with dual stage turbine results in enhanced transient response due to the lower inertia if we compare to the single stage turbocharged system of same volume.



Jose Manuel Lujan et al [3] : In this paper the aim of improving the performance of IC engines working at low ambient temperatures. Pollution and fuel consumption are one of the important topic. In this, we use exhaust heat recovery system for a diesel engine during cold operation. We use the energy obtained from the exhaust to heat the intake air temperature.

In this project the ordinary intercooler is replaced water/ air heat exchanger known as Water charge air cooler. During cold condition the Water charge air cooler comes into play, which uses the exhaust gas from engine. The exhaust gas enters the charger and heat exchange takes place with the ambient air so as to heat the cold ambient air and is fed into the engine.

Jianqin Fu et al [4] : Now we are going to see various types of turbo charging , their principle, working and advantages. Due to the increasingly sever problems of energy and environment, especially the petrol shortage and air pollution ,more attention has to be paid on energy saving and environmental protection. Under this circumstances higher energy utilization efficiency and lower emission are the major development for an IC engine. There are several kind of approaches to improve the IC engine energy utilization they are turbo charging and super charging.

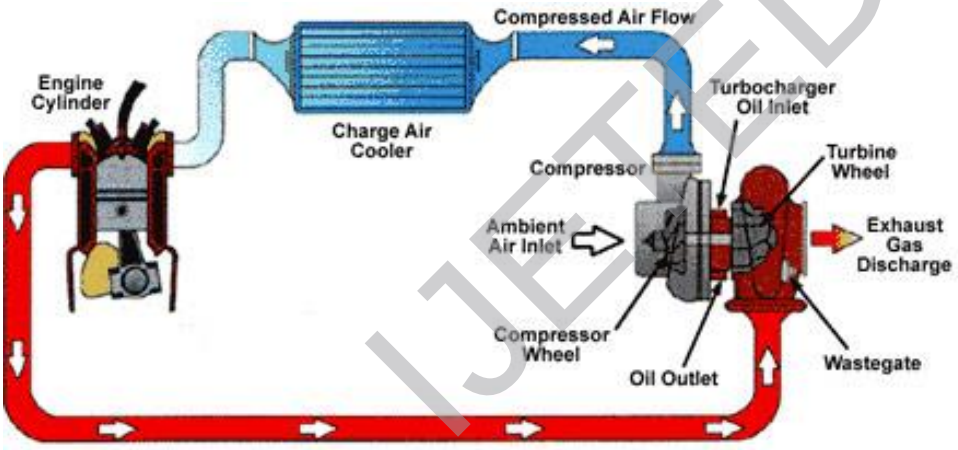
Types of turbo charging

1. Exhaust turbocharging

2. Steam turbocharging

Exhaust turbocahrging:

The system consists of turbine, compressor and intercooler etc. Among the turbine and compressor are connected by a transmission shaft. Since the IC engine exhaust gas has high temperature and pressure, it still contains lots of energy which could be recovered by exhaust turbine. In exhaust turbine the exhaust from the engine is used as the working medium of turbine. The useful work is used to drive the compressor.



Steam turbocharging

In steam turbocharging a set of steam power cycle system is coupled to IC engine exhaust pipe, which uses the high temperature exhaust gas as the heat source of steam power cycle. The system consists of pump, heat exchanger, valve, turbine, condenser, compressor. The heat exchanger is used to heat and evaporate the water. The steam makes the turbine to run which in turn runs the compressor.

Jenelle Pope [5] : The purpose of this is to analyze turbocharged diesel engine. In this project Chevrolet suburban was used, it comes with a stock turbo charger. In order to extract more power from the engine, a new larger turbo was used. The

new turbo is coupled with air water inter cooling system to decrease the inlet air temperature. Thus the upgradation of turbo along with the intercooler produces better results than the stock turbo.

Qijun Tang et al [6] : In this paper, various kinds of improved modes of exhaust gas turbocharging has been investigated on the performance, including steam assisted turbocharging, electronically controlled turbocharging.

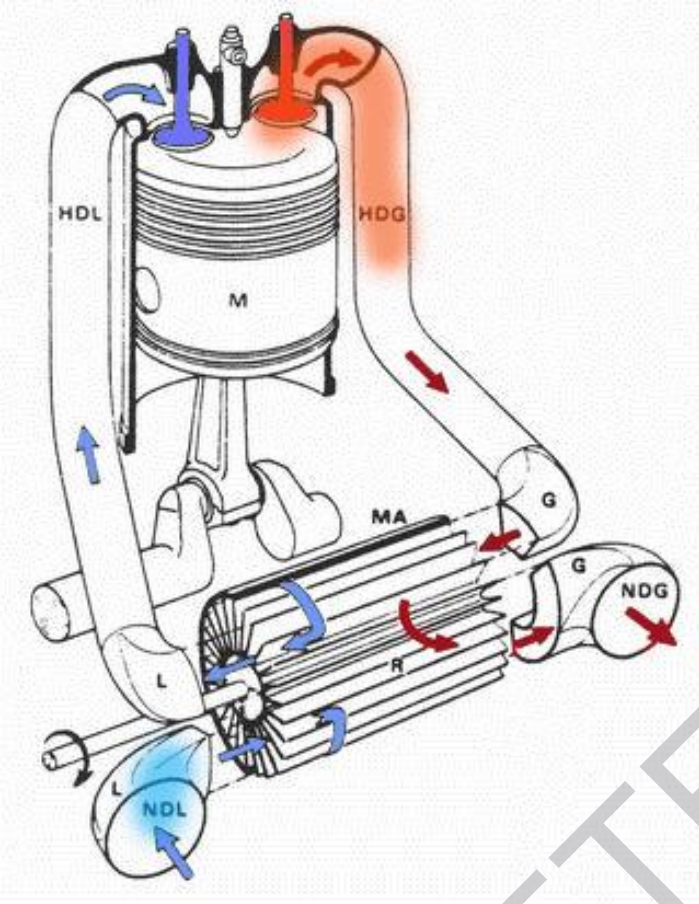
Steam assisted turbocharging

A steam generating plant is coupled to the exhaust pipe so as to utilize the engine exhaust gas energy to generate high-temperature steam. The high temperature steam which has been produced is injected into the turbine. Thus it can be used as the working medium for turbine. By this means the turbocharger working performance can be improved under low-speed and low-load engine operating condition.

Electronically controlled turbocharging

This system consist of a motor, the motor is used as the generator to recover the exhaust gas energy or else it acts as the prime mover for the compressor. When the engine operates under low speed or under acceleration, the exhaust gas mass flow rate is very low to drive the compressor, and the intake pressure is also lower than the target boost pressure. So under these circumstances, the charger switch begins to open the compressor will be driven by motor along the turbine. When working under high speed or high acceleration the exhaust gas is enough to run the compressor so the discharger switch begins to open then the drive to the compressor changes from prime mover to generator.

P.Spring et al [7] : In this paper we are going to discuss about the exhaust gas recovery using pressure-wave supercharger. In pressure-wave supercharger energy is transferred between two gaseous fluid streams by bringing them together for a short time in a narrow channel. Pressure-wave mechanism uses the physical that if two fluids of different pressures are brought into contact, pressure equalization is faster than mixing. This device uses unsteady waves to produce a steady flow of gas to the engine.



Wladyslaw et al [8] : In this paper we are going to discuss the main problem in the charged spark ignition engine was to control the air-fuel ratio near stoichiometric values at various boost pressure in order to extract more torque at the same level of specific fuel consumption and engine exhaust gas emission. Charging such engine was related with the problem of knock in the medium and high values of load at lower speeds. Higher boost pressure will lead to abnormal combustion and knocking. So we give a boost pressure control algorithm which prevents the knock, so the engine can work near the knock boundary. Toyota Yaris 1300cc SI engine was used for this experiment was equipped with variable turbine geometry turbocharger with the possibility to control mass flow rate in the turbine by using an additional waste gas system. Computer control programs in lab view environment was given in order to analyze knock signals produced and to regulate the opening signal was fed to the engine control unit, where it was transformed by fourier transforms. This gave a distribution of knock signals in the range of 2000-8000 hertz. Control signal for the knock was obtained in the range of 0-0.1 Volts and was transferred to the engine control unit for regulating the mass flow rate of

exhaust gases through the variable geometry turbine. When the value is greater than 0.01 Volts then the valve in waste gas was opened much more to reduce mass flow rate of the engine exhaust gas through the turbine which in turn decreases the rotational speed of the turbocharger and thus compressor pressure ratio falls.

Muqeem [9] : The main objective of a turbocharger is to improve the efficiency of an engine by increasing the density of intake air. When the pressure of the intake air is increased, the temperature will also increase. The turbocharger unit makes use of intercooler to cool down the inlet air temperature near to the ambient temperature. The inter cooling of intake air was increased by installing a specially designed inter cooler in which the inlet air runs as a hot fluid and the refrigerant of the air conditioning system from cooling coil fitted in the dash board runs as a cold fluid. The intake air is cooled by the intake air flowing through the fins of the intercooler and the refrigerant coming from the evaporator. When an normal air is cooled by an intercooler the mass of the oxygen becomes 1.43 times but when refrigerated the mass of oxygen becomes 2.618 times. Increase in the oxygen leads to faster burning rates and can control the exhaust emission.

CONCLUSION

It is observed that the exsisting study on turbo and super chargers shows positive influence of turbo and super charger on IC engine power characteristic and emission characteristic. The air fuel ratio is always constant. So there is scope to vary the air fuel ratio and obtain the best suited air fuel ratio and that can be optimized.

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