

FABRICATION AND EXPERIMENTAL ANALYSIS OF SOLAR BASED THERMO ELECTRIC COOLING SYSTEM

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Abstract:- *In the recent years, electricity crisis is main problem for us. It's time to use the renewable sources of the nature. In this project a thermoelectric cooling system using solar energy is fabricated. It is eco-friendly project. It is made by using thermoelectric module worked based on peltier effect. The sun oriented based thermoelectric refrigeration framework is having potential use of capacity and transportation of life sparing medications and organic materials at remote zones of our nation where grid power is unavailable. In this project a prototype of thermoelectric refrigeration system working on solar photo voltaic cells generated DC voltage is fabricated and experiment has been conducted. By the experimental results performance parameters are analysed for the fabricated system.*

Keywords: *Solar Panel, Peltier Plate, Heat sink, Cooling fan, Thermoelectric Cooling, Battery.*

1.INTRODUCTION

In 1821, Thomas Seebeck found that a persistently streaming current is made when two wires of various materials are consolidated and warmed toward one side. In 1821, Thomas Seebeck discovered that a ceaselessly streaming current is made when two wires of various materials are combined and warmed toward one side. This thought is known as the Seebeck Effect. The Peltier effect was found in 1834 by a French physicist Jean Charles Peltier. Peltier found that the use of a current at an interface between two disparate materials brings about the retention/arrival of warmth. They utilize no ozone exhausting chlorofluorocarbons, conceivably offering an all the more earth dependable contrasting option to traditional refrigeration. They can be greatly smaller than blower based frameworks. Seebeck effect and Peltier effect forms the basis for the thermoelectric refrigerator. Scottish researcher William Thomson (later Lord Kelvin) found in 1854 that if a temperature distinction exists between any two purposes of an ebb and flow conveying conductor, warm is either advanced or retained relying on the material. The Peltier impact is one of three kinds of thermoelectric impact.

Currently, even in 21st century there are many places in India where there is no less electricity available therefore storage and refrigeration of food stuff is a big issue in rural areas. Solar is freely available in plenty. This system should prove to be 100% eco-friendly and cheapest refrigeration system for such people. As our project runs on solar system, people can take benefits of cooling and heating effect from this system.

2. LITERATURE

1. Mr. Swapnil Betal, "Test Analysis of Solar based Thermo-Electric Heating and Cooling System", International Journal of Engineering Trends and Technology (IJETT) – Volume 20 Number 3 – Feb 2015.

- 1) The principle target of our venture is to outline and make examination of a Heating and Cooling framework which uses non-regular vitality source (i.e. Sun powered Energy) with the assistance of Thermoelectric Module which takes a shot at the standard of the Peltier impact.
- 2) The real contrast between the current framework and our framework is that, our task works without utilization of mechanical gadget and without refrigerant as well.
- 3) As the module is compact in size one can design (i.e. shape, capacity) the system according to his requirement.

2. Akshata Patil-Yelavkar. et.all, "Design, Manufacturing and Experimental Analysis of Thermoelectric Lunch Box", International Journal of Engineering Research and Technology. ISSN 0974-3154 Volume 10, Number 1(2017) © International Research Publication House <http://www.irphouse.com>.

1) This paper talk about creation and Experimental Analysis of thermoelectric cooling framework taking a shot at Peltier impact target of the outline is to keep up nourishment at 40°C and to diminish the water temperature by 5°C. working model is made and Performance is seen under different conditions conclusion is gotten.

3. Sarath Raj et.all, "Trial Analysis, Design and Fabrication of Portable Thermoelectric Vaccine Preservation", International Journal of Mechanical and Industrial Technology ISSN 2348-7593 (Online) Vol. 3, Issue 2, pp: (117-128), Month: **Gregorian calendar month** 2015-March 2016, **out there** at: web.researchpublish.com.

1) The target of this undertaking work is to create compact thermoelectric refrigeration framework equipped for keeping up immunization temperatures between 8 °C and 13 °C.

2) The principle framework comprised of thermoelectric module as cooling generator alongside protected lodge, battery and charging unit.

3) Thermoelectric components play out an indistinguishable cooling capacity from Freon-based vapor pressure or assimilation fridges.

4) To ensure the success of this project several criteria's are to be satisfied such as portability, size and cost of the system.

3. WORKING PRINCIPLE

The thermoelectric impact is a procedure of the generation of electromotive power out of temperature contrast on two conductor or semiconductor-based electronic parts, and in reverse temperature distinction acquired by applying a DC current.

The direct current (DC) is passed from a negative to positive type semiconductor material The temperature TL of the interconnecting transmitter abatements and warmth is assimilated from the earth (cooling impact) by the 'chilly end' of the thermoelectric module, and exchanged or 'pumped' through to the 'hot end' of the module 'TH' because of the Peltier impact. cooling effect occurs, as shown in the Figure, when electrons pass from a low energy level in the positive type material through the interconnecting conductor to a higher energy level in the n-type material .Normally, the 'hot end' of the module will be attacehd to a heat sink in order to reject this heat into the atmosphere.

Useful thermoelectric gadgets rose in the 1960's and have grown fundamentally from that point forward with various producers presently promoting thermoelectric modules for cooling, warming and power age applications. The potential employments of this framework extend from cooling of the electronic segments, to household iceboxes and aeration and cooling systems for cooling/warming a room space.

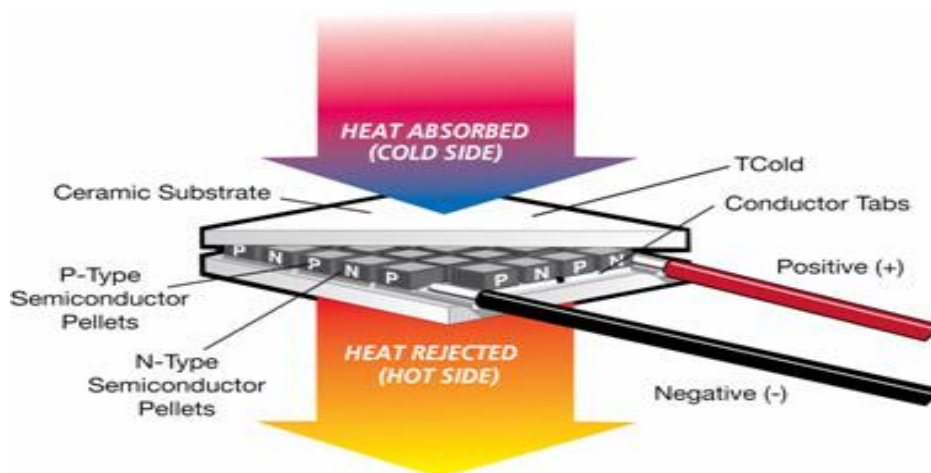


Fig 1: schematic thermoelectric module operation cooling mode

Thermoelectric refrigeration replaces the three primary working parts with: a chilly intersection, a warmth sink and a DC control source. The refrigerant in both fluid and vapor shape is supplanted by two divergent conductors. The blower is supplanted by a DC control source which draws the electrons starting with one semiconductor then onto the next. The assimilation or arrival of warmth at an intersection in which there is an electric current is called as the Peltier impact. DC current connected to two conductors.

4.CONSTRUCTION

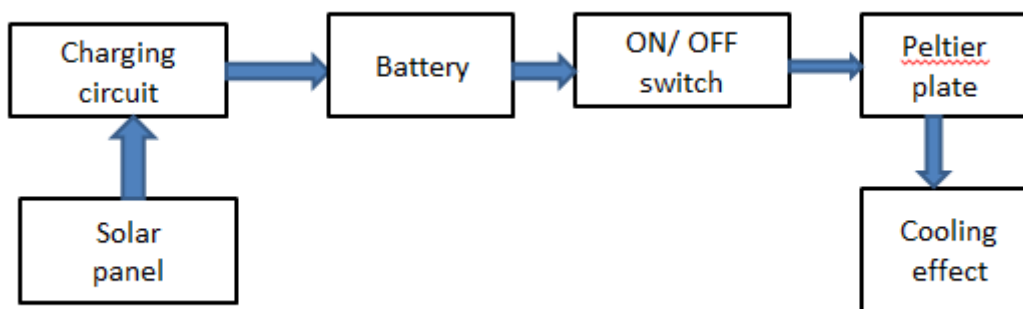


Figure 2 .Block diagram solar based thermoelectric cooling system

Here this system heat or cool the product using thermo-electric module .the construction set up for this system have following parts.

- 1.Solar panel
- 2.Charging circuit
- 3.Battery
- 4.Insulation box
- 5.Thermoelectric cooling

A. Solar panel :

Sun powered boards fundamentally comprise of P.V cells are also called as photovoltaic cells. Photovoltaic cell is produced from semiconductor like silicon base. At the point when this material is presented to light its created an electric current. P.V cells can be produced using crystalline silicon (polycrystalline silicon). Which thickness of around 100-300 um thick there are additionally polycrystalline thin film cell with thickness of 1-10 um. That layer converged on each other to shape cells. That arrangements of cells put on a board or metallic plate to frame sun oriented board.

B. Insulation Box:

Insulation box that term characterize as giving protection from temperature distinction to put inside temperature consistent or at required temperature. The protection box contain both cooling and Heating compartment which is similarly isolating in to two segment The aggregate protection confine is partitioning to three areas first best segment is for warming reason and another is for cooling. The base piece of the protection box is used as a storage room for the thermo electrical circuit and cooling fans.

C. Charge Controller :

Charge controller comprise of the gadgets circuit which is having distinctive diodes and resisters that represent the controlling reason for variety in present and another marvel are given beneath: a. Charge controller takes current from P.V boards. b. Sun oriented battery charging controller manages the voltage yields from the sun powered boards and keeping from being cheating. c. It additionally blocking venerates current. d. It can separate the lower voltage supply. e. It gives over-burden insurance.

D. Battery:

At the point when for the sun oriented battery is developed it will work with about any 12 V battery innovations it will generally worked best with lead corrosive battery. Its comprise of blend of lead plates and electrolyte to change over electrical vitality into potential synthetic vitality and the other way around Lead corrosive battery is an electrical stockpiling gadget that utilization as a substance response to store and depends vitality. The fundamental development of lead corrosive battery is given beneath:

- a. A flexible plastic holder
- b. Positive and negative interior plates made of lead
- c. Plate isolates made of permeable manufactured material
- d. Electrolyte – A weakened arrangement of sulphuric corrosive and water (sulfuric acid).
- e. Battery terminals.

E. Thermoelectric cooling :

Thermoelectric circuit comprise of the P and N write semiconductors sets (alludes to as a couple) Thermoelectric circuit utilized a wonder of thermoelectric refrigeration with the rte of invert warm retention. At the point when current goes through the intersection of the two unique sorts of conductors it result in temperature change on both side of a module. After that one side end up hot and another side wind up cool.

4. WORKING

At the point when sunlight based beams or little sun based radiation occurrence on the sun oriented P.V boards, at that point photovoltaic cells comes in to picture to play out their activity and by little measure of warmth creation its produce power The standard of intensity age behind the solar panel comprises of the usage of the photovoltaic impact of semiconductors. At the point when such a cell is presented to light, electron-gap sets are produced in extent to the power of the light.

A charge controller is a fundamental piece of almost all power frameworks that charge batteries, regardless of whether the power source is PV. Its motivation is to guard your batteries appropriately bolstered and as long as possible. A few controllers likewise counteract battery over release, shield from electrical over-burden, or potentially show battery status and the stream of intensity. That controlling voltage is send to the battery for putting away reason battery store that electric current as synthetic as we probably am aware battery putting away by electric vitality that will changed over in to the compound vitality. That putting away electric vitality will conveyed through transformer to thermoelectric circuit and another for Fan.

The TEC comprises of a p-n material intersection. The activity can likewise be clarified utilizing the p-n intersection hypothesis utilized as a part of diodes - the most basic semiconductor gadget. On the off chance that a LED (light discharging diode) is broke down, it can be seen that the light that is delivered by LED, takes after an indistinguishable rule from thermoelectric cooling. In p-material, the charge bearers are openings and in n-material the charge transporters are electrons. The free electrons in then material move in the conduction band, and development will just occur affected by a connected voltage. This is known as electron movement.

In any p-n intersection where a voltage is connected, the openings and the electrons persistently recombine (when current streams from the n-material to the p-material). On account of the LED, electron stream is from the p-material to the n-material. The electrons move from the conduction vitality level (n-material) to the valence band (P-material).The adjustment in vitality level from a higher vitality level to a lower vitality level makes the electron radiate vitality and this vitality is emitted as noticeable light a similar rule can be connected to thermo-electric cooling.

5. EXPERIMENTAL SECTION



Figure 3: solar based thermoelectric cooling system

Experimental procedure:

1. The solar panel are exposed to sun.
2. By absorbing the solar radiation to the PV panel generated the electric power.
3. The solar panel are used to generate DC current.
4. The DC current stored in the battery by using charging circuit.
5. Then the battery is connected to Peltierplate .
6. The Peltier plate arrangement has cold temperature on top side of the plate and hot temperature on the bottom side of the plate.
7. Then the experimental values like time, cold temperature,hot temperature is found out using Peltier plate arrangement.
8. By varying time,hot temperature, cold temperature values are taken.
9. By using below experimental values and then calculate COP.

6. EXPERIMENTAL VALUES

Drawn values at room temperature at 34.6°C

| S.NO | Time (sec) | Cold side (°C) | Hot side (°C) |
|------|------------|----------------|---------------|
| 1 | 0 | 34.6 | 34.6 |
| 2 | 15 | 32.2 | 34.9 |
| 3 | 30 | 31.2 | 35.6 |
| 4 | 60 | 29.6 | 36.3 |
| 5 | 120 | 28.2 | 37.1 |
| 6 | 180 | 27.8 | 38.6 |
| 7 | 240 | 25.4 | 39.8 |
| 8 | 300 | 24.1 | 41 |
| 9 | 360 | 20.4 | 46.4 |
| 10 | 420 | 18.6 | 50.3 |

Table 1: representation of experimental values

SAMPLE CALCULATIONS

By using table. 1 values below calculations are done. Formulas are consider from the paper [2]

Seebeck coefficient (s) = 0.01229 V/K

Module thermal conductance (K) = 0.1815 W/K

Module resistance (R) = 4 Ω

Current (I) = 7.5 amp

Cold temperature (T_C) = 289.2 K

Hot temperature (T_H) = 323.3 K

$$\begin{aligned} \text{Heat absorption (Q}_L) &= - [SI T_C - 1/2I^2R - K(T_H - T_C)] \\ &= - [26.63 - 112.5 - 0.1815(52.7)] \\ &= 95.43 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{Energy Input (W)} &= SI ((T_H - T_C)) + I^2R \\ &= 4.85 + 225 \\ &= 229.85 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{COP} &= Q_L/W \\ &= 95.43/229.85 \\ &= 0.415 \end{aligned}$$

7.RESULTS AND DISCUSSION

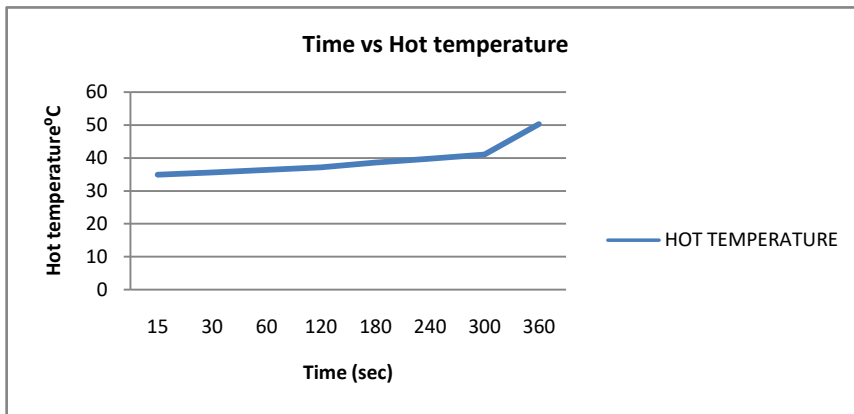


Figure 4: time vs hot temperature

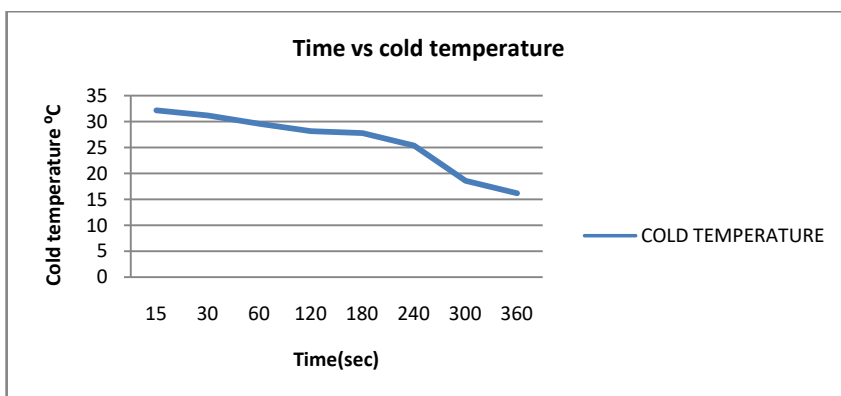


Figure 5: time vs cold temperature

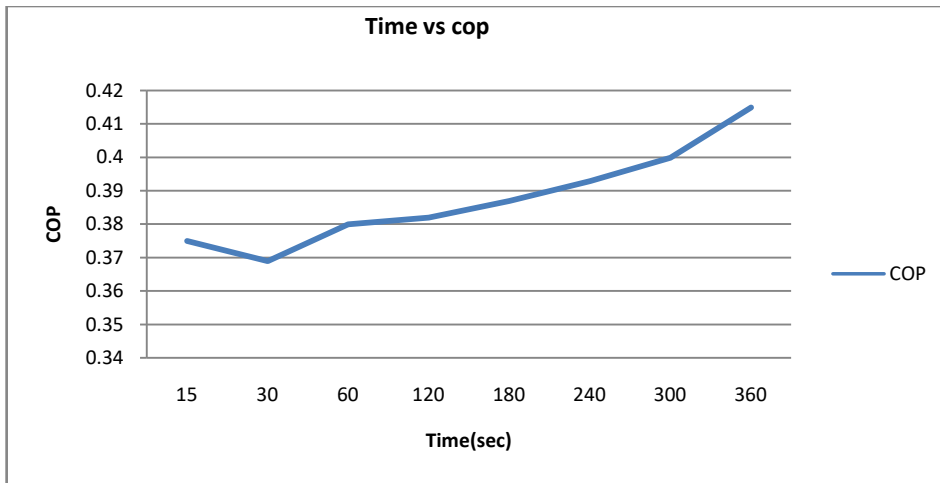


Figure 6: time vs COP

The fig .4 & 5 represents the cooling temperature decreases and hot temperature increases with corresponding time interval. the fig.6 represents the time increases from starting point to ending point but the COP is slightly increases from starting point of time interval to ending point of time interval.

8. CONCLUSION

- 1) In this project a prototype of thermoelectric cooling system working on solar photo voltaic cells generated DC voltage is fabricated and experiment is conducted.
- 2) By the experimental results performance parameters (i.e heat absorption Q_c , energysupply W , coefficient of performance COP) is analysed for the fabricated system.
- 3) In this project the cold temperature decreases, hot temperature increases and COP slightly increases with the time interval respectively.
- 4) The solar based thermoelectric cooling system is having some of the potential applications likemilitary (or) medical equipments.
- 5) In this aspect thermoelectric cooling system has some advantages like high coefficient of performance and low cost.
- 6) The main feature aspect to be noted is that it is a one-time investment on maintenance free.

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