

Thermoelectric Energy Harvesting for Powering LED Using Tealight

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Abstract : In the 21st century, several topics are discussed about the impact of climate change, natural disasters and others that affect mother nature. Therefore, sustainable development is our main agenda in upcoming years to overcome the issue. Energy harvesting is a part of green technology that harvest waste energy around us in the form of heat energy, vibration energy, electromagnetic waves, etc. and convert it into easy-to-use electric energy. The fabricated device, called TEG Kit, harvest electricity by exposing a differences temperature across a thermoelectric generator (TEG) module. This is achieved by sandwiching the thermoelectric generator module with heatsink towards tealight candle at the optimum height of 7.5cm from base of the wooden block. The harvested voltage about 1.81V and connected series with DC-DC Booster have enough power to light the strip Light Emitting Diodes (LEDs). The significance of project has value-added in contribution of society to support rural communities without access of electricity for lighting.

Keywords: Thermoelectric Generator, Energy Harvesting, Sustainable Energy

1. Introduction

In the 18th century, scientists talked about renewable energy and non-renewable energy which play important roles in saving natural resources such as fossil fuels, followed by the 19th-century sustainable

energy topics on sustaining energy for a longer period of usage. Green technology popularized in the 20th century with a surge in green products such as environmentally friendly, hybrid cars, energy efficient, recycling products etc. Currently in the 21st century, we are applying energy harvesting methods which is part of green tech to harvest waste energy into useful electrical energy. Therefore, Thermoelectric generator (TEG) is a part of energy harvesting to harvest heat waste into electrical energy from heat waste of human activities such as heat wastes from machines, combustion engine, heat from burning candles, heat from boiling water etc. Thomas J. Seebeck discovered the seebeck effect where conversion of temperature differences directly into electricity from heat waste products [1]. This thermoelectric generator (TEG) energy harvesting had been widely used in many applications such as portable lighting by Rogers B et al. [2], C.K. Keat et al. [3] demonstrated a battery charger based in an oven, Siti Nooraya M.T et al. [4] also presented a low power supply, automobile [5-6] and industrial applications in remote area [7-8]. In this project, thermoelectric generator module (Figure 1) was demonstrated to harvest heat waste from tealight candles into electrical energy and powered LED strip via DC to DC Step-Up Booster.

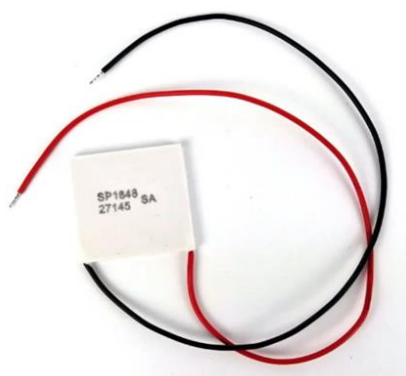


Figure 1: Thermoelectric Generator Module

2. Materials and Methods

Table 1 shows materials used in this project where most of the items were recycled from consumer products. For example, the thermoelectric generator (TEG) module was recycled from used electrical appliances such as a water filter machine, cooling water machine and refrigeration, used heatsink from a computer motherboard, used aluminium carbonate drink can and used strip LED.

Table 1: Materials [9-10]

Item	Material	Specification
1	Thermoelectric Generator Module, (SP 1848-27145)	i. Size: 40mm x 40mm x 4mm ii. Operating Temperature: -30C to +120C
2	DC-DC Step-Up Booster Kit	i. Input : 0.9 – 5 V (DC) ii. Output : 5V (DC)
3	White LED / Strip LED	Forward voltage : 2.5 V
4	Wooden Block	Size : 83mm x 69mm x 9mm
5	Screw	Height : 64 mm
6	Used Aluminum Can	Carbonate Drink Can
7	Used Aluminum Computer Heatsink	Size : 83mm x 68mm x 32mm
8	Thermal Grease	HY 500, Halnziye Electronics
9	Retort stand	Laboratory type
10	Multimeter	Type: Victor VC830L
11	Mini-Type Dual Channel K/J Thermometer	Type: UT320D
12	Tealight candles	Normal tealight candle

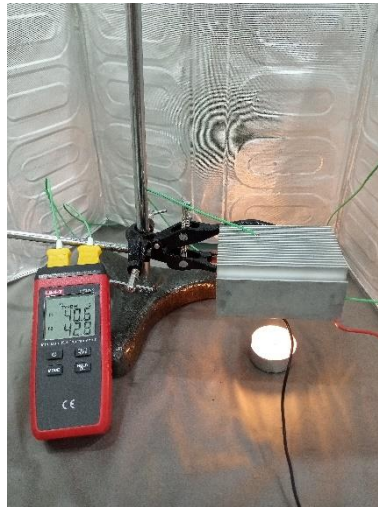


Figure 2: Experimental Setup

Figure 2 shows an experimental setup to determine the optimum height of TEG (range from 5 to 12.5 cm) responding to temperature differences, which is the conversion into electrical output based on the manufactured datasheet of TEG. The experiment was carried in 60 minutes using a tealight candle as heat energy and temperature were measured using a Mini-Type Dual Channel K/J Thermometer. After the optimum height of TEG is obtained, the TEG Kit body was built using used carbonate drink can, wooden block and screw (the specification details as shown in Table 1). Figure 3 shown the complete design 2D Orthographic projection TEG Kit. The tealight candle is placed under the sandwiching of thermoelectric generator module with heatsink. The harvested output of TEG Kit can be measured by using a digital multimeter to check whether the TEG Kit has enough power to light an LED.



Figure 3: 2D Orthographic projection

3. Results and Discussion

Figure 4 shows the optimum height of TEG at 7.5 cm which the system delivered the highest differences temperature of about 58°C at 45 minutes and the energy harvested output about 1.81 V. The output voltage had insufficient forward voltage to drive an LED where an ideal LED needs about 2.5 V to be switched on. To overcome this problem, the TEG kit was connected with DC-DC Step-Up Booster to deliver steady-state voltage at 5.0 DC V and successful powering an LED and Strip LED for 2 hours, as shown in Figure 5.

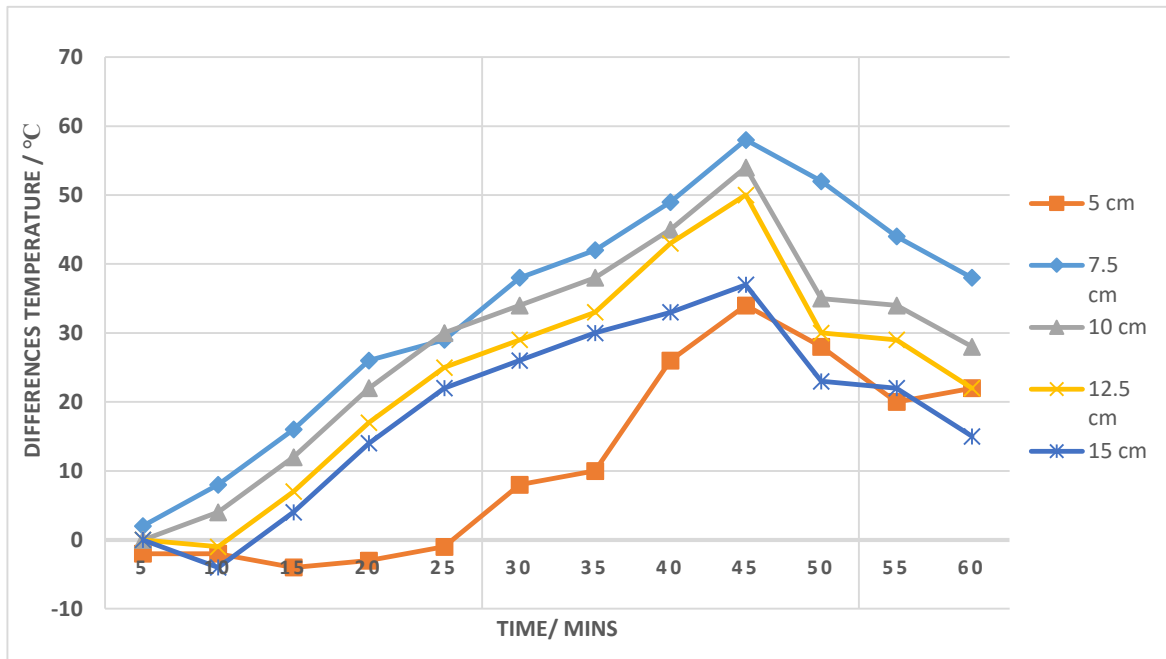


Figure 4: Graph of Optimum height of TEG

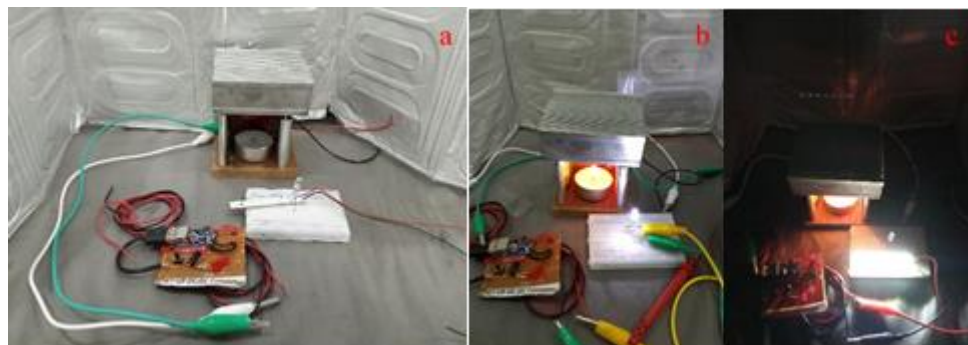


Figure 5: (a) Application of TEG Powered LED based Tealight, (b) Powering an LED, (c) Powering Strip LED during night mode

4. Conclusion

In conclusion, this project was successful demonstrated thermoelectric generator energy harvesting for powering an LED or Strip LED using tealight candles whilst applying the 3R concept (Reduce, Reuse and Recycle) and the concept of green technology. The significance of project has value-added in contribution of society to support rural communities without access of electricity for lighting. Future developments need to be refined using high-performance TEG module as well as a current booster to charge a 5V power bank or smartphone.

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