Design and Development of an Integrated System for the Conventional Two and Four Wheeler by using High Pressure of Exhaust Gases

Mintu Giri
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Sagar wadhwani
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Rohit Kumar
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Vikas Kumar Maurya
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Nawneet Tiwari
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Prof. Surendra Agrawal.
H.O.D, Mechanical Department
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Abstract - This paper is an attempt to present the new concept of utilizing the exhaust generated from the two and four wheeler during the exhaust and through this system the recovery of the waste heat from the conventional commercial two wheeler and four wheeler is done. In this project a 125 cc engine bike is used and its exhaust manifold is coupled to the turbine inlet with the help of an injector nozzle and the outlet of turbine shaft is connected to the generator to produce electricity, this generated ac current is converted into dc and stored in the battery. Experimental analysis is done on the such designed and developed hybrid vehicle system and observed that the results which was better than the earlier developed systems.

Keywords: hybrid vehicle, exhaust manifold, injector, experimental analysis ,turbine

I. INTRODUCTION

Transportation is the main cause of pollution, exhaust gases produced when the vehicle move on the road which pollute the environment. To assure sustainability and more confidence on energy supply, the European Union has studied a careful energetic policy for the next ten years, whose aim is to reduce greenhouse gas levels and energy consumption by 20% and increase the share of renewables by 20%, all these three targets by 2020.[1]

Even every country is emphasizing to use the renewable energy sources. but harnessing the renewable energy is very difficult. If the renewable energy source is harnessed on the large scale then it will be beneficial to the country otherwise capital investment is more than the electrical energy production.

So for the protection of environment and enhancement of energy produced from the vehicle we are introducing a very new methodology which will be helpful to reduce the consumption of conventional energy i.e petrol, diesel, gas etc.

The waste heat containing exhaust gases from the conventional two wheeler and four wheeler are recovered in three different methods

i)By introducing an additional combustion chamber to inject the additional suitable fuel and then allow it to expand which forms the part of turbo charger unit.And this additional fuel is burnt through the waste heat from the exhaust.[9]
ii) Waste heat can be used to produce the electrical energy by using a thermoelectric generator.
iii)In the third methodology energy recovery can be done by coupling a compressor and an alternator to the turbine shaft for the production of electrical energy and air is compressed which can be used for running any auto auxiliaries.
Cogeneration is the method of simultaneous production of heat and other form of energy in a process. Many cogeneration techniques have been employed in IC engines to recover the waste heat. Turbo charging is also a kind of waste heat recovery technique in which the exhaust gases leaving the engine are utilized to run a turbine to produce power.[9]
We are using the high pressure jet of exhaust from the IC engine to run the vehicle.

Working Principle

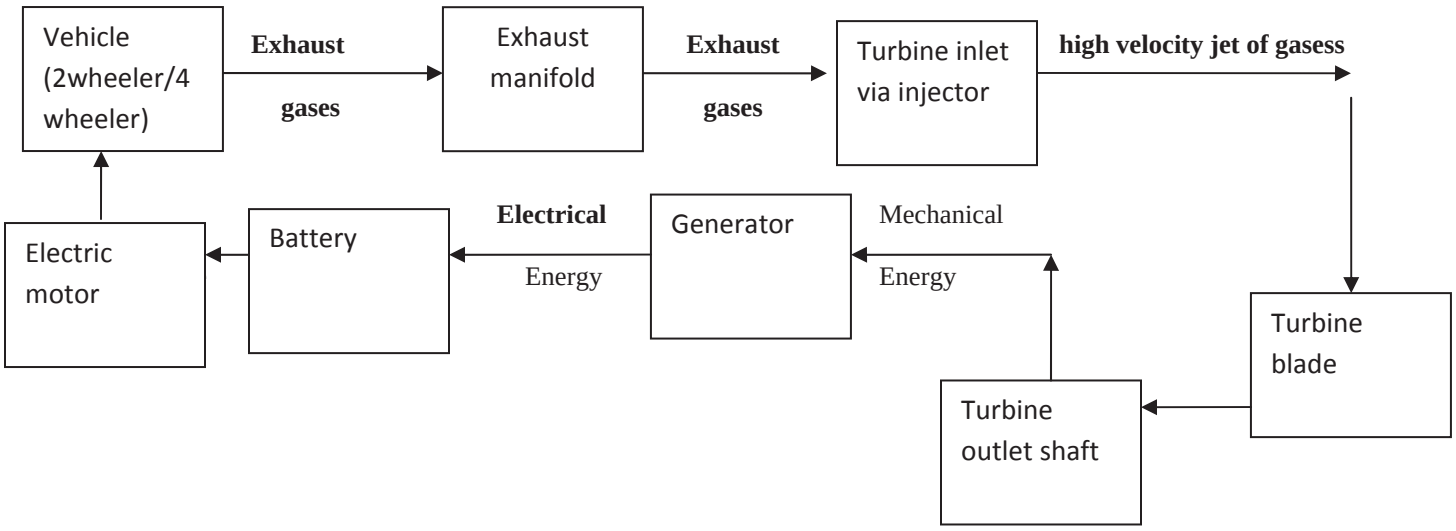

Fig.1 Schematic arrangement of different component

This arrangement is showing that how the designed system will work exhaust containing the hot flue gases these gases are injected through the injector to the turbine then turbine rotor which is already keyed to the generator through the shaft and mechanical energy is converted into the electrical energy and this produced energy is stored into the battery.And this battery is connected to the Electric motor which will work as a power for the vehicle to move on.

System description

1.Exaust system

An exhaust system is usually piping used to guide reaction exhaust gases away from a controlled combustion inside an engine or stove. The entire system conveys burnt gases from the engine and includes one or more exhaust pipes. Depending on the overall system design, the exhaust gas may flow through one or more of:

- Cylinder head and exhaust manifold
- A turbocharger to increase engine power.
- A catalytic converter to reduce air pollution.
- A muffler / silencer , to reduce noise.

II.TURBINE ROTOR

Turbine is designed in such a manner that it can be attached to the exhaust nmanifold of a vehicle.To produced the mechanical energy a high velocity jet of exhaust gases is introduced in the turbine through the inlet of the turbine which is already attached to the injector.

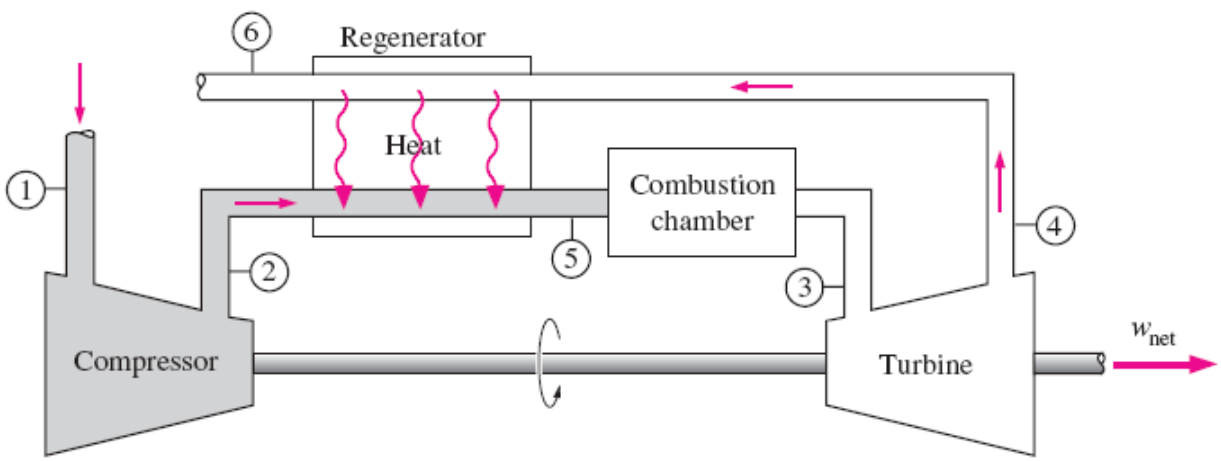

Fig.2 working principle of a turbine[1]

III.ELECTRIC MOTOR

The chosen architecture for the electric motor is the Surface Permanent Magnet Synchronous Motor, which can assure a high torque density with reduced weight and space required. The electrical machine has its rotor keyed to the drive shaft of the internal combustion engine, and is capable to supply torque MOSIM'12 - June 06-08, 2012 - Bordeaux – France such that the overall engine torque for the hybrid vehicle.[8]

IV.BATTERIES

The battery pack has been designed considering Lithium-Polymer cells, which have the advantages of not being ammable and to have a exible structure that can assure a smarter usage of the available space.

V.GENERATOR

There are two main types of generators.
(1) **Direct-current (DC) generators** produce electric current that always flows in the same direction.
(2) **Alternating-current (AC) generators**, or alternators, produce electric current that reverses direction many times every second.
Both kinds of generators work on the same scientific principles. But they differ in the ways they are built and used.

How a Generator Works

Basic Principles. A generator does not create energy. It changes mechanical energy into electrical energy. Every generator must be driven by a turbine, a diesel engine, or some other machine that produces mechanical energy. For example, the generator in an automobile is driven by the same engine that runs the car.

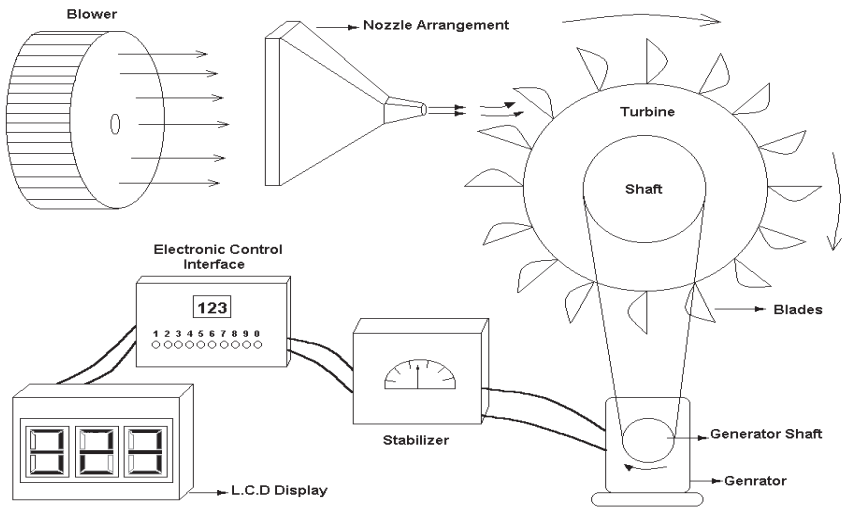

Fig.3 System arrangement[1]

Designing of the system

Let us first define all the design parameters.

1) Let d = diameter of nozzle of pump.

2) Let V1 = velocity of water jet supply by the pump.

3) Let A = cross sectional area of the nozzle.

4) Let Q = discharge of water from the nozzle.

5) Let D = diameter of the turbine wheel (Model).

6) Let H = head required to drive the turbine.

7) Let S.P. = shaft power required to be derived from the motor.

8) Let ρ = density of water.

9) Let C_v = coefficient of velocity.

10) Let g = acceleration due to gravity.

11) Let η = efficiency desired from the turbine.

Dates/Values to be kept constant:

1) Diameter of the nozzle 'd' = 1 c.m. or 0.01 m.

2) Efficiency desired to be obtained by the turbine as according to most of the cases is taken a modest 80% (η = 0.8).

3) According to the centrifugal pump chosen by us, using hit & trial method we came to the conclusion that the turbine model should have a diameter of 17 c.m. (D = 17c.m. = 0.17 m.)

4) Density of exhaust = kg/m.^{3}

5) Shaft power to be derived = S.P. = 4 volts.

6) Coefficient of velocity = Cv = 0.985

7) Acceleration due to gravity = g = 9.81 m./sec^2

Design calculations [8]

Overall efficiency = $\eta = \dfrac{(S.P.)}{(\rho.g.Q.H/1000)}$ ----------(1)

Discharge of the air jet = Q = Area of jet × Velocity of the jet

$Q = A.V1$ ----------(2)

Now value of $A = \pi/4.(d)^2$

Our main aim is to find the value of the discharge of air required to run the turbine efficiently i.e. without any vibrations or imbalances.

Therefore, we will go about the calculation as per the following procedure:

Overall efficiency = $\eta = \dfrac{(S.P.)}{(\rho.g.Q.H/1000)}$ ----------(1)

Discharge of the air jet = Q = Area of jet × Velocity of the jet

$Q = A.V1$ ----------(2)

Now value of $A = \pi/4.(d)^2$

Substituting the value of 'd' in A, we get

$A = \pi/4.\ (0.01\times0.01) = 7.85 \times 10^{-5}$ ----------(3)

Substituting the value of A from (3) to (2), we get

$Q = 7.85 \times 10^{-5} \times V1$ ----------(4)

As we are using exhaust from the vehicle to supply energy, we will have to find the value of head (H)

Therefore, from formula

$$H = \frac{V1^2}{Cv^2 . 2g}$$

Substituting the value of C_v and g in the above equation, we get

$$H = \frac{V1^2}{Cv^2 . 2g} = \frac{V1^2}{(0.985 \times 0.985 \times 2 \times 9.81)}$$

$$H = \frac{V1^2}{19.036} \quad \text{----------(5)}$$

Substituting the value of H in terms of V1 from equation (5) and the value of Q in terms of V1 from equation (4), in equation (1), we get

$$\eta = \frac{(S.P.) \times 1000}{(\rho.g.Q.H)}$$

$$0.8 = \frac{(0.4 \times 10^{-3}) \times 1000}{(1000 \times 9.81 \times 7.85 \times 10^{-5} \times V1 \times V12)}$$

Which finally gives, $V_1 = 50$ m. /sec. ----------(6)

Now, we can use this value of $V_1$to find the discharge from the jet.
Substituting the value of V_1 from equation (6) to equation (4), we get the following result:

$Q = 7.85 \times 10^{-5} \times V_1$

$Q = 7.85 \times 10^{-5} \times 50$

$Q = 0.003925$ m.^{3}/sec. $\Rightarrow Q \approx 0.004$ m.^{3}/sec.

Basic Design Conclusions:

On the basis of above calculations, we can conclude that,

To efficiently run our turbine of 17 c.m. diameters a discharge of 0.004 $m.^3$/sec. is required.

Following are the *additional considerations* that are taken for this system in relevance to this design:

1) If the quantity of discharge of Exhaust is known, the specifications of a turbine can be found upto a certain practical limit because larger turbines will not be able to run on the exhaust.
2) Also the material of the turbine should be as light as possible so as to make the turbine more efficient and work friendly.
3) The turbine should be made up of a material, which is also very strong and therefore should not break during its operation.
4) The supply of the exhaust gases must be constant so as to smoothly operate the prime mover.
5) The constant supply of the exhaust gases will also ensure an unfluctuating voltage output. This will help in better performance of the system.
6) We recommend using **fiber/plastic** as the material to make a strong and light turbine. Because use of any other heavy material will not ensure such smooth and efficient working of the prime mover.
7) The pulley and the turbine should be well balanced statically as well as dynamically for efficient working of the turbine.
8) The shaft diameter should be taken to an appropriate value so as to reduce the relative number of revolutions on the turbine shaft, required to rotate the generator shaft.

VI. RESULT AND DISCUSSIONS

In order to find out the feasibility of running a DC dynamo by the turbo charger, the engine was allowed to run at different speeds .the output of the generator was also noted.

Table:1 Experimental Data

Engine Speed in RPM	1200 RPM	1800 RPM	2400 RPM	3500 RPM	4000 RPM
Output voltage of the Alternator	----	-- ----	9.0V	11 V	

Power produced by the electrical machine
Power (P) = Voltage x Current
= 11 V x 0.48 A
= 5.48 Watts

BHP Produced = 5148 Watts

Table: 2 Energy split data as applied to the test engine

Total power given by fuel	Useful power at crank shaft	Frictional losses	Cooling losses	Exhaust gases
100 %	25%	5%	30%	40%
20592 Watts	5148 Watts	1029Watts	6178Watts	8237Watts

VII. CONCLUSION

The system which is designed is our attempt to minimize the emissions from the engine and utilize the high pressure exhaust of the exhaust, so that the waste heat recovery system is designed and developed using some specific and suitable design parameters to make the system more powerful and efficient .Power output from the engine is enhanced and compared with the conventional two wheeler . This will carry on in the future because in coming days there will be increase in the demand of fuel efficient engines with more power and zero emissions and this is possible with some advancements in conventional engine technology.

REFERENCES

[1] Mohd Muqeem,Dr. Manoj Kumar "Turbocharging of Ic engine: a review" Volume (4)(2013), pp. 142-149.

[2] J Panting, K R Pullen and R F Martinez-Botas, "Turbocharger motor–generator for improvement of transient performance in an internal combustion engine" Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering 2001 215: 369, DOI: 10.1243/0954407011525700.

[3] S. Shaaban and J. Seume, "Impact of Turbocharger Non-Adiabatic Operation on Engine Volumetric Efficiency and Turbo Lag" Hindawi Publishing Corporation, International Journal of Rotating Machinery, Volume 2012, Article ID 625453, 11 pages, doi:10.1155/2012/625453.

[4] A., Tett, R., and McGuire, *J.*, "Exhaust Heat Recovery using Electro-Turbo generators," SAE Technical Paper 2009-01-1604, 2009, doi: 10.4271/2009-01-1604.

[5] Husain, Q., Brigham, D., and Marienville, C., "Thermoelectric Exhaust Heat Recovery for Hybrid Vehicles," SAE Int. J. Engines 2(1):1132-1142, 2009, doi: 10.4271/2009-01-1327.

[6] Leising, C., Purohit, G., DeGrey, S., and Feingold, J., "Waste Heat Recovery in Truck Engines," SAE Technical Paper 780686, 1978, doi: 10.4271/780686.

[7] http://www.zircotec.com%7CInformation on exhaust heat management.

[8] Fluid mechanics by R.K.Bansal.

[9] S.N.Srinivasa Dhaya Prasad N.Parameshwari " A Feasibility study on waste heat recovery in an IC engine using electro turbo generation" Proceedings of the National Conference on Trends and Advances in Mechanical Engineering, YMCA University of Science & Technology, Faridabad, Haryana, Oct 19-20, 2012