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Generation of Electrical Energy for Charging of a Battery by using Exhaust Gas Energy

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Abstract: ***In present day most of the automobile vehicles runs and depends upon the automotive electronics therefore the need of electrical energy for running the electronics system. By using the exhaust gas energy it can produce the energy or charge the battery or power the electrical systems in different operating conditions. The system assists the existing battery during demand. The gas from combustion engine goes as waste approximately 70%of heat without utilizing properly. An attempt is made to charge the battery and it can use to power the electrical systems by using energy from exhaust gas turbine. It is used for the conversion of heat energy to electrical energy. To charge the battery by using the mechanical power from the engine exhaust manifold turbine without compromising the engine efficiency with limited back pressure. The main aim is to convert the heat energy to electrical energy through turbine which gets the higher out turn energy from the exhaust gases. The exhaust gas is utilized for charging and assisting the electrical system.***

Index Terms: Exhaust gas, Turbine, motor, Electrical systems, Battery.

I. INTRODUCTION

In an internal combustion engine 70 % percentage of energy of the fuel is moved away by the exhaust and some portion of heat loss is increases the engine brake power and reduces the fuel consumption and emissions of the internal combustion engine. The exhaust heat recovery system turns the thermal losses in the exhaust manifold into electrical energy. The heat recovery technology seems to be more and more increased due to the interest by car manufactures. The technology plays a great role to increase the heat energy to electrical energy to save the fuel and reduces the emissions. This technology used in exhaust manifold of the internal combustion engines to produce the electrical energy for the batteries. The technology also can be introducing in hybrid engines and can be introduced in future. The 30 to 35% of energy in fuel is lost as heat in gasoline engines as well in diesel engine 40 to 55% is lost as heat. The Chevrolet had introduced the exhaust heat recovery system in 2016 to accelerate the coolant heat up time. Low amount of fuel is used and emission is reduced and it gives faster heat up of engine coolant which in turn increases the engine heat much faster. In the hybrid vehicle it also warms the battery pack. The cooling system is connected with a heat exchanger placed in the exhaust pipe for converting the exhaust gas to thermal energy to the cooling system.

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Existing system uses the cranking from the IC engines to power or charge the battery at all operating conditions this project deals that instead of taking more power from cranking we can use or power the battery and accessories through the exhaust gas energy [1]. Thermo electric generators are used for generate the electrical energy from thermal energy from exhaust gas. The electrical energy converts to useful energy by using exhaust gas. The single cylinder diesel engine is used for this project and the selection of turbine had made for this project and turbine which is placed at the exhaust manifold and turbine is mounted by housing which is called as turbine housing and the turbine housing has inlet and outlet for the flow of gases [2]. The exhaust gases from the exhaust manifold made to flow over the turbine and the turbine is rotated. The turbine which is connected to the generator or dynamo through the shaft and which is connected from the turbine and the bush is connected between the turbine and generator. Finally the generator is connected to the battery for charging the system and used to energize the auxiliary systems. The generator is used to exit the power from the exhaust heat recovery method. The generation of electric power from the bike and it is used to power the auxiliary units. This device act as a restriction during exhaust flow because of which a small backpressure may be generated [3]. This back pressure can be harmful for engine and engine may work improperly. Thermal storage improves overall efficiency of a waste recovery system and the exhaust gas energy storage is used for charging [4].

II. METHODOLOGY

A. Block diagram

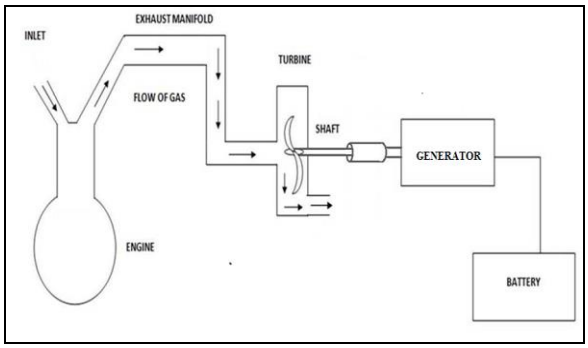

Figure 1. Block diagram of Turbo battery charging system

B. Materials and methods

The existing turbine is used in the exhaust manifold for utilizing the energy from the exhaust gas. The material is used for turbine is alloy steel and shaft is made up of mild steel.

The properties of a material are Temperature stability, High strength, Toughness, Wear resistance, Corrosion resistance, Harden ability. The turbine housing is made up of cast iron and it withstands the high temperature and pressure. The turbine has nine blades and withstands the flow of gases and turbine is coupled with the shaft and housing is used for turbine to increase the flow of gases to pass to the turbine directly and to make the turbine rotate at high speed and to increase the torque of the turbine. The shaft which is made up of mild steel, one end of the shaft is connected to the turbine and the other end is connected to the generator. The generator is connected to the battery through resistance and ammeter which is placed in the circuit.

Figure 2. Turbine blade

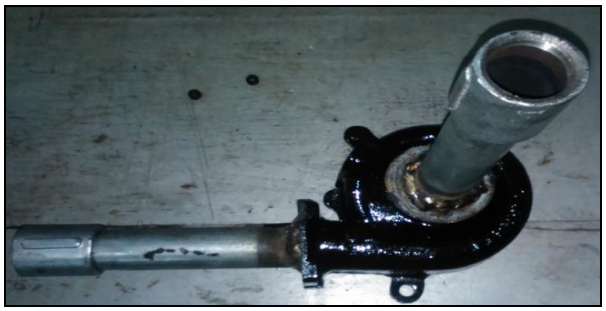

Figure 3. Turbine housing

Shunt wound operates on direct current. The armature and field windings are connected with parallel combination called as shunt and this type of winding is called as shunt winding. The electrical terminology shunts winding used for carrying the loads. Some designs also used for higher voltages to achieve and have better bearing as well higher tolerance designs. They are the best option for high speed and high volume requirements. The detail specification and construction of direct current shunt type motor shown in figure.

Table 1.Specifications of Generator

1	Model	DME44BM6HF MODEL
2	Type	Shunt Wound type generator
3	Commutation	Brushless DC generator
4	Voltage	24v DC
5	RPM	200 to 500 rpm
6	Current	0.3 amps to 4 amps

It contains all the fundamental parts which include stator, rotor, and commutator. The input supply is used for the stationary element of the dc motor and the shunt field windings are made up of several turns of coil of fine gauge wire windings. The turns are made-up of thin wire and the shunt winding is quite smaller in size. Unlikely heavier gauges on the winding in series motors the shunt wounded winding cannot carry very high current.

The advantages are simpler and less maintenance, higher efficiency & more reliable lower heat production & quitter applications industrial application, automotive applications, Robotics, CNC.

III. EXPERIMENTAL SETUP

The experimental setup of turbo battery system is connected to the exhaust manifold end and the flow of exhaust gases pass through this pipe and make the turbine to rotate at all operating conditions. Turbine rotates the shaft and which is connected to the generator or dynamo and the dynamo is twisted and makes the battery to charge and also power the auxiliary accessories such as air condition, lights and etc.The voltage from the generator is measured using multimeter and current is measured by placing the circuit which is connected to load, resistance, rheostat and ammeter. The experimental setup is made for this project and it deals a major role day today of automotive electronics. The turbine which is connected to generator which is opposite to the exhaust pipe. The setup is placed and distance from the exhaust manifold is 15cm to reduce the backpressure of the system. The whole setup which is placed at the end of the tail pope which is used to connect with generator. The generator is balanced by using four bolt joints and acts a prototype setup. The turbine housing is connected by the hand lever which is used to reduce the vibration during engine running and to withstand the backpressure at high engine revolution per minute.

Figure 4. Shows generator coupled

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Figure 5. Shows maximum voltage reading

Table 2.Shows the engine specification

S.NO	PARAMETERS	SPECIFICATIONS
1	Engine Manufacture	kirloskar oil Engines ltd
2	Bore & stoke	87.5mm x 110mm
3	Cylinder	01
4	Compression ratio	17.5:1
5	Speed	Min.1500 rpm
6	Cubic capacity	0.661 liters
7	Cooling method	Water cooling engine
8	Timing of fuel	27 degree BTDC
9	Running at 1500rpm	5.9kw
10	Injection pressure	200 bar

IV. RESULTS AND DISCUSSION

The load indicated in the table while the load increases slightly or gradually the voltage also increases. The temperature and pressure of the single cylinder engine rises, normally. The temperature and pressure of this engine is 300 degree and 2bar this temperature and pressure increases when the load is increased depending upon the operating conditions. Pressure and temperature will vary depending on load conditions as well as voltage will vary. Therefore the voltage should be checked by using multimeter. The voltage is calculated by using the multimeter during variable condition. The below calculation is calculated depends upon the literature survey. The battery used for charging and it is tested and to measure the voltage by using voltmeter. The current is measured by ammeter while energy is recovery made by the exhaust gas. The area of turbine is measured and calculated on the basis of design criteria. The power available at the turbine is calculated by below formula.

Formula

Area of Swept (A) = (3.14) x (radius of turbine) ^{2}

Velocity of the Turbine = (3.14 x D x N)/60

Where,

D= turbine diameter
N= rpm
Turbine power
P= (1/2) x Density x (Velocity) ^{3}xCpxArea

Model Calculation

Swept area (turbine),
Area = 22/7 x (radius) ^{2}
=3.14 x 0.08^2
=0.020096 m^2
Velocity of the turbine, Velocity
= (3.14 x D x N)/60
= (3.14x0.15x45/60)
=0.020096 m2
Power available at the turbine-
=1/2 x Density x Area x Velocity$^{3\,x}$ cp
=0.5 x1.25 x 0.020096 x $(0.35325)^3$ x 0.5
=3.21 x 10^{-5} watts.

Table 3.Shows the engine rpm and power

Engine (Rpm)	Turbine speed (m/s)	Power (watts)
1500	**0.3254**	**$4.222x10^{-5}$**
1800	**0.4254**	**$4.678x10^{-5}$**
2000	**0.4786**	**$5.122x10^{-5}$**
2500	**0.5421**	**$5.122x10^{-5}$**

Table 4.Voltage attained by using Exhaust gas

S.No	Load (Nm)	Time (sec)	Voltage (v)	Current (amp)
1	0	55	18.3	0.3
2	6	40	18.9	1.5
3	12	33	21.8	2.4
4	18	26	22.7	3.2
5	24	23	23.2	4.1

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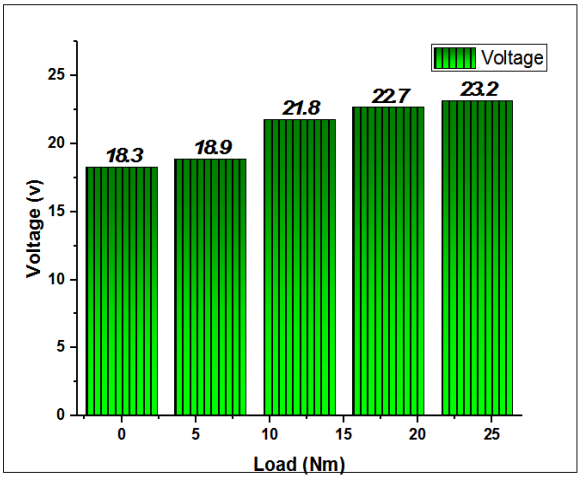

Figure 6. Load vs. voltage

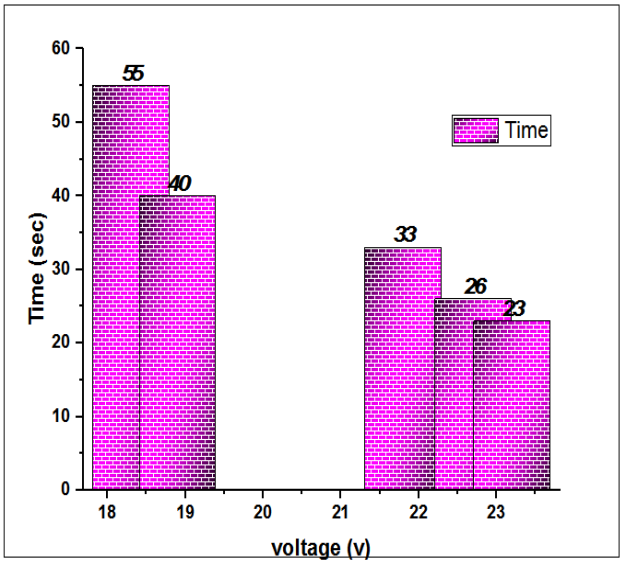

Figure 7. Voltage vs. Time

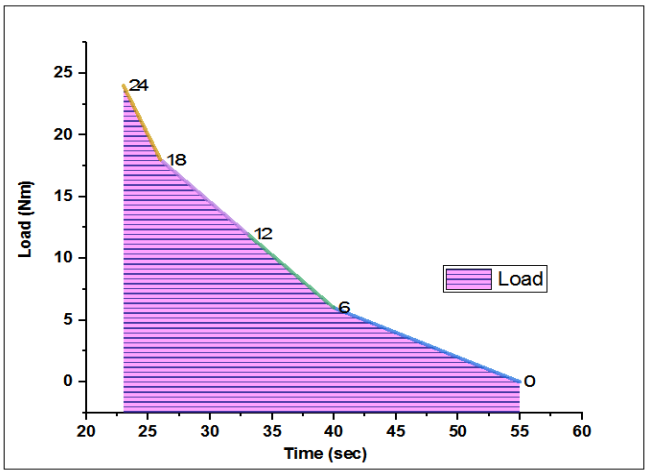

Figure 8. Time vs. Load.

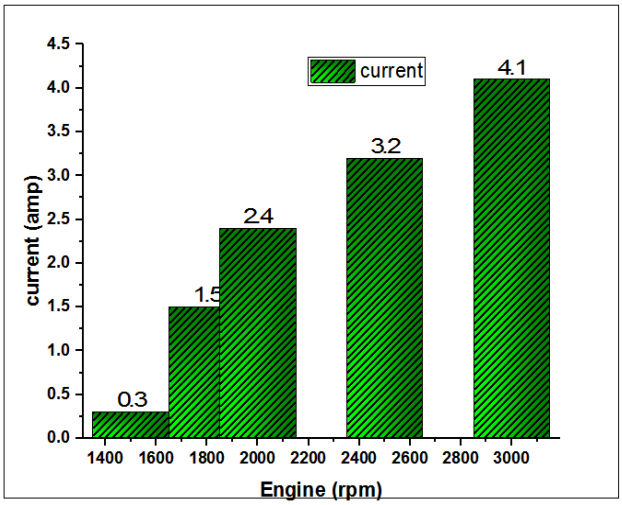

Figure 9. Influence of Engine speed on current.

V. CONCLUSION

The research explains that energy from the exhaust gas is utilized and heat recovery entails and reused the exhaust gas. The combustion engine recognizes the improvement in performance and emissions in future technology. The exhaust gas used to store the electrical energy by using heat energy and it is used for lighting circuits and electrical accessories. The system proposed for utilize the waste energy with limited backpressure. The potential energy is converted to useful energy by using exhaust gas from an engine. The maximum engine speed in 3000 rpm the current produced 4 ampere. This project is cost effective is the important concern. The analysis founds an applicable method from heat energy to electricity and potency of gasoline in an exceedingly vehicle will be improved. Thermoelectric generator is a technology for convalescent waste heat of the vehicle exhaust because it seems smaller, possesses low noise and vibration, needs terribly maintenance is low and has a protracted life. Automobile manufacturers are introducing thermoelectric generator upcoming field. Performance and efficiency of a thermoelectric generator may be different consistent with the modification in speed of the vehicle, engine revolutions per minute and installation position. The normal potency of a thermoelectric generator is 3 to 4 percentage and the most efficiency or potency achieved in automobile.

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