Highly efficient electricity generation with Peltier Module

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Abstract**—** *this work presents the efficient generation of electricity using the principle of Seebeck effect which is a phenomenon in which a temperature difference between two dissimilar semiconductors produces a voltage difference between the two substances. The higher the temperature differences, the higher the voltage it produces. Here two innovative ways of harvesting energy is proposed i.e one from direct sunlight using Fresnel lens during daytime and one from simple heat source candle during night time. Generating electricity with wind energy and solar panel is common nowadays and moreover the cost is high. The aim of this paper is to generate electricity in remote areas where electricity is still irregular and insufficient. The designed module produces power in small watt for application in low power consumption electronic products even at the absence of wind and sun energy. The total output voltage of the design module when using candle as heat source and water as coolant, produce DC 7.6vol and current of 4.3mA with a total power of 31.64 Watt which is enough to light low power LEDs and charging of mobile phone.*

Keywords— *Peltier module, seebeck effect, thermocouple, Fresnel lens, DC amplifier.*

I. INTRODUCTION

These days the demand of electricity is rising tremendously with the growing industries and household electrical appliances. To fulfill these daily requirements different energy sources like coal, water, wind and solar energy are employed at a very high cost. From all these sources, energy is extracted and utilized but the demand for power is still at large. Even though the world is fast changing and developing there are still many villages and far flung areas where electricity is not reached and still a demand. From some the power generation method after harvesting energy, heat is simply wasted as byproduct into the environment. If such heat can be converted even in a small mill watt range, it can be reuse in domestic low power lighting and in running low power consumption electronic products. According to thermodynamics law of energy also known as law of conservation of energy, energy cannot be created nor destroy but can be transform from one form to another. Thermoelectric device which work with the principle of seebeck effect converts temperature gradient between the two junctions into voltage and vice versa can be utilize to harness electricity from heat. In Fig. 1 the basic generation of electric power from thermocouple is shown where both the junction is maintained at different temperature gradient i.e one side is heated with a heat source and the other side is attached with heat sink. The output voltage is directly proportional to the temperature difference between the two sides of the module. As the direct output of the device is normally low, it is further amplified with a Darlington pair transistors circuit.

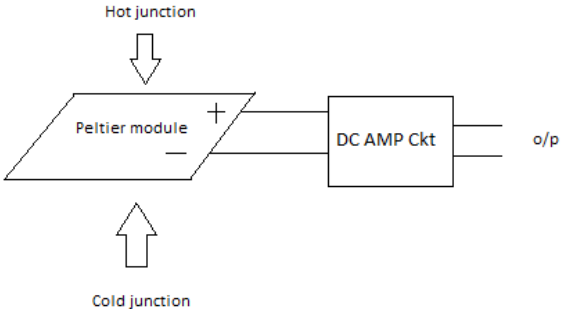

Fig. 1 Electricity generation with Peltier module

Different work has been carried out recently by different experts to generate electricity from heat source. When one side of the Peltier module is focus and heated by Fresnel lens and the other side is attached with heat sink DC voltage can be obtained as reported by [1]. Another innovative and effective way to harvest power during day time is by using highly concentrated solar disc to heat the hot junction which is kept at the focus of the parabola dish as suggested by [2]. To overcome the problem of depletion of battery charge of Cell phones while travelling, body heat is also converted into voltage to charge the battery [3]. And moreover in cooking gas the upper flame of the burner is use for conducting heat and the surrounding part of the flame around the burner is wasted normally. This wasted heat can also be converting into electrical energy as presented by [4]. This paper is also proposed and implemented with a simple set up which gives output as high as 7.6 DC voltages for real life application which is explain in the subsequent section.

II. Module OPERATION

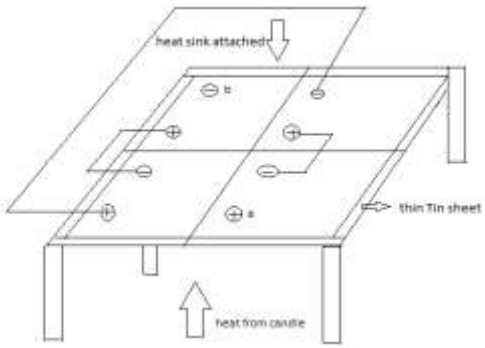

Fig. 2 set up module configuration

The set up configuration of the module is shown in Fig. 2. Four Peltier devices are connected in series and mounted on a thin Tin sheet as Tin is the cheapest metal with very low specific heat capacity [5]. From the bottom of the set up configuration, candle is placed which will heat the sheet with instant heat distribution towards the hot junction of the modules. On top of the modules heat sink is fixed with a heat sink paste and a total output is taken across Vab.

Another way of producing electrical power is with the help of solar energy as shown in Fig. 3. This Fresnel lens main application is the collection of solar light. It collect all light rays on one side that falls on its surface area and beam straight towards the focus on the other side with very high power and heat any material that is placed around its focus. The hot junction of the set up configuration can be heated during sunny day with Fresnel lens as shown in Fig. 3. In Peltier device the separation of both junctions is thin in dimension, so the heat from the hot junction can be easily pass towards the cold junction and heat up both side with little temperature difference. In order to maintain more temperature difference for more output between the junctions heat sink is attached towards the cold side of the module. Heat sink is a passive device which transfers heat energy generated by electronic components into the surrounding air to regulate the temperature of the components.

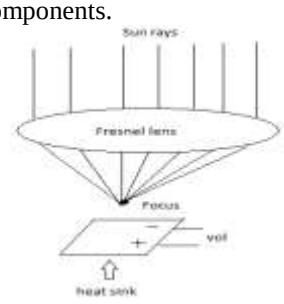

Fig. 3 heating the hot junction with Fresnel lens

To build the complete set up configuration a list of materials required is listed in Fig. 5

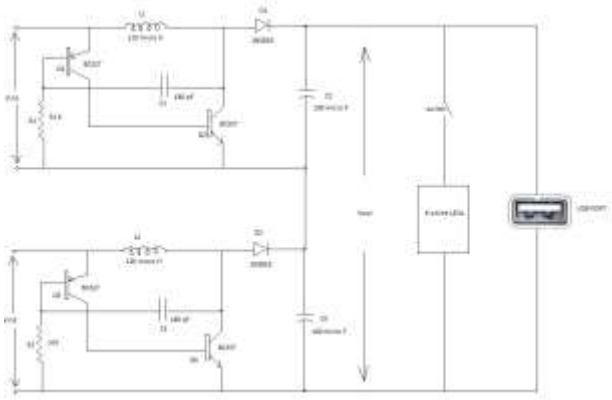

Fig. 4 Booster circuit connection of the module

The detail circuit connection of DC output amplifier circuit is shown in Fig.4. It employs two Darlington pair transistor of npn and pnp transistor. The two inputs are obtained from series connection of two Peltier's output to drive the Darlington pair sufficiently. Finally the total output is taken across the two dc step up voltage circuits which are connected in series for high output. The output can sufficiently drive 6 white LEDs when the switch is turned on. Moreover it can charge mobile phone through the USB port letting the switch open to supply enough current for charging.

SERIAL NO.	NAME OF COMPONENTS	QUANTITY
1.	PELTIER MODULE (TEC1-12706)	4
2.	ALUMINIUM PLATE	1
3.	INDUCTOR a) 220 uH	2
4.	RTV GLUE (TEMP. WITHSTAND)	1
5.	HEAT SINK PLATES	4
6.	RESISTOR a) 51 KILO OHM	2
7	LED	6
8	DIODE 1N5819	2
9	PCB	1
10	TRANSISTOR	
	(A)BC 327	2
	(B)BC 337	2
11	CAPACITOR	
	(A)100 Pico Farad (ceramic)	2
	(B) 100 Pico Farad (ceramic)	2
12	SWITCH	1
13	USB port	1

Fig. 5 required materials

Every Peltier device has a maximum temperature it can withstand. It is at this temperature where it gives the maximum output voltage as shown in the input output characteristic in Fig. 6. The output voltage rises linearly with the temperature difference between the two junctions and becomes constant after reaching the maximum temperature it can withstand. For safety operation the module is operated below the rated maximum temperature it can handle. The characteristics shows o/p is directly proportional to temperature difference and finally gives constant

output. All temperatures are measured in Fahrenheit and the output in vol.

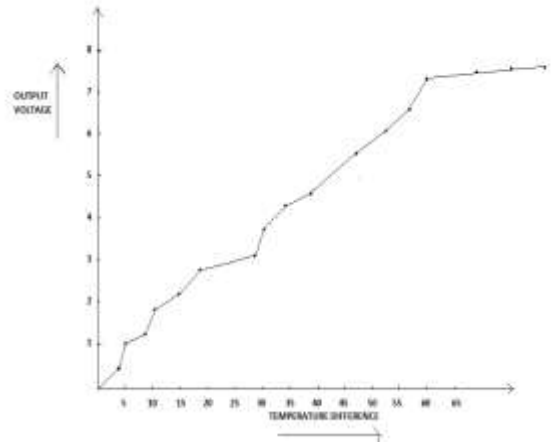

Fig. 6 Voltage vs temperature difference of Peltier device

The different readings of temperature and output voltage are shown in Fig. 7. The observation is made when candle is used as a source of heat which heat the bottom of the module and water packet as cooling agent which is placed on top of the module as shown in Fig. 8. The amplifier output voltage linearly rises and attains a constant voltage at 7.6 Volt when the temperature difference is 62 Fahrenheit which is 16.6^0 Celsius. Maintaining a large temperature difference is still a challenge as the Peltier device thickness is very thin. More output can be obtained when using ice cube as coolant.

Sl no	TEMPERATURE(FAHRANHEIT)			OUTPUT VOLTAGE	
	HOT(DEG F)	COLD(DEG F)	DIFFERENCE(DEG F)	PELTIER DEVICE OUTPUT(V)	BOOST OUTPUT(V)
1	94.6	91.3	3.3	0.26	0.58
2	102.5	97.7	4.8	0.40	0.98
3	106.1	99.2	6.9	0.47	1.08
4	110.2	101.5	8.7	0.51	1.12
5	116.2	104.8	11.4	0.65	2.01
6	121.2	106.2	15	0.80	2.35
7	128.8	107.9	20.7	0.92	2.98
8	132.7	108.1	24.6	1.09	3.02
9	138.6	110.5	28.1	1.26	3.19
10	143.3	112.1	31.4	1.45	3.8
11	148.3	114.5	36.2	1.62	4.35
12	156.4	118.1	38.3	1.76	4.78
13	176	126.1	49.9	2.09	5.75
14	187	131.9	55.1	2.81	6.23
15	196.5	138.2	58.3	3.25	6.87
16	208.1	146.1	62	3.55	7.36

Fig. 7 Observation table of temperature difference and output voltage

The complete set up configuration with circuit connection is shown in Fig. 8 and Fig. 9. The output voltage of 7.6V from the DC voltage amplifier circuit can easily power the low wattage LEDs. This can even charge small rated current battery like mobile phone through a usb port. In order to maintain a constant output the water packet which is placed above the heat sink is replaced after every 35 minute.

Fig .8 the output voltage lighting 6 white LEDs

Fig. 9 output voltage charging cell phone

III . CONCLUSION

This proposed model is robust and innovatively designed to generate electricity in two different ways from two different heat sources. During day time the heat from the sun is collected by Fresnel lens and focus to the hot junction of the peltier module through a tin sheet and a small rechargable battery can be charge efficiently. At night heat from the candle flame or charcoal acts as heat source with water as coolant to light up low power LED's. To increase the output voltage four Peltier module are connected in series by attaching four heat sink to the cold junction. The more the temperature difference betwwen the cold and hot junction the more the output it will give. The obtained output is furthur step up by a DC amplifier using darlington pair transistor which can power 6 LEDs efficiently and can even charge cell phone through USB port as shown in Fig. 8 and Fig. 9 respectively. Output voltage graph along with its temperature difference is also shown in Fig. 6 and Fig. 7 respectively. This module can be efficiently and effectively use in villages and isolated areas where they are completely cut off from the modern and developed cities.

IV. REFERENCES

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