Sustainable Development in Two Wheeler using Exhaust Gases

Shrikant Gawas[1], Abhishek Tawde [2], Onkar Raorane[3] , Rehan Prabhulkar[4] , Aditya Hule[5]

[1]Professor, SSPM's college of Engineering and Technology, Kankavli, Maharashtra, India

[2,3,4,5]Student, SSPM's College of Engineering and Technology, Kankavli, Maharashtra, India

ABSTRACT

In present situation everyone needs to ride a high powered, high fuel efficient and less emission vehicles. In this experiment waste heat recovery technology have been developed to recuperate and turn it into subsidiary energy in order to increase the output of the engine along with the generation of electricity. Extensive work and research have been identified in order to utilize waste heat energy using turbocharging. Turbocharging is one of the most widespread methods to increase the power of internal combustion engines (ICE) using e waste exhaust energy. Due to rich air fuel mixture combustion, emissions will be increased. Hence, by implementing the turbocharger, more engine output power can be generated with low environmental emissions. Consequently the main objective of this paper is to assess each waste heat recuperation technology predicated on current developments, research trends and its future in an automotive application.

Keywords: Waste Heat Recuperation, Turbocharging Emissions, Internal Combustion Engine (ICE)

1. INTRODUCTION

Due to growing population, the energy resources are depleting and pollution levels are increasing day-by-day with the progress of civilization. For the past few years the motorcycles sales in India have been growing at faster rates and recently surpassed approximately one million vehicles a month mark. Due to this increase of motorcycles, petrol consumption and emission rate increases day by day with respect to growing population. Viewing from the socioeconomic perspective, as the level of energy consumption is directly proportional to the economic development and total number of population in a country, the growing rate of population in the world today indicates that the energy demand is likely to increase drastically with the same rate [9]. Substantial thermal energy is available from the exhaust gas in modern automotive engines out of which two-third of the energy from the combustion in a vehicle is lost as waste heat, of which 35-45% is in the form of hot exhaust gas. This exhaust coming from the engine contains two energies, i.e. pressure energy and heat energy. Emission rate can be controlled by using exhaust energy recovery and providing proper compressed air into the inlet of cylinder. These conditions can be achieved with help of turbocharger, thermal activator device and dynamo.

1.1 TURBOCHARGER

Turbocharger works on the principle of turbocharging. Turbo-charging, simply, is a method of increasing the output of the engine without increasing its size. 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 the cylinder. the turbo charging 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 (CO_2) emissions.

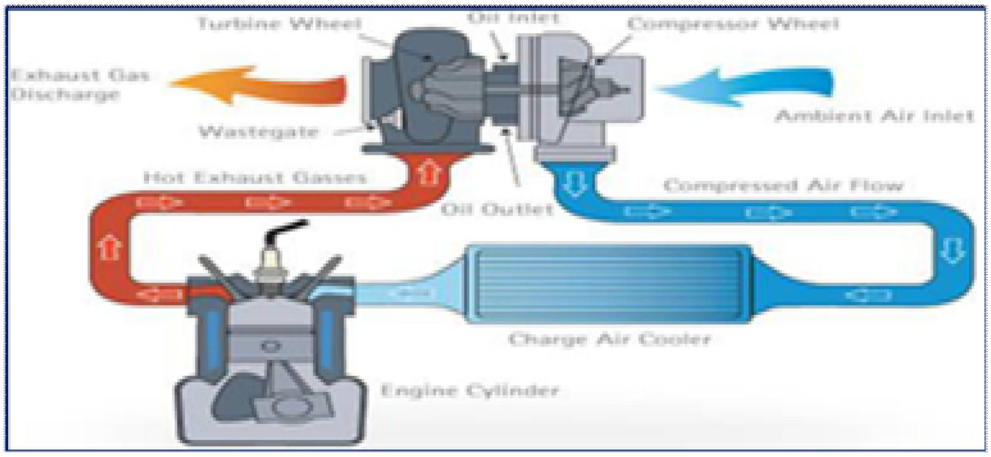


Figure 1 :- Working of Turbocharger [7]

Currently, the primary reason of using turbochargers is the reduced consumption and emission of harmful gases.

1.2 DYNAMO

Dynamo is an electrical generator. This dynamo produces direct current with the use of a commutator. Dynamo were the first generator capable of the power industries.The dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. On small machines the constant magnetic field may be provided by one or more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.

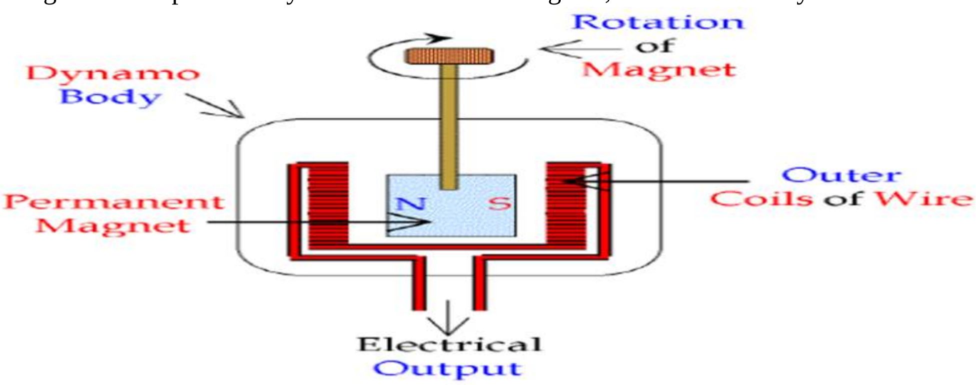


Figure 2 :- Dynamo [8]

The commutator was needed to produce direct current. When a loop of wire rotates in a magnetic field, the potential induced in it reverses with each half turn, generating an alternating current. However, in the early days of electric experimentation, alternating current generally had no known use. The few uses for electricity, such as electroplating, used direct current provided by messy liquid batteries. Dynamos were invented as a replacement for batteries. The commutator is a set of contacts mounted on the machine's shaft, which reverses the connection of the windings to the external circuit when the potential reverses, so instead of alternating current, a pulsing direct current is produced.

1.3 THERMAL ACTIVATOR DEVICE

The thermal activator device is a thermally activated device connected between engine head and air filer which uses hot air from engine head and creates ionized and reactive oxygen to ensure full combustion of fuel through chemical process taking place inside it and delivers ionized oxygen between carburetor and air filter.

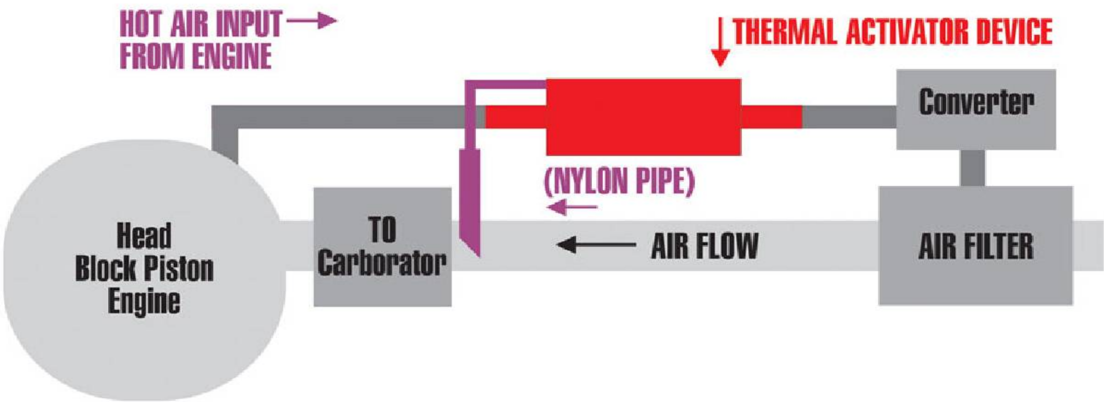


Figure 3 :- Thermal Activator Device

2. LITERATURE REVIEW

Muqeem et. al., [2015] concluded that the objective of turbocharger is to enhance the output of an internal combustion engine without increasing the cylinder capacity. The application of a turbocharger is to improve an engine's volumetric efficiency by increasing the density of the intake gas (usually air, entering the intake manifold of the engine) along with to improve the engine efficiency and emissions as much as possible.

J. Dass et. al., [2013] developed a prototype of turbocharger fabrication in two wheeler engine, in which the efficiency of engine can be improved and at the same the emissions from the engine can be controlled.

A. Gritsenko et. al., [2015] developed a hydraulic accumulator combined with a braking device which minimizes the risk of dry friction and emergency failures of the turbocharger. A hydraulic accumulator used in the lubrication system of the ICE turbocharger ensures the regular lubricating and cooling of the rotor bearings when the engine crankshaft rpm drop, as well as it stops in case of its overload at the rotor slowing down mode. A braking device makes it possible to reduce the rotor slowing time for preventing oil starvation and dry friction of the rotor bearing.

A. Feneley et. al., [2016] concluded that variable geometry turbocharging (VGT) at its most basic level is the first step up from standard fixed geometry turbocharger systems. This study details the range of prominent variable geometry technologies that are commercially available or openly under development for both turbines and compressors. Along with prominent diesel engine boosting systems, attention is given to the control schemes employed and the actuation systems required to operate variable geometry devices, and the specific challenges associated with turbines designed for gasoline engines.

E. Corti et. al., [2015] demonstrated that instantaneous turbo speed (i.e. the knowledge of both mean value and fluctuation) can be used to extract information about power delivered by the turbine. The author presents an innovative ,methodology for instantaneous turbo speed estimation. The presented algorithm is based on the analysis of the signals coming from one accelerometer mounted on the compressor diffuser, or from one microphone facing the turbocharger.

G. Balasubramanian et. al., [2015] developed a methodology of generating electrical power using IC engines exhaust gas and performance analysis was conducted by the charging vehicle battery by using bike exhaust gas. The experimental study shows how the kinetic energy of exhaust gas is converted into electrical energy.

Rakopoulos et. al., [2011] developed a computer analysis for studying the energy and availability performance of a turbocharged diesel engine, operating under transient load conditions. The model incorporates many novel features for the simulation of transient operation, such as detailed analysis of mechanical friction, separate consideration for the processes of each cylinder during a cycle (‘‘multi-cylinder’’ model) and mathematical modeling of the fuel pump. This model had been validated against experimental data taken from a turbocharged diesel engine, located at the authors’ laboratory and operated under transient conditions. The availability terms for the diesel engine and its subsystems were analyzed, i.e. cylinder for both the open and closed parts of the cycle, inlet and exhaust manifolds, turbocharger and aftercooler. The

IPASJ International Journal of Computer Science (IIJCS)
Web Site: http://www.ipasj.org/IIJCS/IIJCS.htm
A Publisher for Research Motivation .... Email: editoriijcs@ipasj.org
Volume 5, Issue 2, February 2017 ISSN 2321-5992

present analysis reveals, via multiple diagrams, how the availability properties of the diesel engine and its subsystems develop during the evolution of the engine cycles, assessing the importance of each property.

3. Experimental Setup

In the setup inlet turbine housing of the turbocharger is connected to the engines exhaust outlet pipe at the downward turning section. The turbine is coupled to a compressor, which is used to compressed ambient air. Depending upon the exhaust flow the turbine will start rotating and then drives the compressor which also start to rotate. The exhaust flow coming out from turbine housing is then routed to the atmosphere with the help of silencer. At the outlet of the silencer, turbine is placed in the path of the exhaust. The turbine is connected to a dynamo, which is used to generate power. Depending upon the airflow the turbine will start rotating, and then the dynamo will also starts to rotate. A dynamo is a device which is used to convert the kinetic energy into electrical energy. The generated power is stored in the battery. The hot air from engine head is connected to one end of the thermal activator device (TAD) and other end is given to the air filter. Then the one nylon pipe of TAD is injected in between the carburetor and air filter, other is kept open to the atmosphere.

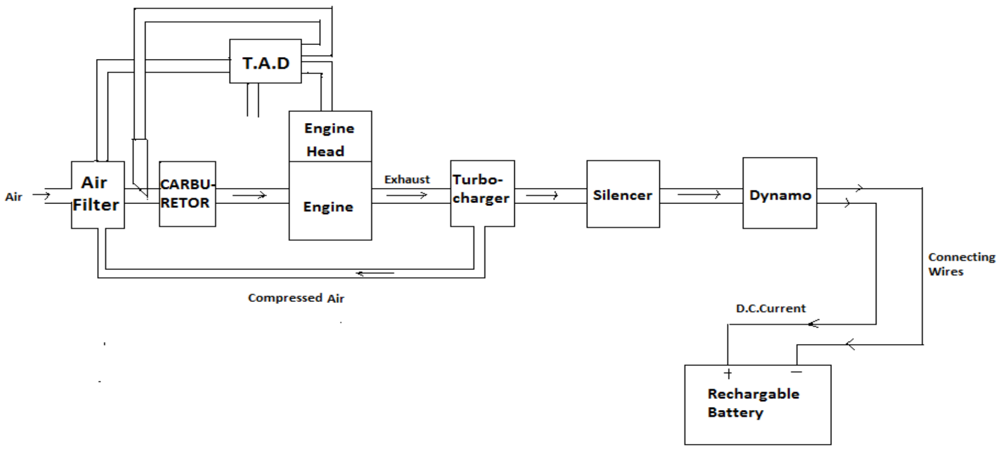


Figure 4 :- Schematic Diagram

Figure 5 :- Turbocharger and TAD arrangement

Figure 6 :- Dynamo arrangement

3.1 ENGINE SPECIFICATION

Type : 4 stroke, single cylinder, DTS-i
Displacement : 149.1 cc
Max power : 15.06 PS @ 9000 RPM
Maximum Torque : 12.5 Nm @ 6500 RPM
Max. Speed :115 Kmph
Bore : 57.0 mm
Stroke : 56.4 mm
Cooling system : Air Cooled
Fuel Type : Petrol
Arrangement : Horizontal
Compression ratio : 9.5: 1

1.1 TESTING

Table 1 :- Average Test

SR. NO.	FUEL QUANTITY	TRIAL NO.	WITHOUT TURBOCHARGER	WITH TURBOCHARGER	INCREASE IN AVG.	RESULT
1.	100ml	1	3.4 KM	5.5 KM	2.1 KM	2.1 KM
		2	3.6 KM	5.2 KM	1.6 KM	
		3	3.2 KM	5.8 KM	2.6 KM	
2.	200ml	1	6.6 KM	10.7 KM	4.1 KM	4.2 KM
		2	6.8 KM	11.0 KM	4.2 KM	
		3	7.0 KM	11.3 KM	4.3 KM	
3.	500ml	1	17.4 KM	27.8 KM	10.4 KM	10.3 KM
		2	17.0 KM	27.2 KM	10.2 KM	
		3	17.2 KM	27.5 KM	10.3 KM	
4.	750ml	1	25.5 KM	41.3 KM	15.8 KM	15.8 KM
		2	25.6 KM	41.0 KM	15.4 KM	
		3	25.4 KM	41.6 KM	16.2 KM	

Table 2 :- Efficiency Test

SR. NO.	SPEED (km/hr)	TIME TAKEN FOR 250ml FUEL CONSUMPTION (sec)	
		WITHOUT TURBOCHARGER	WITH TURBOCHARGER
1.	30	611	829
2.	40	527	715
3.	50	475	593
4.	60	410	520

Table 3 :- Emission Test

	Without Turbocharger	With Turbocharger
CO (%)	1.42	0.60
HC (ppm)	1260	707
CO_2 (%)	1.00	0.80

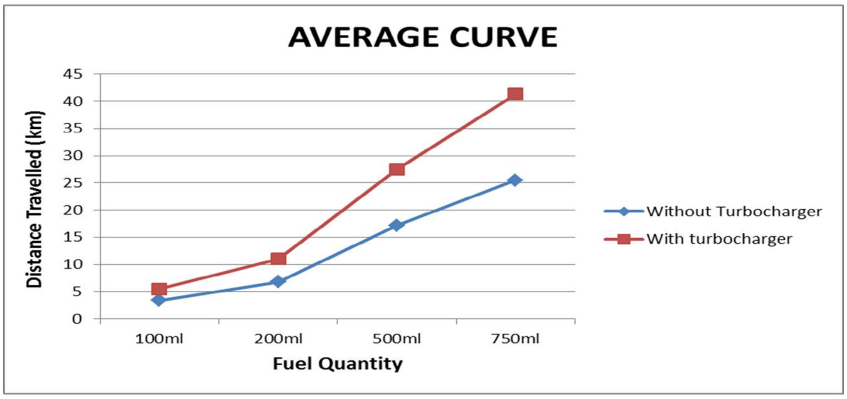
2. RESULTS AND DISCUSSION

Table 4 :- Average Result

SR. NO.	FUEL QUANTITY (ml)	DISTANCE TRAVELLED (km)	
		WITHOUT TURBOCHARGER	WITH TURBOCHARGER
1.	100	3.4	5.5
2.	200	6.8	11
3.	500	17.2	27.5
4.	750	25.5	41.3

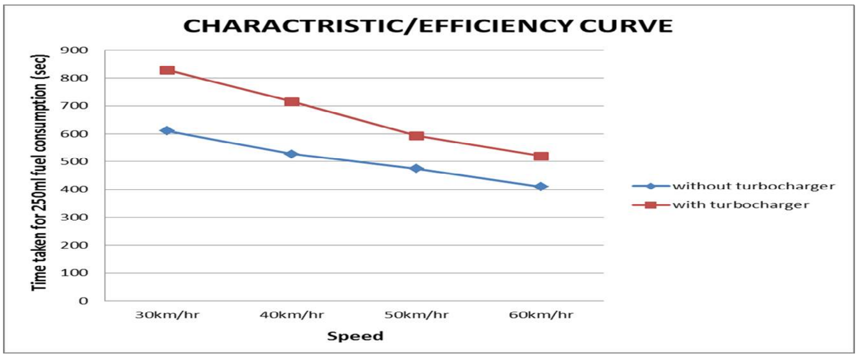
Table 1 and Table 4, shows the average of the vehicle increased after implementing the turbocharger to the vehicle about 18 to 20 km per litre of fuel.

IPASJ International Journal of Computer Science (IIJCS)
A Publisher for Research Motivation ....
Web Site: http://www.ipasj.org/IIJCS/IIJCS.htm
Email: editoriijcs@ipasj.org
Volume 5, Issue 2, February 2017
ISSN 2321-5992



Graph 1 :- Average Curve

Graph 1, shows the comparisons of distance travelled with respect to fuel quantity before implementing turbocharger and after implementing turbocharger in the vehicle. From the graph we can see the increment in the average when we used turbocharger in the vehicle.



Graph 2 :- Characteristic/Efficiency Curve

Graph 2, shows the comparisons of time taken for 250ml fuel consumption with respect to speed of the vehicle before implementing and after implementing the turbocharger in the vehicle. From the graph we can see the increment in the time taken for fuel consumption with respect to a particular speed with turbocharger implemented in the vehicle.

From table 3, it is observed that carbon monoxide and hydro carbon emissions along with CO_2 is reduced with the used of turbocharger along with Thermal activator device in the vehicle protecting the environment from the harmful gases.

3. CONCLUSION

From the study, it has been identified that there are large potentials of energy savings through the use of waste heat recovery technologies. Waste heat recovery entails capturing and reusing the waste heat from internal combustion engine (ICE) and using it for generating mechanical or electrical work. It would also help to recognize the improvement in performance and emissions of the engine if these technologies were adopted by the automotive industry. The study also identified the potentials of the exhaust gas when incorporated with other devices to maximize the power and efficiency of the vehicles along with the generation of electricity improving the fuel economy to a greater extent.

References

[1] Mohd Muqeem, Dr. Mukhtar Ahmad, Dr. A. F. Sherwani, "Turbocharging of Diesel Engine for Improving Performance and Exhaust Emissions: A Review," IOSR Journal of Mechanical and Civil Engineering ISSN: 2278-1684. Volume 12, Issue 4, Ver. III, July-August 2015, PP 22-29.

[2] Amalorpava Dass. J, Mr.Sankarlal. P, "Fabrication And Implementation of Turbo Charger In Two-Wheeler," International Journal Of Computational Engineering Research (ijceronline.com) Vol. 3, Issue. 3, March 2013.

[3] Alexander Gritsenko, Konstantin Glemba, Aleksey Plaksin, "Modernization of the Turbocharger lubrication system of an internal combustion engine," Procedia Engineering 129 (2015) 857 – 862, (www.sciencedirect.com) (http://creativecommons.org/licences/by-nc-cd/4.0/).

[4] Adam J. Feneley, Apostolos Pesiridis, Amin Mahmoudzadeh Andwari, "Variable Geometry Turbocharger Technologies for Exhaust Energy Recovery and Boosting- A Review," Renewable and Sustainable Energy Reviews, (www.elsevier.com/locate/rser) (http://dx.doi.org/j.ser.2016.12.125) , Dec. 2016.
[5] E. Corti, D. Moro, F. Ponti, V. Ravaglioli, N. Cavina, A. Cerofolini, "Automotive turbochargers power estimation base don speed fluctuation analysis,"Energy Procedia 82 (2015) 103 – 110, (www.sciencedirect.com).
[6] G. Balasubramanian, P. Balashanmugam, K. Kumaravel, "Study and performance analysis of charging vehicle battery using bike exhaust gas," IJRDO-Journal Of Mechanical And Civil Engineering ISSN: 2456-1479, Volume-1, Issue-4, April 2015, PP-12.
[7] C.D. Rakopoulos, E.G. Giakoumis, "Availability analysis of a turbocharged DI diesel engine operating under transient load conditions" Energy 29 (2011) 1085–1104, (www.elsevier.com/locate/energy).
[8] S. Vijaya Kumar, Amit Kumar Singh, Athul Sabu, Mohamed Farhan. P, "Generation of Electricity by Using Exhaust from Bike," International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 4, Special Issue 6, May 2015.
[9] Kranthi Kumar Guduru, Yakoob Kol ipak, "Power Generation by Exhaust Gases On Diesel Engine," International Journal of Research and Computational Technology ISSN: 0975-5662, Vol.7, Issue.5, Dec, 2015, Page:06-13.

AUTHOR

Shrikant Gawas completed the B.E. degree from Rajendra Mane college of Engineering and Technology in 2011 and pursing M.E. degree in Heat Power.