International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Dual Power Generation System from Exhaust

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Abstract - *In the modern trends, automobiles have certain disadvantages such as fuel cost relative to mileage, pollution and less efficiency .The progress of automobiles for transportation has been intimately related to the progress of civilization. In here we are introducing a method to make use of the waste energy from exhaust of vehicles. Our project deals with the idea of electricity generation from the flow or velocity and thermal energy of a vehicle exhaust gas. In this project we are placing a turbine in the path of the exhaust gas flowing from the silencer where its kinetic energy is converted into electrical energy and, a thermoelectric generator(TEG) is also placed in the hottest region of the silencer which converts the heat energy into electrical energy with the help of a booster circuit. The goal of this project was to implement the most efficient and fewer polluting sort of electricity generation from the vehicle exhaust gas itself.. It is also good with regard to economic considerations and engine efficiency.*

Key Words: Exhaust, Thermoelectric generator(TEG), Turbine, Booster Circuit, Efficiency

1. INTRODUCTION

Today, the energy researches are widely done in the world and the automobile is so significant that it consumes more than half of the total energy used by all types of transportation combined. Mathematically, the consumption of energy of automobiles accounts for 52% of all energy used by the entire transportation; less than 35% of the energy in a gallon of gasoline reaches the wheels of a car, the remaining heat is expelled to the environment through exhaust of vehicles . The automobile industry belongs to the world's most important economic sectors. Automobiles use IC engines, which have huge amount of energy loss up to 70% in the form of exhaust gas. In the recent times, scientists have tried and refined the automobile technology appreciably, but could not control and determine the loss of energy from IC engine in the form of waste heat. Vehicle manufactures have been hence obliged to meet these standards by designing cleaner and fuel efficiently engines and through provision for treatment of exhaust gases in a better way to provide useful forms. A better method of utilizing the exhaust gas is discussed in here.

2. OBJECTIVE AND SCOPE OF STUDY

The objective of this project is to provide a better method of utilizing the waste energy in a useful form. Thermoelectric generator and turbine are the prime components used to generate electricity using the waste heat and flow velocity of exhaust gas. In the present state on most of the vehicles vast amount of energy have been lost through exhaust. The design described here will help us to conserve and minimizes the loss of waste energy and can be utilized for different purposes.

3. DESIGN CHALLENGES

The major challenges in the design were the construction of the frame in order to allocate the different components used for the design. Stress Strain analysis need to be done in order to determine whether the frame will be able to support the components. Proper dimensions and cross section of base support of frame is to be calculated in order to reduce the vibrations created by the engine. Correct alignment of turbine at the exit of the exhaust pipe is to be done in order to maximize the kinetic energy obtained from it. The scorching portion of exhaust pipe need to be decided to place the thermo electric generator in order to absorb maximum heat from it and at the same time there was a suspicion that whether the booster circuit can provide a sustainable voltage.

4. COMPONENTS USED FOR FABRICATION

4.1 Frame

Mild Steel is the base material used for fabrication of frame. Different machining process like electric arc welding and grinding had been done to construct the frame, the main purpose of the frame is to support the different components of design.

Figure-1: Basic Frame

4.2 Engine

An engine is the most dominant part of an automobile designed to convert one form of energy into mechanical energy. There are two types of engine, internal combustion engine and external combustion engine. Here we are using the petrol engine for converting the waste energy into useful form. In an IC engine the combustion of a fuel occurs with an oxidizer such as air in a combustion chamber. In an IC engine during the combustion of fuel, high temperature and pressurized gases apply significant force to components of the engine, such as the pistons and thereby generates mechanical work.

In our design, the engine of Hero Honda Splendor is used having a displacement of 97.20 cc, four stroke air cooled engine which produces 7.44 BHP at 8000 rpm.

Figure-2: Hero Honda Splendor Engine

4.3 Sprocket and Chain drive

A sprocket is a toothed wheel that is fixed to a shaft. the rotation of sprocket on a shaft is prevented by a key that fits into keyways in the sprocket and shaft. A chain is used to connect two sprockets. One sprocket is the driver sprocket and the other sprocket is the driven sprocket.

In here, a cycle chain sprocket is used. The chain sprocket is coupled with another shaft. The chain helps to convert the rotational power to pulling power, or vice versa, by engaging with the sprocket.

Figure-3: Sprocket and Chain drive

4.4 Turbine

In here an Impulse turbine is used to convert the kinetic energy of the exhaust into mechanical energy. The conversion is generally accomplished by passing the stream of hot gases through a system of stationary passages or turbine blades. By aligning the blades of turbine at accurate position the intensity of tangential force or torque exerting on the blades can be increased and wide amount of energy can be produced.

Figure-4: Impulse Turbine

4.5 Dynamo

A dynamo is an electrical generator that produces direct current with the help of a commutator, it mainly works by the principle of electromagnetic induction. In our design we are using a dynamo of 12 volt to convert the mechanical energy produced from turbine to electrical energy.

4.6 Thermoelectric Generator

Thermoelectric generators are devices that convert heat energy from temperature differences across hot surface and cold surface directly into electrical energy and this phenomenon is known as Seebeck effect (a form of thermoelectric effect).The Seebeck Effect produces measurable amounts of voltage and current. It consists of a P- type and N- type semiconductor, diffusion of charges across the semiconductors creates a voltage potential and is directly proportional to temperature difference.

In here, we are using two modules of TEC1 12706 which are connected in a parallel arrangement and is fixed on to an aluminum heat sink. The arrangement is placed on the bent portion of exhaust pipe to absorb the maximum heat from the exhaust gas passing through it.

Figure-5: Thermoelectric generator modules

4.7 Booster Circuit

In here we are using the circuit to amplify the voltage obtained from TEG modules. In the experiment we can identify that voltage produced from TEG modules are very low (2-3 volt). Circuit will boost the output voltage obtained from it to 12 volt.

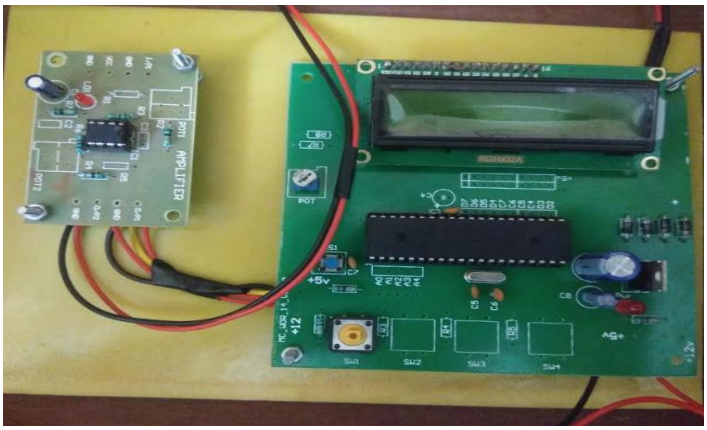

Figure-6: Booster Circuit

4.8 Battery

Lead acid battery is used for the design. it provides the power source for operating the booster circuit. The battery which consists of sponge lead and lead peroxide for converting the chemical energy into electrical power is called a lead acid battery. In here the battery is used to provide a power source for booster circuit for operating it.

Figure-7: Lead Acid Battery

5. EXPERIMENTAL SETUP

The working of the design of power generation from exhaust gas with TEG and turbine is very simple as its construction. Different components required to produce the final output are fixed at the required position. The final output of the design depends on the inlet source which is the waste energy produced during the operation of an engine.

The working of the IC engine in this project has the same working as the normal IC engine for the combustion of the fuel and the air inside the combustion chamber. Here we are using a four stroke petrol engine in order to perform the power generation from waste heat. Inside the engine the fuel energy is converted into useful work and the exhaust gases are released through the exhaust valve and are provided to the atmosphere through a silencer. In this design we are using the waste heat and flow velocity carried out by the exhaust gas for the generation of the power supply.

5.1 Electricity generation from heat energy of exhaust gas

In the bent portion of the silencer we are fixing the TEG for the power generation from the exhaust heat. The TEG is the element used for the power generation which converts the heat energy of the gas into the electrical power by the thermoelectric effect. One of the side of the TEG will be in contact with silencer for absorbing the heat from the exhaust and the other side will be in a cold state, due to this temperature difference a voltage potential is generated and is connected to a boosting circuit to amplify the obtained voltage from TEG and can be used for different purposes.

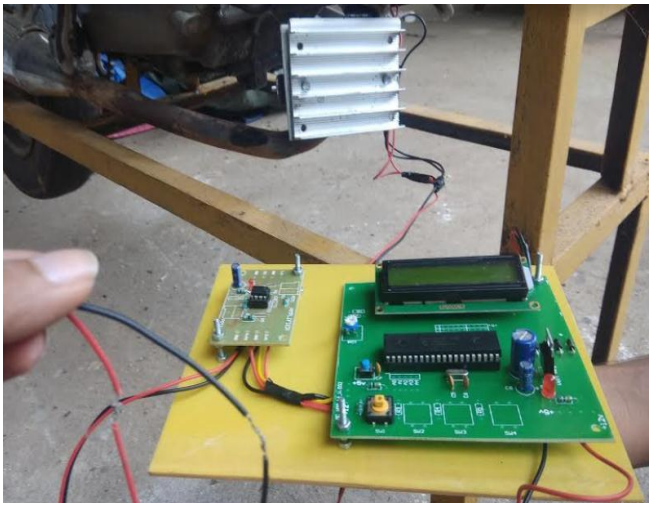

Figure-8: Setup of producing electrical energy from TEG with booster circuit

5.2 Electricity Generation from Kinetic energy of exhaust gas

The kinetic energy of the exhaust is used to rotate the turbine. The speed of rotation of the turbine depends on the velocity of the exhaust gas, velocity of the gases will be higher at higher rpm, turbine which is coupled with a dynamo and its main purpose is to convert the mechanical energy to electrical energy. Power generation with turbine is depicted by the diagram given below

Figure-9: Flow diagram of generation of electricity with Turbine

Figure-10: Setup of producing electrical energy with Turbine

The Obtained power from both TEG and turbine is measured with the help of an external device like a multimeter under different conditions.

6. RESULTS AND DISCUSSIONS

Table-1: Output voltage corresponding to exhaust gas and turbine speed

Exhaust Gas(rpm)	Turbine Speed(rpm)	Voltage(V)
280	250	0.5
350	300	1
400	330	1.2
550	400	1.5

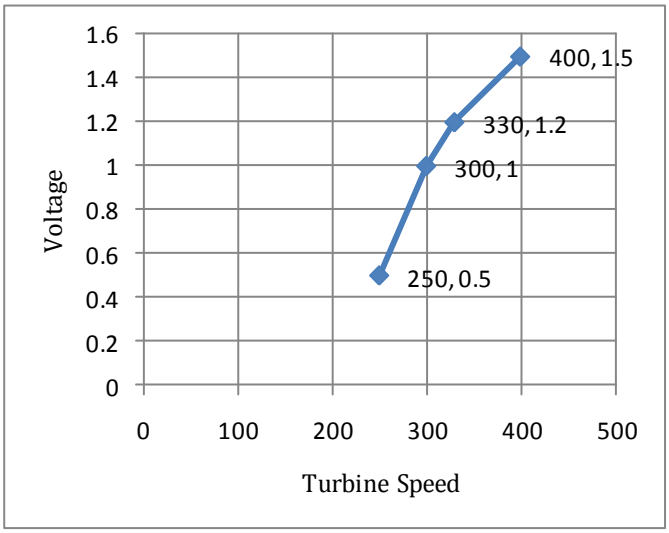

Chart-1: Turbine speed vs. Voltage

Table-2: Output voltage corresponding to temperature difference across TEG

Temperature Difference(°C)	Voltage(V)
35	**1.34**
70	**2.68**
105	**4.02**
140	**5.36**

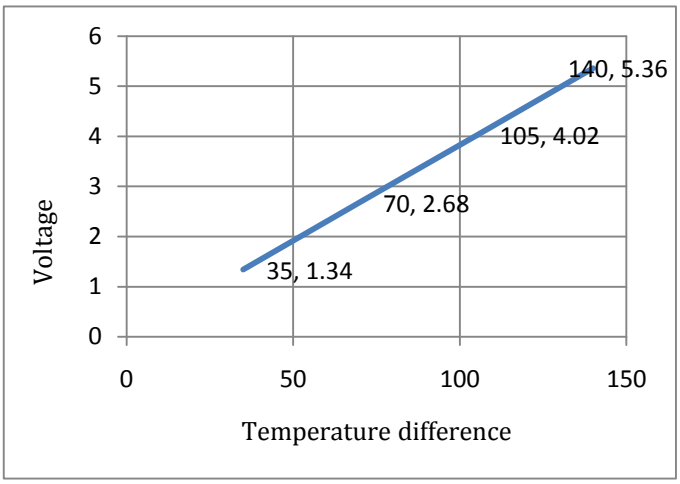

Chart-2: Temperature difference vs. Voltage

7. ADVANTAGES

- Low Cost design and easy to operate
- Waste Energy can be conserved effectively
- Electricity is generated from the exhaust coming from the silencer.
- The thermoelectric power generation is in an advanced stage today and closer to commercial utilization. Significant Progress had been made in development of thermoelectric power generation systems.
- When TEG is placed in a series connection, we can increase the voltage of electricity generated.
- It can be used to store the energy and can be used for different purposes.

8. DISADVANTAGES

- Intensity of electric power is proportional to high velocity ionized gas and heat produced at silencer
- Large space is required for installing it in automobiles.
- The Carbon emission from silencer can choke the turbine.

9. CONCLUSIONS

From the study, it has been identified that there are large potentials of energy savings by the use of various waste heat recovery methods. Waste heat recovery entails capturing and reusing the waste heat from the internal combustion engine and uses it for generating mechanical or electrical energy. It would also help to acknowledge the development in performance and emissions of the engine if these technologies were adopted by the automotive manufacturers.

The method promises a better method of utilizing the waste energy to produce electricity. From the experimental investigation we have observed that the fuel economy can be saved to a greater extent. The design helps to conserve the energy during its operating time. The components required for the design are easily available and of low cost. Thermoelectric generator used in the design is very useful in extracting 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. The generated power source from the exhaust can be stored and can be used for different purposes. This work can be used for many applications in urban and rural areas where power availability is a smaller amount or totally absent.

10. FUTURE SCOPES

The future scope of this design is vast because a large amount of energy from the exhaust of various automobiles is wasted which can be converted into useful form of energy. As a whole, this idea is a blend of energy conservation and closer step commercial applications. In future there might be a technologically developed method in order to connect the thermoelectric generator in series which helps to increase the output voltage. The selection of material for the heat sink is crucial in order to increase the output voltage.

11. ACKNOWLEDGEMENT

We are happy to acknowledge Mr. Eldhose Kurian, Asst. Professor, Viswajyothi College of Engineering and Technology, Kerala, India for providing informative knowledge and suggestions for our topic.

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