FABRICATION AND ANALYSIS OF POWER GENERATOR FROM VEHICLE EXHAUST HEAT BY USING TEG

George Mathan G[1] | Durkaikannan S[2] | Dinesh Gokul M[3]

[1](Department of Mechanical Engineering,Student,Christ the king engineering college,karamadai,Coimbatore-641104, India,mathan717@gmail.com)

[2](Department of Mechanical Engineering,Student,Christ the king engineering college,karamadai,Coimbatore-641104, India, durkaikannan5999@gmail.com)

[3](Department of Mechanical Engineering,Student,Christ the king engineering college,karamadai,Coimbatore-641104, India,gokuldinesh09.hg@gmail.com)

Abstract—*The main objective of this paper is to recover the waste heat from the automotive engine exhaust into useful electrical energy by using thermo electric power generator. Converting the waste heat energy of the exhaust gases into electric power would bring some measureable advantage. Modern automobiles equipped with combustion engines tend to have large number of electronically controlled component. Contemporary car engines exhaust up to 30-40% of heat generated in the process of combustion into useful mechanical work and losing the remaining power in the form of heat to environment. Thermoelectric device could convert some of this waste heat into useful electricity. Therefore, even partial use of the waste heat would allow us to recharge the battery significantly. Since voltage generated is lower than our requirement, we placed a booster circuit to increase the output voltage and to store in the vehicle battery.*

Keywords— Automotive thermoelectric generator, thermo electric effect, Exhaust heat recovery.

1. INTRODUCTION

Renewable energy is energy generated from natural resources such as sunlight wind, rain, tides and geothermal heat which are renewable (naturally replenished). In 2006, about 18% of global final energy consumption came from renewable, with 13% coming from traditional biomass, such as wood-burning. Hydroelectricity was the next largest renewable source, providing 3%, followed by solar hot water/heating, which contributed 1.3%. Modern technologies, such as geothermal energy, wind power, solar power, and ocean energy together provided some 0.8% of final energy consumption.

Climate change concerns coupled with high oil prices, peak oil and increasing government support are driving increasing renewable energy legislation, incentives and commercialization. European Union leaders reached an agreement in principle in March 2007 that 20 percent of their nations' energy should be produced from renewable fuels by 2020, as part of its drive to cut emissions of carbon dioxide.

2. TEG

TEG is an acronym for ‘thermoelectric generator’. A TEG is a device utilizing one or more thermoelectric models as the primary components, followed by a cooling system that can be either passive or active. Such as an open air heat sink, fan cooled heat sink, or fluid cooled. These components are then fabricated into an assembly to function as one unit called a TEG.

When heat is applied to the hot side of a TEG, electricity is produced. Almost any heat source can be used to generate electricity, such as solar heat, geothermal heat, even body heat! In addition the efficiency of any device or machine that generates heat as a by-product can be drastically improved by recovering the energy lost as heat.

2.1 Background of Thermo electrics

Thermoelectric power is the conversion of a temperature differential directly into electrical power. Thermoelectric power results primarily from two physical effects the Seebeck effect, and Peltier effect.

The Seebeck effect is named after Thomas J. Seebeck, who first discovered the phenomenon in 1821. Seebeck noticed that when a loop comprised of two dissimilar materials was heated on one side, an electromagnetic field was created. He actually discovered the EM field directly with a compass! He noted that the strength of the electromagnetic field, and therefore the voltage, is proportional to the temperature difference between the hot and cold sides of the material. The magnitude of the Seebeck coefficient (S) varies with material and temperature of operation.

2.2 TheSeebeckeffect.

In this equation ΔV is the voltage difference between the hot and cold sides, ΔT is the temperature difference between the hot and cold sides. The negative sign comes from the negative charge of the electron, and the conventions of current flow. A negative Seebeck coefficient results in electrons being the dominant charge carriers (n-type), whereas holes are the dominant carrier (p-type) in materials with a positive Seebeck coefficient. The majority charge carriers are said to move away from the heated side toward the cooler side. Minority charge carriers move in the opposite direction, but at a slower rate due to phonon drag and charge carrier diffusion rates. Thus, both n-type and p-type materials are required to realize current flow in a device.

3. DESCRIPTION OF EQUIPMENTS

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice-versa. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side.

This effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can be used as temperature controllers.The term "thermoelectric effect" encompasses three separately identified effects: the Seebeck effect, Peltier effect, and Thomson effect. Textbooks may refer to it as the Peltier–Seebeck effect.

This separation derives from the independent discoveries of French physicist Jean Charles AthanasePeltier and BalticGerman physicist Thomas Johann Seebeck. Joule heating, the heat that is generated whenever a voltage is applied across a resistive material, is related though it is not generally termed a thermoelectric effect. The Peltier–Seebeck and Thomson effects are thermodynamically reversible, whereas Joule heating is not.

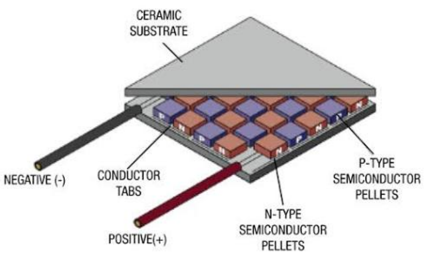


Fig 1: Thermoelectric generator

3.1. Battery:

In our project we are using secondary type battery. It is rechargeable type. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two types of batteries, primary (disposable) and secondary (rechargeable), both of which convert chemical energy to electrical energy. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible; they are recharged by running a charging current through the battery, but in the opposite direction of the discharge current.

3.2 IC Engine

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine the expansion of the high-temperature and -pressure gases produced by combustion applies direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy.

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the Winkle rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described.

3.3 BOOSTER CIRCUIT

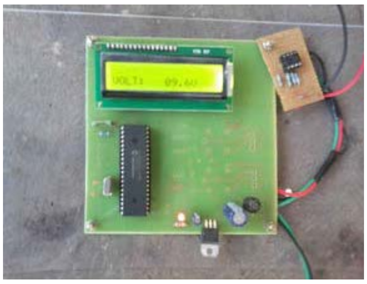


Fig 2 Booster circuit

This section describes the operation modes of LCDs, then describes how to program and interface an LCD to PIC Microcontroller.

The Fig shows the 2x16 LCD Display which is used to display the details about the students who enters the library. In recent years the LCD is finding widespread use replacing LEDs (seven-segment LEDs or other multi segment LEDs). This is due to the following reasons:

The declining prices of LCDs and the ability to display numbers, characters, and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast the LED must be refreshed by the CPU to keep displaying the data and ease of programming for characters and graphics.

3.4. DIAGRAM OF POWER GENERATOR FROM VEHICLE EXHAUST HEAT BY USING TEG

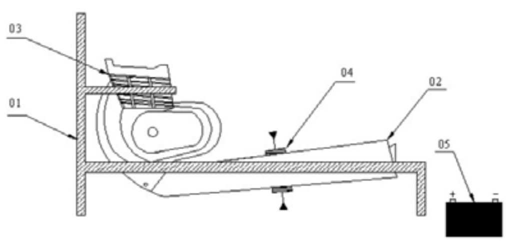


Fig 3: Overall diagram

Table 1: Details of drawing

S.No	Part name	S.No	Part name
01	Base frame	04	Thermo electric generator
02	Silencer	05	Battery
03	Engine	→	To control unit

4. WORKING PRINCIPLE

Here we are placing a TEG (thermoelectric generator) on the silencer. An engine is also placed in the chassis of the vehicle. Depending upon the temperature of the silencer, the electric power is generated. The generated power is stored to the battery. It can be stored in the battery after rectification. The rectified voltage can be inverted and can be used in various forms of utilities. The battery power can be consumed for the users comfort. The vehicle is started and the acceleration is to be given so the amount of leaving the exhaust will be increased The thermal grease will be applied in surface of the silencer it increase the incoming heat pass through it The thermo electric generator convert heat energy in to electric energy.

The TGE convert electrical energy in this we use the booster circuit it will boost the power produced in generator So that we got required amount of power to charge any materials The main purpose of the booster circuit is to boost the produce energy and we got more voltage and the produced energy will be stored in battery.

5. THERMAL ANALYSIS

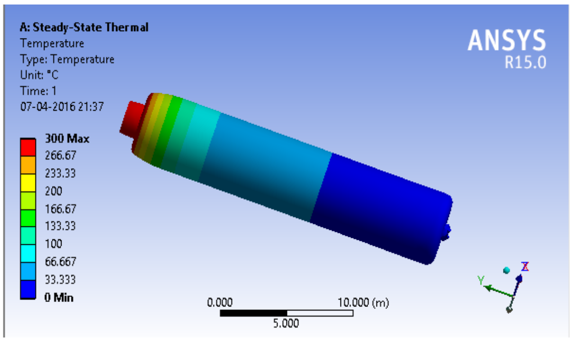


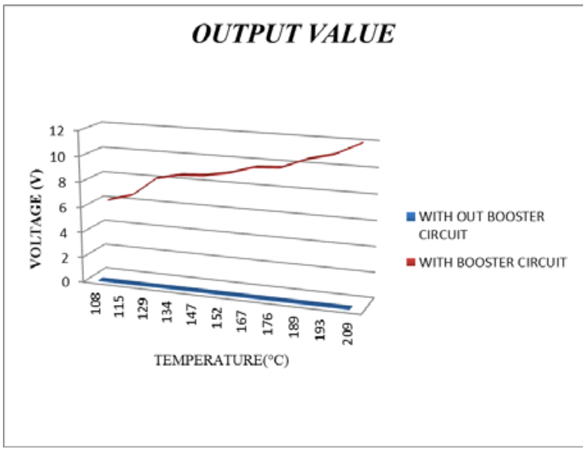
Fig 4 Thermal analysis of temperature

The thermal analysis of temperature is analysed in steady state using ansys software. The main objective is to calculate the minimum and maximum temperature distribution in the silencer. The selected material is structural steel. It is used to fit the thermo electric generator fixed in correct position in the silencer. The initial temperature is 22°c. and to select the material is structural steel To assume the maximum temperature of steel in 600°c.

4.1RESULT AND DISCUTION

Table 2: Output value

TEMPERATURE (°C)	Output voltage (V)	
	WITH OUT BOOSTER CIRCUIT	***WITH BOOSTER CIRCUIT***
108	0.0340	06.05
115	0.0365	06.58
129	0.0401	08.08
134	0.0458	08.51
147	0.0502	08.63
152	0.0522	08.98
167	0.0554	09.58
176	0.0570	09.69
189	0.0617	10.48
193	0.0646	10.98
209	0.0707	11.93



6. CONCLUSION

This project is made with pre planning, that it provides flexibility in operation. This innovation has made the more desirable and economical. This project exhaust gas heat recovery (TEG) power generation system is designed with the hope that it is very much economical and help full in automobile field. This project helped us to know the periodic steps in completing a project work. Thus we have completed the project successfully.

7. ACKNOWLEDGMENT

We are very thankful and grateful to our Department HeadMr.L.Suresh. M.E.,(Ph.D), Co-ordinatorMr.L.Keerthivelrajesh.M.E, and our beloved friends whose great support, valuable advices, suggestions and tremendous help enabled us in completing our project. They have been a great source of inspiration to us.

8. EXPERIMENTAL SETUP

REFERENCES

[1] T. Endo, S. Kawajiri, Y. Kojima, K. Takahashi, T. Baba, S. Ibaraki, T. Takahashi, "Study on Maximizing Exergy in Automotive Engines," SAE Int. Publication 2007-01-0257, 2007.

[2] K. NanthaGopal, RayapatiSubbarao, V. Pandiyarajan, R. Velraj, "Thermodynamic analysis of a diesel engine integrated with a PCM based energy storage system," International Journal of Thermodynamics 13 (1) (2010) 15-21.

[3] HakanÖzcan, M.S. Söylemez, "Thermal balance of a LPG fuelled, four stroke SI engine with water addition," Energy Conversion and Management 47 (5) (2006) 570-581.

[4] P. Sathiamurthi, "Design and Development of Waste Heat Recovery System for air Conditioning," Unit European Journal of Scientific Research, Vol.54 No.1 (2011), pp.102-110, 2011.

[5] S. Karellasa, A.-D.Leontaritisa, G. Panousisa , E. Bellos A, E. Kakaras, "Energetic And Exergetic Analysis Of Waste Heat Recovery Systems In The Cement Industry," Proceedings of ECOS 2012 - The 25th International Conference On Efficiency, Cost, Optimization, Simulation And Environmental Impact Of Energy Systems June 26-29, 2012, Perugia, Italy.

[6] HakanÖzcan, M.S. Söylemez, "Thermal balance of a LPG fuelled, four stroke SI engine with water addition," Energy Conversion and Management 47 (5) (2006) 570-581.

[7]P. Sathiamurthi, "Design and Development of Waste Heat Recovery System for air Conditioning," Unit European Journal of Scientific Research, Vol.54 No.1 (2011), pp.102-110, 2011

[8] S. Karellasa, A.-D.Leontaritisa, G. Panousisa , E. Bellos A, E. Kakaras, "Energetic And Exergetic Analysis Of Waste Heat Recovery Systems In The Cement Industry," Proceedings of ECOS 2012 - The 25th International Conference On Efficiency, Cost, Optimization, Simulation And Environmental Impact Of Energy Systems June 26-29, 2012, Perugia, Italy.

[9] Cengel, Y.A. and Boles, M.A., Thermodynamics: An Engineering Approach, 6th Edition, McGraw-Hill, 2008, p. 651.

[10]. Rowe, D.M. "Thermoelectric Waste Heat Recovery as a Renewable Energy Source," International Journal of Innovations in Energy Systems and Power, Vol.1, no.1. November, 2006.