International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

Generation of Electricity from Waste Heat Energy

Jisha Kuruvila[1], Gokul G Menon[2], Harikrishnan P[3], Namitha Baby[4]

[1]Asst. Professor, Dept. of Electrical and Electronics Engineering, M.A College of Engineering, Kerala, India
[2-4]Student, Dept. of Electrical and Electronics Engineering, M.A College of Engineering, Kerala, India

---***---

Abstract - *This paper describes the design of a system that converts wasted heat energy of a silencer or an exhaust pipe, into electrical energy to charge a cell phone. A Thermo- Electric Cooler (TEC) is used for converting the heat into electrical energy and the output is amplified to at least 5 Volts (minimum voltage required to charge up a cell phone). This paper discusses extensively how this system functions and what are the components used to design it. It involves the renewal and recycling of wasted heat into additional electric power. This is a growing technology and this paper describes the future scopes of this design being implemented at the industrial scale as well as the option of storing the electrical energy from the wasted heat and therefore making it portable.*

***Key Words*: Thermoelectric cooler, converter, heat sink, Seebeck effect, Peltier effect.**

1. INTRODUCTION

This paper describes the design of a system that converts wasted heat energy from exhaust of vehicles into electrical energy. A Thermoelectric Cooler (TEC) is used for converting the heat into electrical energy and the output is amplified to at least 5 Volts. It also covers the theory behind the function of the system and the possibility of implementing closed loop control.

The main concept behind this design is the Thermoelectric effect. It involves the direct conversion of heat energy to electrical potential. This device develops a voltage when there is a temperature difference between the two sides. The output voltage is boosted to a higher level so that charging of mobile phones is possible. There is also a possibility of storing this energy and to utilize the stored energy later. The proposed system is less expensive than the comparable systems available in the market. However, the proposed system using TEC is a better and efficient method. Bulk production will decrease the cost of production considerably.

2. WORKING PRINCIPLE

When two different metals are joined in two ends thereby forming a closed loop, with a temperature difference existing between the junctions, it is known as a Thermocouple. The direct conversion of temperature differences into electric voltage and vice versa is known as thermoelectric effect. A thermoelectric device creates a voltage when there is a temperature difference on either sides. Also, when a voltage is applied to a thermoelectric device, a temperature difference can also be created on either sides of the device. Thermoelectric effect is a collaboration of two different effects: the Seebeck effect and the Peltier effect.

2.1 Seebeck Effect

The conversion of heat at the junction of a thermocouple directly into electricity is known as Seebeck effect. It is named after German physicist Thomas Johann Seebeck who discovered thermo-magnetic effect. The Seebeck effect refers to the electromotive force whenever there is a temperature gradient in a conductive material. Hence for a thermocouple, a voltage proportional to the difference in temperatures at the two junctions is produced. If both the junctions have the same temperature, there is an equal amount of electron diffusion in them. This causes the currents through the junctions to be equal and opposite and hence, the net current is zero. If both the junctions have the different temperatures, the electron diffusion in them are different and hence, currents through them are different. Therefore, a net current is produced. This is known as thermoelectricity.

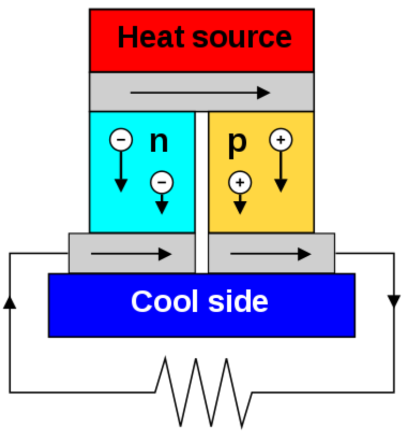

Fig -1: Seebeck Effect

2.2 Peltier Effect

The heating or cooling of an electrified junction of two different conductors is known as Peltier Effect. It was discovered by French physicist Jean Charles Athanase Peltier and is named after him. When a voltage is applied at a junction between two conductors, heat maybe generated or removed at the junction.

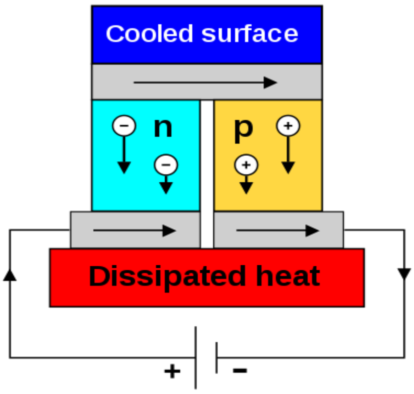

Fig -2: Peltier Effect

3. TEST SETUP

When a voltage is applied across the Thermoelectric cooler, a difference in temperature will build up between the two sides of the device. When operated as a generator, one side of the device is heated to a temperature higher than the other side, and as a result, a difference in voltage will build up between the two sides (the Seebeck effect). The purpose of using this is to convert heat energy into electrical energy. In order to get optimum output 3 TEC modules are used in series.

The TEC modules are encapsulated with the hot side facing the aluminum plate, since it is a good conductor of heat. A passive heat exchanger that cools a device by dispersing heat into the surrounding medium is called a heat sink. The hot side of the TEC module will be facing the heat. The cold side of the TEC module will be facing the heat sink in which the heat will be dissipated. The moving vehicle always keeps the cooling side cool. When implemented in bikes, cooling fan is not required to keep the cold side cool.

A dc - dc converter is used for boosting the output of the TEC. The gate pulses to the MOSFET is given by ATmega328.

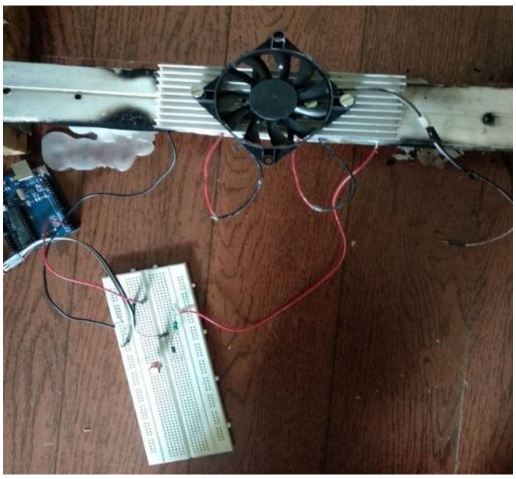

Fig -3: Test Setup

4. SIMULATION AND RESULTS

The simulation was done in two stages. As a first stage, the TEC module was simulated. A TEC module was modelled in MATLAB Simulink and simulation was done. Simulation of the boost converter was done as the second stage.

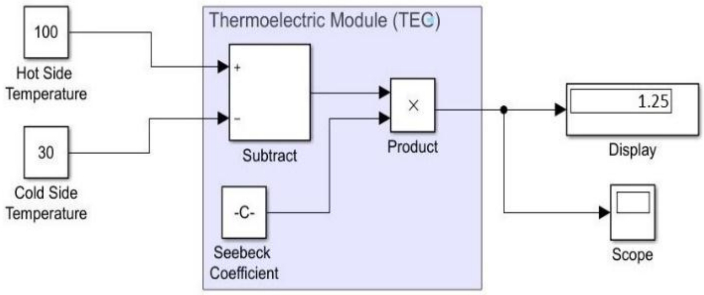

Fig -4: Simulation of TEC Module

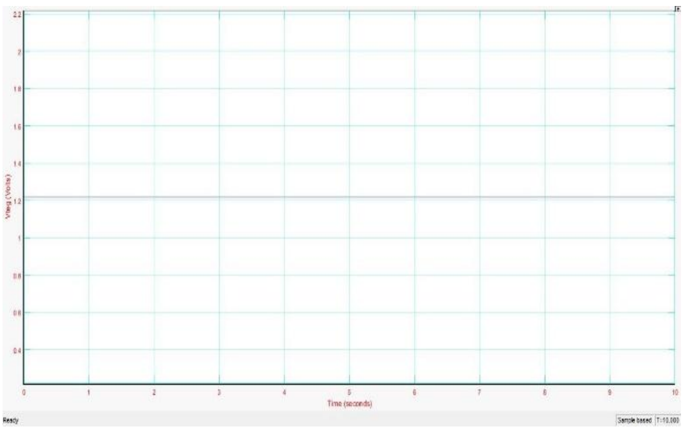

Fig -5: Simulation Result of TEC Module

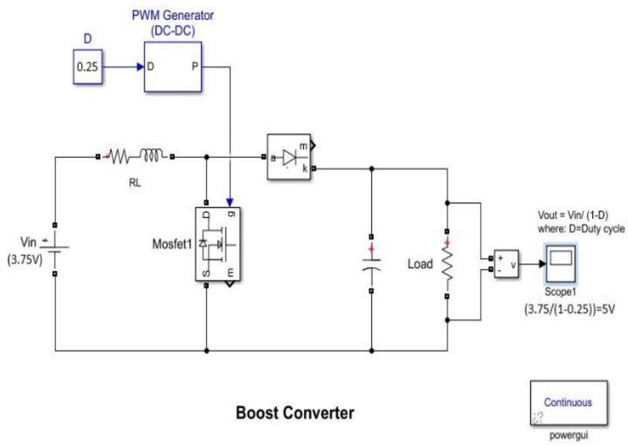

Fig -6: Simulation of Boost Conveter

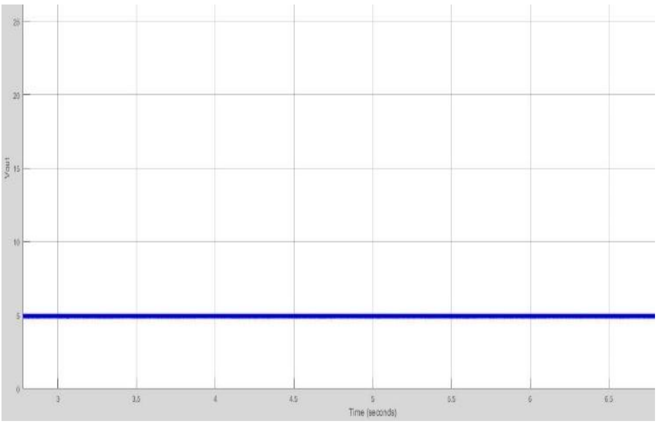

Fig -7: Simulation Result of Boost Converter

A single TEC module gave 1.25V, 0.3A output. Three modules when connected in series gives 3.75V, 0.3A. Boost converter is used to boost this output. The final output is 5V, 0.225 A, which was used to charge up mobile phone.

5. CONCLUSION

In industries, a large amount of heat is usually wasted. If this concept of the designed system is implemented there, it can help power the lighting of a factory. In this case though, the designed system needs much more powerful TEC modules which can generate higher voltages. Closed loop control may be added to enhance the system to provide uninterrupted constant output.

Apart from utilizing the wasted heat energy from exhaust of vehicles, the energy from cooking may also be used to generate electric current and subsequently used for charging mobile phones, power banks, etc.

The future scope of the project is enormous. A voltage sensor can be used to sense the variations in output voltage and correspondingly, the microcontroller maybe programmed to vary the duty ratio of the switching element in the boost converter so that the output voltage is always maintained constant.

6. REFERENCES

[1] Conversion of Wasted Heat Energy into Electrical Energy Using TEG – Hasan U.Zaman, Chowdhury Erfan Shourov, Abdullah Al Mahmood and Noor E Alam Siddique-978-1-5090-4228-9/17/$ 31.00 2017 IEEE.

[2] J. Chen, B. Lin, H. Wang and G. Lin, "Optimal design of a multi-couple thermoelectric generator", Semicond. Sci. Technol., vol. 15, no. 2, pp. 184-188.

[3] "Eletricity Generation Using Thermoelectric Generator - TEG" - Priscilla A. J. Stecanella, Messias A. A. Faria, Elder G. Domingues, Pedro H. G. Gomes, Wesley P. Calixto and Aylton J. Alves - 978-1-4799-7993-6/15/$ 31.00 2015 IEEE

[4] CampStove, "BioLite CampStove | Burn Wood, Cook Meals, Charge Gear", Bioliteenergy, 2016.

[5] J. Kiely, D. Morgan, D. Rowe and J. Humphrey, "Low cost miniature thermoelectric generator", Electronics Letters, vol. 27, no. 25, pp. 2332- 2334, 1991.

[6] Muhammad H Rashid, "Power Electronics : Circuit Devices and Applications" Second Edition.