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Research Paper

PERFORMANCE ANALYSIS ON A TURBOCHARGED TWO WHEELER ENGINE

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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 project; 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. Our fore most aim in selecting this project is to use efficiency turbo charging. It is also good with regard to economical considerations and engine efficiency. Here the authors measured the Vehicular Exhaust emission [(Carbon monoxide (CO), Hydro carbon (HC), Carbon dioxide (CO₂) and Oxides of Nitrogen (NO_x)] of Suzuki engine (100 cc) using MEXA-584L Gas analyzer for gasoline powered vehicles. The real time values were compared with standard ones, and the level qualified. During half throttling about 90% of scooters and 93% of motor bikes were found emitting HC within the prescribed national standard of 2000 PPM.

Keywords: Air Fuel Ratio (AFR), Engine efficiency, MEXA-584L Gas analyzer, Gasoline vehicles, Throttling, Turbocharger

INTRODUCTION

The output of the engine exhaust gas is given to the input of the turbine blades, so that the pressurized air produced. This power, the alternate power must be much more convenient in availability and usage. The next important reason for the search of effective, unadulterated power are to save the surrounding environments including men, machine and material of both the existing and the next fourth generation from

pollution, the cause for many harmful happenings and to reach the saturation point.

The most talented power against the natural resource is supposed to be the electric and solar energies that best suit the automobiles. The unadulterated zero emission electrical and solar power, is the only easily attainable alternate source. Hence we decided to incorporate the solar power in the field of automobile, the concept of many Multi-nationals Companies (MNC) and

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to get relieved from the incorrigible air pollution. What the turbo-charger does is that it simply increases the volumetric efficiency of the engine.

Turbo-Charger

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. BMW was the first to use turbo-charging in a production passenger car when they launched the 2002 in 1973. The car was brilliantly packaged too and paved the way for a simply magnificent 'Turbo Era' in the automotive world. Swedish giant Saab took its cue from this and its ensuing 900 series was one of the most characteristic turbo cars of its time.

Intercoolers the latest turbo's they are used by most of today's turbo-diesel engines to make the compressed air denser. It works like this - on starting, exhaust gases spin the turbine and thus activate a compressor that pressurizes the air. This pressurized air from the turbo-charger is then sent through a duct to an air-cooled intercooler, which lowers the temperature of the intake charge and thus increases its density. The air-cooled intercoolers receive air through separate intakes and that explains the small scoops and louvers usually found on the hoods of turbo-charged cars. Modern turbo-diesel engines also make use of a temperature-sensitive, motor-driven fan which boosts airflow at low engine speeds or when the intake air temperature is high.

Computers soon started playing an even bigger role in cars. Engine management systems linked to fuel-injection systems meant getting more out of the engine was even easier. For example, one can buy chips that can boost power by 100 bhp for some Japanese cars, such as the Nissan Skyline. Moreover, on-road speeds were being restricted all over the world. Though most of the sports cars today are capable of doing more, they are restricted electronically not to exceed 250 kmph even in autobahn-blessed Germany. Turbo-charging lost its edge towards the end of the 1980s and today this technology is used only in select performance cars. Porsche, for example, is all set to build a turbo-charged version of its all-new 911 (water-cooled) with added performance. Turbo engines were banned in Formula One too with the idea of restricting the performance of the cars (and thereby making them safer too). There are many who consider this a backward step in the world of Formula One, which is considered to represent the 'tomorrow' of automotive technology. But if one analyses the performance of normally aspirated cars in F1 today (3,500 cc non-turbo), they perform as well, if not better, than the turbo cars of the early 1980s.

So, there are no full stops in technology. While road cars and even sports and racing cars are going in for more efficient engines, better metallurgy and wilder-than-ever electronics to get their engines to perform at an optimum level without sacrificing the performance edge, turbo-chargers still continue to serve the same purpose they were invented for albeit more so with diesel engines. Modern turbocharger is based on the principle that if air entering in an engine is pressurized more oxygen and then adding more fuel in the engine result in high torque and more power. A turbocharged engine produces more

power overall than the same engine without the charging. This can significantly improve the power to weight ratio for the engine. Now a day's turbochargers are used in heavy vehicle, racing cars and racing bikes. The Supercharger – or, as the Germans call it, Kompressor! It's a common tendency, especially amongst enthusiasts, to look for ways in which to quench the thirst to produce ever more power from the engine of their cars. Well, maybe not so much in our country—but certainly in more affluent countries, where enthusiasts have the financial capability, and desire, to soup up their cars in the search for better performance.

One of the most common solutions is to turbocharge a car—a technology we've looked at in detail in the past—while the other popular route is to install a supercharger. Now, these were actually invented even before the internal combustion engine was developed for mainstream use in industrial and automotive applications. So, as a technology, it's been around for a while—and has seen constant development over the years. Some of the earliest performance cars of the world used superchargers to boost their performance—these included legendary classics such as the Mercedes 540K, Bugatti Type 35C, and, of course, the famous 'Blower' Bentley's, which conquered Le Mans and were the fastest cars of their day. So, it could be said that in the history of force induction, this is the earliest, and one of the most successful progenitors.

In the 1970s of past century, with the turbocharger's entry into motor sports, especially into Formula 1 racing, the turbocharged passenger car engine became very popular. The word "turbo" became quite fashionable. At that time, almost every automobile manufacturer

offered at least one top model equipped with a turbocharged petrol engine. However, this phenomenon disappeared after a few years because although the turbocharged petrol engine was more powerful, it was not economical. Furthermore, there was the "turbo-lag" problem, the delayed response of the turbochargers, which was at that time still relatively large and not accepted by most customers. The real breakthrough in passenger car turbocharging was achieved in 1978 with the introduction of the first turbocharged diesel engine passenger car in the Mercedes-Benz 300SD, followed by the VW Golf Turbo diesel in 1981. By means of the turbocharger, the diesel engine passenger car's efficiency could be increased, with almost petrol engine "driveability", and the emissions significantly reduced.

Motorcycle Turbo Charger

Using turbochargers to gain performance without a large gain in weight was very appealing to the Japanese factories in the 1980s. The first example of a turbocharged bike is the 1978 Kawasaki Z1R TC. It used a Ray jay ATP turbo kit to build 0.35 bar (5 lb) of boost, bringing power up from 90 hp (67 kW) to 105 hp (78 kW). However, it was only marginally faster than the standard model.

In 1982, Honda released the CX500T featuring a carefully developed turbo (as opposed to the Z1-R's bolt-on approach). It has a rotation speed of 200,000 rpm. The development of the CX500T was riddled with problems; due to being a V-twin engine the intake periods in the engine rotation are staggered leading to periods of high intake and long periods of no intake at all. Designing around these problems increased the price of the bike, and the performance still was not as good as the cheaper CB900 (a 16 valve in-line four)

during these years, Suzuki produced the XN85, a 650 cc in-line four producing 85 bhp (63 kW), and Yamaha produced the Seca Turbo. The XN85 was fuel injected, while the Yamaha Seca Turbo relied on pressurized carburetors. Since the mid 1980s, no manufactures have produced turbocharged motorcycles making these bikes a bit of an educational experience; as of 2007 no factories offer turbocharged motorcycles (although the Suzuki B-King prototype featured a supercharged Hayabusa engine). The Dutch manufacturer EVA motorcycles builds a small series of turbocharged diesel motorcycle with an 800 cc smart cdi engine. Laminated materials so that currents cannot circulate reduced higher resistance materials (silicon rich iron, etc.).

EXPERIMENTAL SET UP

Today, the turbocharging of petrol engines is no longer primarily seen from the performance perspective, but is rather viewed as a means of reducing fuel consumption and, consequently, environmental pollution on account of lower carbon dioxide (CO₂) emissions. Currently, the primary reason of using turbochargers is the reduced consumption and emission of harmful gases. A turbocharger, often called a turbo, is a small radial fan pump driven by the energy of the exhaust flow of an engine. A turbocharger consists of a turbine and a compressor on a shared axle. The turbine inlet receives exhaust gases from the engine causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure, resulting in a greater mass of air entering each cylinder. In some instances, compressed air is routed through an intercooler before introduction to the intake manifold.

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. The objective of a turbocharger is the same as a supercharger; to improve upon the size-to-output efficiency of an engine by solving one of its cardinal limitations. A naturally aspirated automobile engine uses only the downward stroke of a piston to create an area of low pressure in order to draw air into the cylinder through the intake valves. Because the pressure in the atmosphere is no more than 1 bar (approximately 14.7 psi), there ultimately will be a limit to the pressure difference across the intake valves and thus the amount of airflow entering the combustion chamber. This ability to fill the cylinder with air is its volumetric efficiency. 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.

Engine Specification

Type of fuel used	: Petrol
Cooling system	: Air cooled
Number of cylinder	: Single
Number of stroke	: Two Stroke
Arrangement	: Vertical
Cubic capacity	: 100 cc.

Spark Ignition Engine

A Spark Ignition (SI) engine runs on an Otto cycle—most gasoline engines run on a modified Otto cycle. This cycle uses a homogeneous air-fuel mixture which is combined prior to entering the combustion chamber. Once in the combustion chamber, the mixture is compressed, and then ignited using a spark plug (spark ignition). The layout of turbo-charged engine with parts is shown in Figure 1. The SI engine is controlled by limiting the amount of air allowed into the engine. This is accomplished through the use of a throttling valve placed on the air intake (carburetor or throttle body). Mitsubishi is working on the development of a certain type of SI engine called the gasoline direct injection engine. The fabricated turbocharger engine (Suzuki) is shown in Figure 2.

Figure 1: Layout of Turbocharger Engine (Suzuki) with Parts

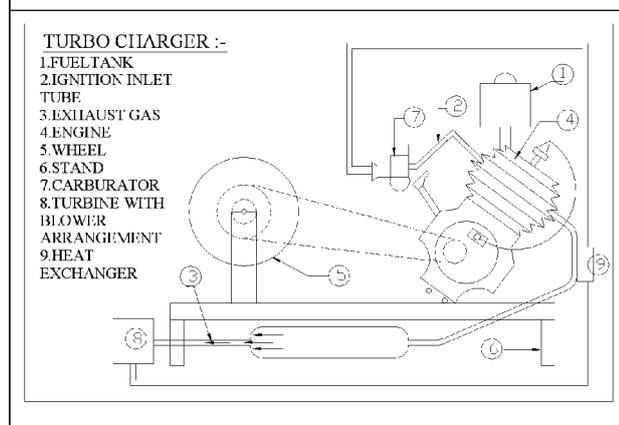


Figure 2: Fabricated Turbocharger Engine (Suzuki)



METHODOLOGY

(Characterization of Exhaust Emissions from Gasoline Powered Vehicles)

Although vehicle exhaust emissions of air pollutants are generally decreasing, it has not been possible to reduce air quality problems in cities in the past 10 years. In particular, the concentrations of particulates and ozone are too high, causing severe health effects. Besides improving the local air pollution situation, the reduction in global warming due to greenhouse gas emissions is of great importance for the mobility sector, in view of increasing worldwide mobility and demand for transportation. Finally, numerous established researchers are predicting bottlenecks in energy supply for the next few decades, pointing to the importance of clean biofuels.

The requirement for future motor vehicles is therefore very clear: emissions of toxic pollutants such as particulates and ozone precursors have to decrease to near zero, greenhouse gas emissions have to be reduced far more than in recent years and the introduction of biofuels has to be enabled on a large scale.

Exhaust emission measurements on motor vehicles are often performed using the official European driving cycle. This is a practical test cycle for type approval purposes, but allows limited comparability with real-world driving. Few exhaust gas and particulate emission data are available from modern motor vehicles representing a real-world driving pattern.

The major air pollutants include gases like carbon monoxide, sulphur dioxide, oxides of nitrogen and particulates like respirable suspended particulate matter and suspended particulate matter. These air pollutants in the

atmosphere have an adverse effect on human life and are contributed by various sources.

In order to protect human health, property and environment from the adverse effects of air pollution, the National Ambient Air Quality Standards have been set by the Central Pollution Control Board. The air quality standards have been developed primarily on the dose effect/dose response relationships. The standards set are an integral part of air quality management which is required to set long term as well as short-term goals for air quality improvement and formulation of strategies and implementation of various programs.

Emission Measurement

For more than 55 years the name HORIBA has been synonymous with high quality analyzers and systems. Exceptional results in the automotive engine emissions measurement and environmental monitoring are internationally recognized, as well as the excellent performance of our instruments. Making the right solutions for industry has enabled HORIBA to grow into its leading role. HORIBA’s drive for innovation and performance is underlined by the fact that 800 engineers are employed in the R&D departments around the world. HORIBA develops and manufactures products and systems for testing of all types of engines: heavy-duty to small utility,

on road systems to non-road, marine to locomotive, automotive to aeronautic. Our extensive product line includes analyzers, analytical systems, dilution/sampling systems, dynamometers and automation systems to assist engineers to evaluate and advance: exhaust gas and particulate emissions, engine performance, fuel economy, fuel cell reformer efficiency, other parameters of engine and vehicle. The specification of MEXA-584L Automotive emission analyzer is given in Table 1.

HORIBA offer products covering the following ranges of Emissions Measurement Systems:

- Analytical Systems
- On-Board Systems (PEMS)
- Portable Emissions Analyzers
- Dilution/Sampling Systems
- Other Systems

Automotive Emission Analyzer MEXA-584L Handy, Efficient all-in-one gas Analysis)

Perfect for engine inspection and tuning, the MEXA-584L portable gas analyzer, complies with international standard OIML class O and is loaded with features to make your analysis easier and accurate. In this analysis MEXA-584L portable gas analyzer was used for the measurement of on-board exhaust emission.

Table 1: Specifications of Automotive Emission Analyzer

Measured components(standard)	CO,HC,CO ₂ ,AFR,LAMDAand(O ₂ ,NO option)
Measurement principle	CO, HC, CO ₂ : Non-dispersive infrared (NDIR)Air-to-fuel ratio (AFR), Excess air ration (lambda): carbon balance method or Brettschneider method (with O ₂ measurement). AFR and lambda are calculated by the carbon balance method in standard configuration.
Conformed standard	OIML Class 0 - CE – FCC
Ambient humidity	Under 90% relative humidity

The purpose of the MEXA-584L portable gas analyzer is to measure the relative volumes of certain gaseous constituents such as carbon monoxide (CO), carbon dioxide (CO₂), hydrocarbon, oxygen (O₂), and nitric oxide (NO) in the exhaust gases of the motor vehicles, engine speed and engine oil temperature can also be measured. The various parts of MEXA-584L portable gas analyzer is given in Table 2.

It allows you to simultaneously measure CO, HC, CO₂ (non-dispersive infrared: NDIR) and air-to-fuel ratio (AFR) or excess air ratio (A) in idle state. It optionally measures O₂, NO, engine speed (RPM) and oil temperature (TEMP). Lightweight and compact with a clear LCD and effortless operation, it can be used as a simple measurement instrument in any work situation. A schematic front view of MEXA-584L portable gas analyzer is shown in Figure 3.

S. No.	Names	Description
1.	NO sensor	Measures NO concentration
2.	O ₂ sensor	Measures O2 concentration
3.	Strainer unit	For protecting pump in drain line
4.	Exhaust outlet	Sample gas outlet
5.	Ground terminal	The power cable cannot be connected to ground terminal directly use terminal
6.	Power inlet	Connects the power cable
7.	Power switch	Turns the power on

Figure 3: Emission Measurement of Automotive Emission Analyzer



Figure 4: Filter used in Automotive Emission Analyzer



Emission Measurement of SUZUKI ENGINE

Vehicles of various make and models are in use in Chidambaram. The most common among the

two wheel gasoline vehicles are Hero Honda motor bike (4 stroke, 100 cc), Yamaha motorbike (2 stroke 100 cc) TVS jive motorbike, TVS flame motorbike 125 cc, Bajaj platinum motorbike, TVS

XL motorbike, Apache motorbike, Bajaj Discover 135 cc motorbike, Bajaj Pulsar 150 cc DTS-I motorbike, etc. Here the authors measured the exhaust emissions of Suzuki engine with and without turbocharger. The real time values were compared with standard ones, and the level qualified.

RESULTS AND DISCUSSION

Estimation of CO, Hydrocarbon CO₂ and NO

The exhaust emissions of gasoline-powered vehicles for CO and Hydrocarbon were monitored using an Automotive Emission Analyzer MEXA-584L idling conditions, 1/4 throttling, 1/2 throttling, 3/4 throttling and full throttling conditions. The MEXA-584L simultaneously measures CO, HC, CO₂ (non-dispersive infrared: NDIR) and air-to-fuel ratio (AFR) or excess air ratio (A) in idle state. It optionally measures O₂, NO, engine speed (RPM) and oil temperature (TEMP). Lightweight

and compact with a clear LCD and effortless operation, it can be used as a simple measurement instrument in any work situation.

The Carbon monoxide Hydrocarbon and Nitrogen oxide at full acceleration conditions and λ (Air fuel) at idling conditions for some selected gasoline vehicles were also monitored to access the change in emission characteristics. The emission measurement of Suzuki engine (Without Turbo-charger) by using Horiba gas analyzer is shown in Table 3.

The emission measurement of Suzuki engine (With Turbo-charger) by using Horiba gas analyzer is shown in Table 4.

CO and Hydrocarbon Emissions

Variation in CO and Hydrocarbon emissions of two wheel vehicles, i.e., Suzuki engine (Two strokes) at idling engine conditions and maximum possible load conditions are provided at Tables 5 and 6. About 90% of scooters and 85% of motor

Table 3: Emission Measurement of Suzuki Engine (Without Turbo-Charger)

	Co % Volume	HC PPM Volume	Co ₂ % Volume	λ (Air fuel)	O ₂ % Volume	No PPM Volume
Idling	0.04	687	0.71	9.999	19.90	69
25%	0.01	314	0.70	9.999	20.23	59
50%	0.03	296	0.38	9.999	20.35	81
75%	0.05	290	0.34	9.999	20.42	84
Max	0.06	305	0.36	9.999	20.39	89

Table 4: Emission Measurement of Suzuki Engine (With Turbo-Charger)

	Co % Volume	HC PPM Volume	Co ₂ % Volume	λ (Air fuel)	O ₂ % Volume	No PPM Volume
Idling	0.01	57	0.08	9.999	20.77	21
25%	0.03	134	0.20	9.9999	20.76	41
50%	0.05	185	0.22	9.999	20.83	48
75%	0.04	115	0.16	9.999	20.75	48
Max	0.05	180	0.24	9.999	20.78	52

Table 5: Carbon Monoxide (CO) Emission Characteristics of Two Wheel Gasoline Vehicles (two stroke) (In %)-Without Turbo-charger						
Vehicle Name	Vehicle Model	Idling	25%	50%	75%	100%
Suzuki engine100 cc	2004	0.04	0.03	0.05	0.05	0.06

Table 6: Hydro carbon (HC) Emission Characteristics of Two Wheel Gasoline Vehicles (two stroke) (In %)-Without Turbo-Charger						
Vehicle Name	Vehicle Model	Idling	25%	50%	75%	100%
Suzuki engine100 cc	2004	387	314	296	290	305

bikes were found emitting CO within the prescribed national standard of 4.5%. About 33% of scooters and 83% of motor bikes were found emitting Hydrocarbon within 2000 ppm.

The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact that all scooters tested were having two stroke engines while a few models of motor bikes had four strokes engine as well which do not require pre-mixing of mobile oil in petrol as lubricant.

No national standards are prescribed for Hydrocarbon emissions from vehicles at idling conditions. Here the authors measured the emission characteristics [(Carbon monoxide (CO), Hydro carbon (HC), Carbon dioxide (CO₂) and Oxides of Nitrogen (NO_x)] of Suzuki engine using Gas analyzer.

Variation in CO and Hydrocarbon emissions of two wheel vehicles, i.e., Suzuki engine (Two strokes) at idling engine (With Turbo-charger) conditions and maximum possible load conditions are provided at Tables 7 and 8.

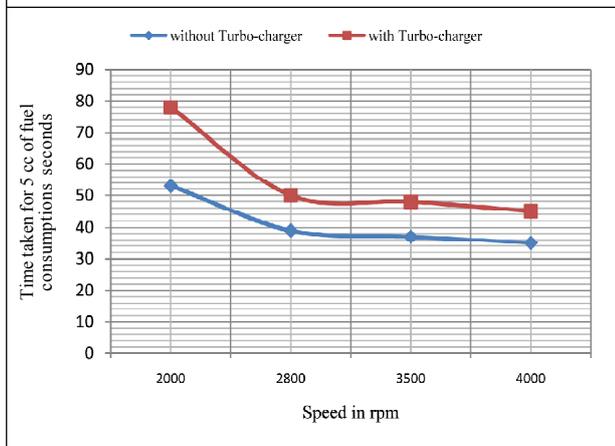
During half throttling about 90% of scooters and 93% of motor bikes were found emitting HC within the prescribed national standard of 2000 PPM. The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact that all scooters tested were having two stroke engines while a few models of motor bikes had four strokes engine as well which do not require pre-mixing of mobile oil in petrol as lubricant.

The characteristic curve for Suzuki engine with and without turbo-charger (Improving efficiency) is shown in Figure 5. During full throttling about

Table 7: Carbon Monoxide (CO) Emission Characteristics of Two Wheel Gasoline Vehicles (two stroke) (In %)-With Turbo-Charger						
Vehicle Name	Vehicle Model	Idling	25%	50%	75%	100%
Suzuki engine100 cc	2004	0.01	0.02	0.03	0.04	0.05

Table 8: Hydro carbon (HC) Emission Characteristics of Two Wheel Gasoline Vehicles (two stroke) (In %)-With Turbo-charger						
Vehicle Name	Vehicle Model	Idling	25%	50%	75%	100%
Suzuki engine100 cc	2004	57	134	185	115	180

Figure 5: Characteristics Curve for Suzuki Engine with and Without Turbo-Charger (Improving Efficiency)



52% of scooters and 47% of motor bikes were found emitting HC not within the prescribed national standard of 2000 PPM. The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact that all scooters tested were having two stroke engines while a few models of motor bikes had four strokes engine as well which do not require pre-mixing of mobile oil in petrol as lubricant.

Advantages

- 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.
- Better Fuel Economy by the way of more power and torque from the same sized engine. A century of development and refinement—For the last century the SI engine has been developed and used widely in automobiles.
- Continual development of this technology has produced an engine that easily meets

emissions and fuel economy standards. With current computer controls and reformulated gasoline, today's engines are much more efficient and less polluting than those built 20 years ago.

- Low cost – The SI engine is the lowest cost engine because of the huge volume currently produced.

Disadvantages

- The SI engine has a few weaknesses that have not been significant problems in the past, but may become problems in the future.
- Difficulty in meeting future emissions and fuel economy standards at a reasonable cost. Technology has progressed and will enable the SI engine to meet current standards, but as requirements become tougher to meet, the associated engine cost will continue to rise.
- Throttling loss lowers the efficiency – To control an SI engine, the air allowed into the engine is restricted using a throttling plate.
- The engine is constantly fighting to draw air past the throttle, which expends energy.
- Friction loss due to many moving parts .The SI engine is very complex and has many moving parts. The losses through bearing friction and sliding friction further reduce the efficiency of the engine.
- Limited compression ratio lowers efficiency – Because the fuel is already mixed with the air during compression, it will auto-ignite (undesirable in a gasoline engine) if the compression ratio is too high. The compression ratio of the engine is limited by the octane rating of the engine.
- Lack of response called the Turbo Lag. If the

turbo is too big, the boost will build up slowly because more exhaust pressure 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. Non liner rise in power and torque. Cost, Complexity: Turbocharger spins at very high revolutions (1 lakh per minute) So proper cooling and lubrication is essential if it not to destroy the engine.

CONCLUSION

We have designed and fabricated a prototype of the Turbocharger was implemented in Two-wheeler, In which the efficiency of the Engine can be increased .Thus we have developed a method to increase the efficiency of the engine and at the same time to control the Emissions from the engine. The experimental setup of block diagram is shows the arrangement of turbocharger in two-wheeler. This type of engine will be more efficient than existing engines.

This work 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. The first hybrid on the market will cut emissions of global-warming pollutants by a third to a half and later modes may cut emissions by even more.

To conclude, the benefits of turbocharging are:

- Increased engine power output (in the region of 50% increase)
- Improved fuel consumption (improved pressure balance across the engine)
- Altitude compensation
- A very high percentage of two wheel gasoline vehicles (48%) were found not complying with the prescribed National Emission Standards. The increase in Carbon monoxide and Hydrocarbon emissions by two wheel gasoline engines at accelerated engine speed was quite significant.
- About 90% of scooters and 85% of motor bikes were found emitting CO within the prescribed national standard of 4.5%. About 33% of scooters and 83% of motor bikes were found emitting Hydrocarbon within 2000 ppm.
- During half throttling about 90% of scooters and 93% of motor bikes were found emitting HC within the prescribed national standard of 2000 PPM.
- During full throttling about 52% of scooters and 47% of motor bikes were found emitting HC not within the prescribed national standard of 2000 PPM.
- It was observed that the Carbon monoxide emissions from two wheel vehicles increased from two to three times at the full acceleration engine conditions.
- It was observed that the Hydrocarbon emissions from two wheel vehicles increased from two to four times at the full acceleration engine conditions.
- By the use of turbo charging in two wheelers the power can be enhanced. A properly tuned turbo engine can produce 20% + more power

compared to stock, but expect an increase in fuel consumption.

- 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.
- Automotive oil condition monitoring is far from a mature technology. As this technology progresses and becomes more popular in the automotive industry, there will be many generations of sensors developed to improve accuracy and range of capability.
- While some vehicles come standard with oil change technologies today, the majority do not. The companies developing these sensor technologies must be able to convince the automotive industry and the public of their general reliability and value. If this is successful, we may see condition-based oil changes become the latest trend in vehicle technology over the next few years.

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