

REVIEW PAPER ON PELTIER EFFECT BASED FOOD CONDITIONER**¹Mr.Prashant Sharad Gadhe**HOD EE, Manav School of Polytechnic, Vyala, Akola¹hodee.msop@gmail.com¹**ABSTRACT**

The development in semiconductor electronics has increased rapidly the progress that's being made in semiconductor industries and has become one among the prime factors of dependency in today's world. Minimal power consumption and miniaturization of the semiconductor chips are the main features that lead the table of why this industry is a top notch one. During the course of time, various branches of science have joined hands to make bigger technological advancements. One of the most popular combinations being Mechanical and Electronics, called Mechatronics. Refrigerator system is one such example where miniaturization is formed possible with the usage of advanced semiconductors, which also concentrates on reduced power consumption. Amongst the numerous ways, utilization of Peltier Module is that the most favorable one as per our research. In this paper, we aim at presenting a preponderant, propitious and a simple solution for performing both cooling and heating effects in a more efficient manner by the utilization of solar energy. The Peltier module is more efficient, static and straight forward to handle. It is reliable and eco-friendly.

Keywords: Semiconductor, Peltier module, Mechatronics, Solar Energy

I.INTRODUCTION

Thermoelectric are based on the Peltier Effect, The Peltier Effect is one of the three thermoelectric effects; the cooling of one junction and the heating of the other when electric current is maintained in a circuit of material consisting of two dissimilar conductors; the effect is even stronger in circuits containing dissimilar semiconductors. The Peltier modules [1] are implemented mainly for cooling purpose. However, through the Peltier effect we can additionally accomplish heating or control of temperature. In every case, a DC voltage is required. The technique for thermoelectric cooling [2] (utilizing the Peltier effect) is valuable since it can cool an entity with no moving pieces or other complex apparatus that confines the cooler from its encompassing environment. The gadgets that are built to exploit this wonder are known as Peltier components [6] (TECs). The essential thoughts from the simple Peltier components can be associated with the arrangement to build significantly more complex Peltier modules, which have more prominent cooling capacities. However, the best temperature contrast between the warmth sink and the cool locale for a Peltier gadget is on the order of 50°C. Today's thermoelectric coolers make use of modern semiconductor technology in which doped semiconductor material takes the place of the dissimilar metals used.

II.PELTIER MODULE

Distinct type semiconductors have complementary Peltier coefficients. The array of elements which are electrically in series and thermally in parallel are soldered between two ceramic plates. The semiconductor materials preferred for the peltier effect devices are solid solutions of compounds such as bismuth telluride, antimony telluride and bismuth solenide because they provide the best performance from -30°C to 120°C and can be made both n-type and p-type. Fig 1 shows peltier module.

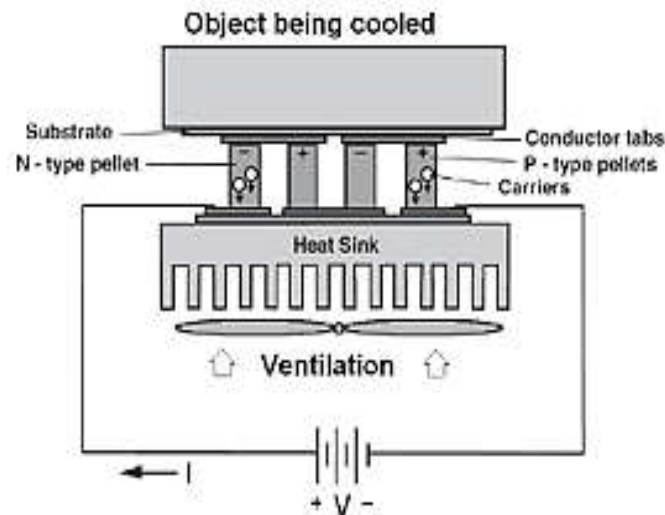


Figure1. Peltier Module for cooling

The heat absorption by the peltier module is given by:

Peltier heat absorption $Q = P \times I \times t$ (1)

Where,

P = Peltier Coefficient,

I = current and

t = time

Equation 1 is in line with the experimental results obtained as in the curve of temperature with respect to time as shown in fig 2. According to this, the rise in the temperature is linear with respect to time keeping the current as constant. During the experiment, high voltage was supplied. This resulted in a high current. Due to this high voltage, heat was produced at the hot side of the device. Hence heat produced is directly proportional to time taken. The above equation can be represented by removing the proportionality. Hence a proportionality constant is introduced which is known as Peltier co-efficient. Traditional cooling methods are usually not suitable. The use of Peltier module is environmentally safer than other cooling units. Some benefits of using peltier module and its effects are as it is solid state construction (no moving parts), precise temperature control, vibration free operation, Chloro-Fluro Carbon free, no electrical noise, performance in any physical or gravitational orientation, operates in zero gravity.

III.WORKING OF PROTOTYPE

The aim of the paper is the usage of both cooling and heating effect induced by the peltier module. The cooling effect of the peltier is observed by the extraction of heat. The gel pack absorbs and retains the temperature for a long time and in turn cools any object present inside that quadrant. The heat which is extracted is utilized by the alternative quadrant for heating purpose. This feature is realized with the prototype which consists of four structures where the minimal loss of latent heat is taken care by the usage of required insulation. Each structure is cubical in shape. Peltier modules embedded on the perpendicularly placed walls features an array of alternating n- and p- type semiconductors. The cooling effect of any unit is proportional to the number of coolers utilized. The current passes through one or more pairs of elements from n- to p-type, which leads to cooling. Decrease in temperature at the junction (cold side), results in the absorption of heat from that environment. The electrons travel from a high-energy state to low energy state. Electron convey carries the heat

along the elements of the peltier module and relinquish it on the opposite junction (hot side). Cooling effect occurs at one junction. The adjacent junction receives the heat from the colder junction causing an increase in the temperature. This causes heating effect.

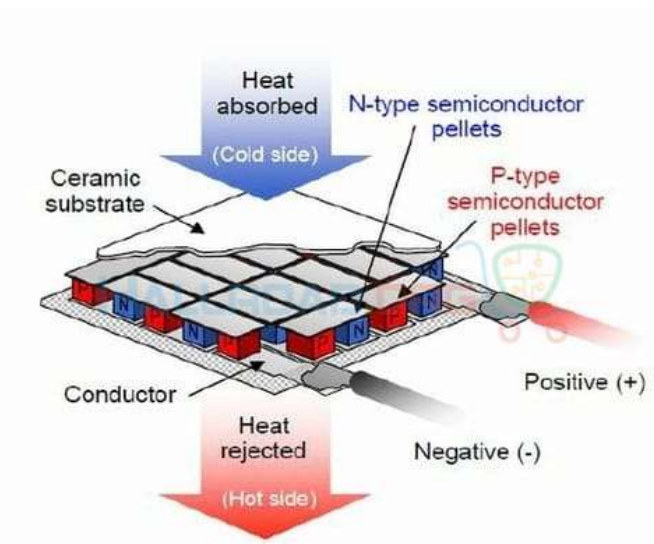


Figure2. Working Prototype

IV. POWER CALCULATIONS

Power Consumption by Load:

$$\text{Power} = I_L \times V_L \dots\dots\dots (2)$$

Where,

I_L = Load Current $I_L = 10\text{A}$

V_L = Load Voltage $V_L = 12\text{V}$

$$\text{Power} = 10 \times 12 = 120\text{W}$$

Battery Specifications:

Battery Voltage $V_B = 12\text{V}$

Battery Capacity $C_B = 24\text{Ah}$ ($8\text{Ah} \times 3$)

Battery type: Li-Po Battery

Watt-hour Calculation of Battery:

$$\text{Watt-hour} = V_B \times C_B \dots\dots\dots (3)$$

$$= 12 \times 24 = 288 \text{ Wh}$$

Complete time of operation from a full charged battery

$$TC = \text{Watt-hour of battery} / \text{Power} \dots\dots\dots (4)$$

$$= 288 / 120 = 2.4 \text{ h}$$

The variation in temperature on heat radiating side and heat absorbing side of peltier module is recorded with respect to time and a graph is plotted and is as shown Fig 6.

The red line represents the hot side and the blue represents the cold side. Temperature is measured in °C and time is measured in seconds. The initial temperature was in the range of 30 ± 0.5 °C. When the DC voltage was applied to the device, we could observe a sudden decrease in temperature at the cold side, and a sudden increase in temperature at the hot side. The temperature at the cold side gradually decreased with time. The heat absorbed by the peltier module is released at the other end. This resulted in a gradual rise in the temperature at the hot side. The temperature variations were constantly observed and noted down. According to the observation, the minimal temperature that was noted at the cold side was in the range of -10 ± 0.5 °C. Similarly, the hot side observed a temperature variation and the maximum temperature reached at the hot side was in the range of 96 ± 0.5 °C.

V.OTHER CHARACTERIZATION

Measurements can be made to test different characteristics of the device, including the modules supply voltage ripple, temperature range, settling time for several temperatures and maximum power consumption.

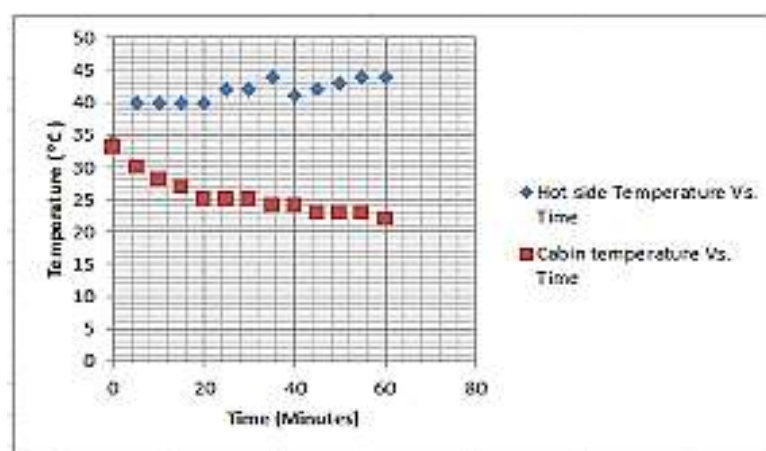


Fig 3. Temp vs Time for peltier module

VI.CONCLUSION

The Temperature characteristics of both heat radiating and heat absorbing side of the peltier module were calculated depending on the values obtained by the prototype. The voltage vs time graph provided a constant result during the observation of the prototype's performance. The experiment was conducted over the course of varying concentration of solar energy. As observed from the experimental results, the maximum temperature that can be achieved in the hot chambers is approximately 96°C and the minimum temperature that can be achieved in the alternate chambers is approximately -11°C, constituting the colder one. Hence the heat energy which is extracted through the peltier module is utilized efficiently for heating purpose serving both the cause of heating and cooling in one single module.

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