RESEARCH ARTICLE

DOI: 10.34256/bsr1927

BULLETIN OF SCIENTIFIC RESEARCH

Thermoelectric Based Power Generation for Battery Charging

S. Gomathi [a,*], D. Sri Vidhya [a], T. Venkatesan [a]

[a] Department of Electrical and Electronics Engineering, K.S.Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India.

*Corresponding Author: gomathis@ksrct.ac.in DOI: https://doi.org/10.34256/bsr1927

Received: 23-09-2019
Accepted: 05-11-2019

Abstract: Power generation based on renewable energy sources has experienced an important growth due to the challenge of global warming and climatic conditions. This paper proposes the power generation based on Thermo Electric Modules. Peltier module is a device which converts heat energy into electrical energy. Peltier module is a device that uses the principle of thermoelectric effect and converts temperature differences in to an electric voltage and vice versa. The conversion technology is based on the See beck effect and high thermal concentration using optical concentrators. Pettier module produces no air pollution or hazardous waste, free of moving parts, which reduces the maintenance cost of the proposed system. Peltier module is made up of semiconductor materials such as Bismuth Telluride. The temperature on the panel can be controlled by using Fresnel lens and it is connected to charge controller. The generated voltage is increased with increase in temperature. The panel is connected to the battery through the charge controller. The experimental set up has been implemented. The output voltage obtained from the panel is of 2.18 volts. The voltage is increased up to 12 volts using boost converter. The obtained DC voltage of 12 volts is charged using battery and it can be used for charging of rechargeable household appliances and electronic gadgets.

Keywords: Thermo Electric Modules, Peltier module, Seebeck effect, battery, charge controller.

1. Introduction

Thermoelectric technology started its history in the 17th century and has been developing over the years. Later on, many discussions were carried out with many disadvantages of the Thermo Electric Generation (TEG) technology. Even though many disadvantages are found, the power generation based on the TEG technology has been used in several areas. In renewable energy technology, power generation based on the photovoltaic cell has been used predominantly. Photovoltaic panels are based on Solar cells, while Solar-Thermal electric panels are based on Peltier cells. The Peltier - panel is used to convert the solar-thermal energy in to an electrical energy. This energy conversion is based on the See beck effect. Nowadays, the renewable energy sources are dominating, since it does not produce pollution and hazards to the environment.

The sunlight is converted into an electrical energy through photovoltaic cell and solar thermal. Photovoltaic cells are built up flat panels. In this paper Peltier panel is used to generate electrical energy based on the

Seebeck effect. Solar energy is freely available throughout the year with no pollution. The electrical power is generated according to the thermo electric module. The proposed system consists of Peltier module, heat sink, boost converter and battery.

Peltier module converts heat energy into electrical energy. It converts the temperature difference into an electrical voltage and vice versa based on the thermoelectric effect principle. The temperature difference is calculated from the hot side and cold side of the module.

During power generation, the thermoelectric module is to be cooled. Instead of cooling the panel, the heat energy as thermal waste is utilized for the energy conversion. Thermoelectric converter is connected at the backside of the solar panel. This forms the hybrid module. This grren energy technology is widely used in industry, since the industry produces more heat energy during the process.

Bansal and Martin [1] explained on Thrombelastogarphy (TEG) in practical by considering the clinical use in trauma resuscitation. The performance characteristics are investigated and compared with three domestic refrigerators, namely vapour - compression, thermoelectric and the absorption refrigerators based on the real experimental data.

Jeffrey Snyder.G et al [2] proposed that the intensive reduced efficiency and compatibility factor are derived for the thermoelectric power generation. The overall efficiency is derivable from a thermodynamic state function of two variables, the relative current density and temperature. Najath Akram and Nisabha Jayasunder [3] stated that the thermoelectric effects are the physical principle which is used to directly convert heat energy into electricity or vice versa based on charge carrier and phonon transport phenomena in a solid. Priti G. Bhadake and Chetan B. Patond [4] explained about to design and analyze the heating and cooling system which utilizes non-conventional energy source (Renewable energy sources) with the help of Thermo-Electric module that works on the principle of the Peltier effect.

2. Experimental Setup

The block diagram of the proposed system is shown in figure 1. It consists of solar panel, TEG panel, charge controller, battery and DC load. The sunlight is converted into an electrical energy by the solar panel and heat is converted into an electrical energy by the TEG panel. The produced electrical energy is stored in the battery. The DC load is connected with battery to utilize the electricity.

The hardware setup of the proposed system is shown in figure 2. Fresnel lens is located on the top of panels in the form of a stand so that the light source is focused through it. Charge controller is connected to both solar panel and TEG panel separately to charge the electricity. The charge controller is connected to the battery for the storage of generated electrical energy. The energy stored in battery is in DC power. The stored energy can be used for the working of rechargeable household appliances.

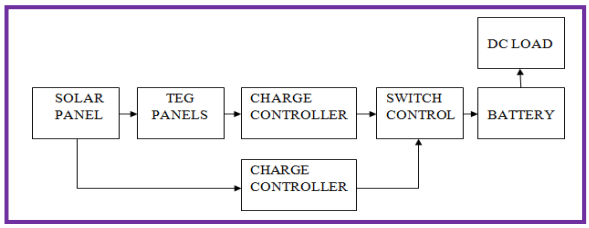

Fig 1. Block Diagram of the proposed system

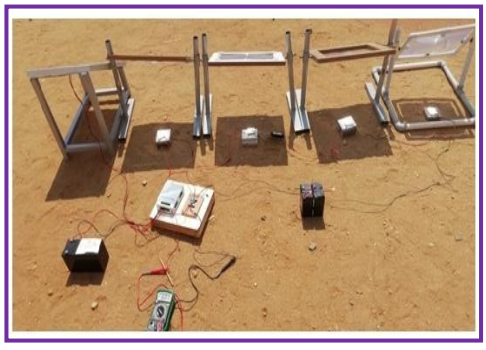

Fig 2. Hardware setup of the proposed system

Table 1 shows the rating of the components used in the proposed system. Peltier module of size 40mm ×40mm is used under the temperature of 32° C. Temperature is varied on the warm side of cell and the voltage is observed on cold side is at 25° C.

Table. 1 Size and ratings of the components used

Components	Size	Ratings
Fresnel Lens	28cm ×20cm	296°C
TEG panels	40mm ×40mm	Up to 500°C
Heat Sink	14.2cm × 5cm × 3.5cm	-
Battery	0.5 ah to 100+ ah	24Volts
Thermister	0.4 – 10mm	-50 to 150°C

3. Results and Discussion

For the various temperature differences, the voltage is measured which is noted down when a concave lens is placed over the Peltier module.

Table. 2. Temperature Vs Voltage

Temperature in ° C	Voltage in mv
42.1°C	64
40.8°C	76
42.1°C	77
43.2°C	86
41.3°C	119

Table.2 consists of temperature and output voltage. When the temperature difference is 42.1°C, the voltage produced is 64 mV. 76 mV is generated when the temperature is 40.8°C. When the temperature is 42.1°C and 43.2°C, the voltage generated are 77 mV and 86 mV respectively. The voltage of 119 mV is generated when the temperature difference is of 41.3°C.

4. Conclusion

The solar energy and heat energy has been converted into an electrical energy. Based on the temperature difference, the voltage has been generated in terms of mV. This generated voltage can be increased by increasing the number panels. In industry, large amount of heat is produced and is wasted as heat. This heat energy can be utilized for the generation of an electrical energy. The experimental set up has been implemented. The output voltage of 2.18 volts has been obtained. The voltage is increased up to 12 Volts by using the boost converter. The obtained DC voltage of 12 volts is charged using battery and it is used for charging of rechargeable household appliances and electronic gadgets.

5. References

1. Bansal **a**nd Martin (2013) 'Thrombelastogarphy (TEG) practical considerations on its clinical use in trauma resuscitation' International Journal of Engineering Research ISSN: (2319-6890) (online), 2347-5013(print) Volume No.3, Issue No.9, pp : 536-539 01 Sept 2013.
2. Jeffrey Snyder.G et al (2012) 'Photovoltaic Driven Dual Purpose Thermoelectric Refrigerator for Rural India' -International Journal of Advancements in Research & Technology, Volume 2, Issue 6, June-2013 ISSN 2278-7763.
3. Najath Akram and Nisabha Jayasunder (2014) 'Thermoelectric effects' International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-4 Number-2 Issue-15 June-2014.
4. Priti G. Bhadake and Chetan B. Patond (2015) 'Heating & Cooling system which utilizes non-conventional energy source' International Journal of Engineering Trends and Technology (IJETT) – Volume 20 No. 3 – Feb 2015.
5. Li X, Xie C, Quan S, Shi Y, Tang Z. Optimization of Thermoelectric Modules' Number and Distribution Pattern in an Automotive Exhaust Thermoelectric Generator. IEEE Access. 2019 May 29.
6. Wan Q, Mok PK. A 14-nA, Highly Efficient Triple-Output Thermoelectric Energy Harvesting System Based on a Reconfigurable TEG Array. IEEE Journal of Solid-State Circuits. 2019 Mar 14;54(6):1720-32.
7. Sempels ÉV, Lesage FJ. Optimal thermal conditions for maximum power generation when operating thermoelectric liquid-to-liquid generators. IEEE Transactions on Components, Packaging and Manufacturing Technology. 2017 Mar 20;7(6):872-81.
8. Sempels ÉV, Kempers R, Lesage FJ. Load-bearing figure-of-merit characterization of a thermoelectric module. IEEE Transactions on Components, Packaging and Manufacturing Technology. 2015 Dec 10;6(1):50-7.
9. Kim J, Kim C. A DC–DC boost converter with variation-tolerant MPPT technique and efficient ZCS circuit for thermoelectric energy harvesting applications. IEEE Transactions on Power Electronics. 2012 Dec 10;28(8):3827-33.
10. da Luz LT, Nascimento B, Rizoli S. Thrombelastography (TEG®): practical considerations on its clinical use in trauma resuscitation. Scandinavian journal of trauma, resuscitation and emergency medicine. 2013 Dec;21(1):29.

About the License