

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 9, Issue 2, February 2020

# Enhancing the Performance of Alternative Refrigeration System Using Peltier Module

Naveen S<sup>1</sup>, Krishnamoorthi P<sup>2</sup>, Pravin R<sup>3</sup>, Prince S<sup>4</sup>,

Dr. Neethimanickam I<sup>6</sup>, Mr. Sheik Sulaiman S<sup>6</sup>,

Department of Mechanical Engineering, Francis Xavier Engineering College, Tirunelveli, Tamilnadu, India<sup>1,2,3,4</sup>

Professors, Department of Mechanical Engineering, Francis Xavier Engineering College, Tirunelveli,  
Tamilnadu, India<sup>5,6</sup>

**ABSTRACT:** In this paper aims towards developing a system which will produce cooling effect without the use of mechanical devices and also refrigerant. Thermoelectric cooling system does not require working fluids or any moving parts. Thermoelectric refrigeration devices have a distinct place in medical applications, electronic applications, scientific equipment and other applications.

The difference between the existing methods is that a thermoelectric cooling system refrigerates without use of mechanical devices (Conventional Condenser fins and Compressor) and without refrigerant. In this proposed work, the main aim is to develop a refrigeration system with a capacity of 4l of cooling chamber. It is necessary to design a system capable of maintaining the temperature of the materials between 30<sup>0</sup>C to 23<sup>0</sup>C.

**KEYWORDS:** Thermoelectric Colling, 2. Medical applications, 3. Refrigerant.

### I. INTRODUCTION

“We have pleasure in introducing our idea “FABRICATION OF PELTIER COOLING SYSTEM”, which is equipped by heat sinks, peltier (thermoelectric module) element, etc. It is the system which is designed to produce cooling but the main objective behind the project is that the thermoelectric module (peltier module) to produce cooling effect. This is means that food stub cooling is done without the use of greenhouse gases which would ultimately reduce the global warming which is usually caused by other refrigeration system. Thermoelectric cooling, also known as “The Peltier Effect”, is a state method of heat transfer through dissimilar semiconductor materials. Thermoelectric cooler (TEC), or peltier Cooler uses the peltier effect for the exchange of heat. The modern commercial TEC consists of a number of p – and n – type semiconductor couples. The heat pumping direction can be altered by altering the polarity of the charging DC current. Heat will be rejected through the module from inner side to the outer surface. Inner module face will be cooled while the outer face is simultaneously heated.

Hence buildings composited thermoelectric cooling and heating systems are proposed. Thomas Seebeck, found that an electric current would flow continuously in a closed circuit made up of two dissimilar metals provided that the junctions of the metals were maintained at two different temperature. The peltier effect was discovered in 1834 by a French watchmaker and part time physicist Jean Charles Sthanse Peltier. Peltier found that the use of a current at an interface between two dissimilar materials results in the absorption of heat and release of heat at the subatomic level, this is a result of the different energy levels of materials, particularly a and p type materials. As electrons move from p type material to n type materials, electrons jump to a higher energy state absorbing energy, in this case heat, from the surrounding area. The reverse is also true. As electrons move form n type materials to p type material, electrons a fall to a lower energy state releasing energy to the surrounding area. Objective of this project is to design thermoelectric

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 9, Issue 2, February 2020

Refrigerator Utilize Peltier effect to refrigerate and maintain a specified temperature, perform temperature control in the range  $5^{\circ}\text{C}$  to  $25^{\circ}\text{C}$ . Interior cooled volume of 5Liters Retention for next half hour.

## II. MATERIAL REVIEW

Thermoelectric module is made of two different semiconducting materials, which generate thermoelectric cooling effect (Peltier effect) when a voltage of similar polarity & in appropriate direction applied through the connected junction. Two heat sinks & fans area attached to hot and cold sides of thermoelectric module in order to enhance heat transfer and system performance. There exists optimum current & optimum voltage for maximum coefficient of performance (COP) for a specific module and fixed hot/cold side temperature.

### THERMOELECTRIC COOLING:

In thermo - electrical refrigeration system, the peltier effect is the phenomenon of to create a heat flux between the junctions of two different types of materials. A peltier heater, cooler or thermoelectric heat pump is a solid – state active heat pump, which convert heat form one side of the device to the other, with consumption of electrical energy, depending on the direction of the direction of the current. Such an instrument is also called a peltier device, peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). Thermoelectric cooling uses the peltier effect to create a heat flux between the junctions of two different types of materials. They can be used either for heating or for cooling (refrigeration), although in practice the main application is cooling. It can also used as a temperature controller that either heats or cools. This technology is far less commonly applied to refrigeration than vapour – compression refrigeration. The main advantages of a peltier cooler are its lack of moving parts or circulating liquid, near – infinite life and potential to avoid leaks, and its small size and flexible shape. Its main disadvantage is high cost and poor power efficiency. Many researchers and companies are trying to develop peltier coolers that are both cheap and efficient.



Fig1. TEC

### PELTIER EFFECT:

A peltier cooler can also be used as a thermoelectric generator. When operated as a cooler, a voltage is applied across the device, and as a result, a difference in temperature will build up between the two sides.

When operated as a generator, one side of the device is heated to a temperature greater than the other side, and as a result, a difference in voltage will build up between the two sides.

## III. WORKING PRINCIPLE

A typical thermoelectric module is composed of two ceramic substance that serve as a foundation and electrical insulation for P – type and N – type Bismuth Telluride dice that are connected electrically in series and thermally in parallel between the ceramics. The ceramic also serve as insulation between the modules internal electrical elements

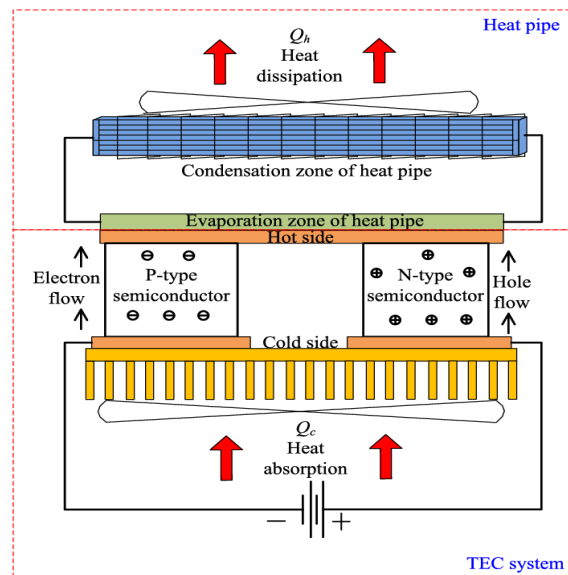
## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 9, Issue 2, February 2020

and a heat sink that must be in contact with the hot side as well as object against the cold side surface. Electrically conductive materials, usually copper pads attached to the ceramics, maintain the electrical connections inside the module. Solder is most commonly used at the connection joints to enhance the electrical connections and hold the module together. Couple is term used in most modules as even number of P – type and N – type dice and one of each sharing an electrical interconnection. While both P – type and N – type materials are alloys of Bismuth and Tellurium, both have different free electron densities at the same temperature. Deficiency of electrons is in P – type dice, while N – type has an excess of electrons. As current flows up and down through the module, it attempt to establish a new equilibrium within the materials. The current treats the P type material as a hot\junction needing to be cooled and the N – type as a cold junction needing to be heated.



**Fig.2TEC SYSTEM DIAGRAM**

Couple is term used in most modules as even number of P – type and N – type dice and one of each sharing an electrical interconnection. While both P – type and N – type materials are alloys of Bismuth and Tellurium, both have different free electron densities at the same temperature. As current flows up and down through the module, it attempts to establish a new equilibrium within the materials. The current treats the P type material as a hot\ junction needing to be cooled and the N – type as a cold junction needing to be heated.

The TEM operating working principle is based on the peltier effect. The peltier effect is a temperature difference created by Applying a voltage between two electrodes connected to a sample of semiconductor material. One of the TEM sides is cooling and the other side is heating. When a TE module is used, you must support heat refection form its hot side. If the temperature on the hot side is like the ambient temperature, then we can get the temperature on the cold side is lower. According to current value that is, leaking through a thermoelectric module the degree of the cooling is depended. Electrons act as the heat carrier in a thermo electric heat exchanger. The heat pumping action is actual function of the quantity of electrons crossing over the p – n junction.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

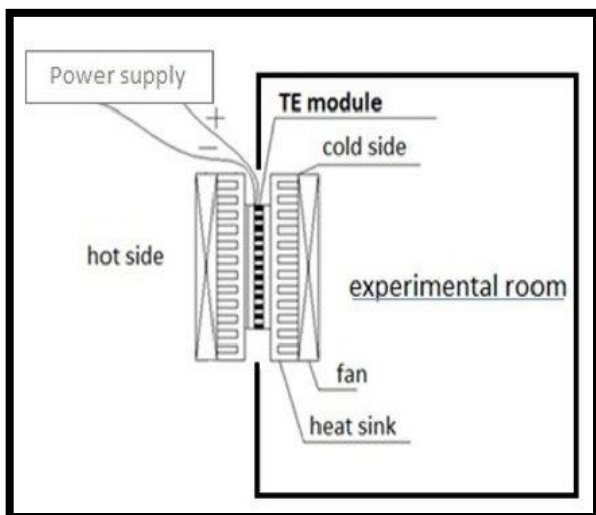
Vol. 9, Issue 2, February 2020

### Performance specification;

Hot side temperature ( $^{\circ}\text{C}$ )	26 $^{\circ}\text{C}$	50 $^{\circ}\text{C}$
Q max (watts)	50	56
Delta T max ( $^{\circ}\text{C}$ )	65	75
I max (Amps)	6.3	6.3
V max (Volts)	14.4	16.3
Module Resistance (ohms)	1.93	2.34

### EXPERIMENTAL SET UP:

For experimental purpose the conventional refrigerator system is taken. Thermoelectric module is connected to the wall of the refrigerator. Cold side of the module is inside that of the container of the refrigerator and hot side is in contact with the surrounding air. Heat will be removed from hot side with help of heat sink. Heat sink is connected on the hot side of the module.



**Fig.3 Experimental set up**  
**Fig. a Actual model of experimental set up**

### FEATURES OF PELTIER MODULE:

- Conventional system can use or generate harmful gasses like Chloro Fluoro Carbons (CFCs) and Hydro Chloro fluorocarbons (HCFCSA).
- The peltier module cannot use or generate these harmful gasses.
- Peltier module can operate on DC power source.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 9, Issue 2, February 2020

- By using proper closed loop circuit, the peltier module can control precise temperature.

## IV. CONCLUSIONS

The “PELTIER COOLING SYSTEM” is working with satisfactory conditions we are able to understand the difficulties in maintaining the tolerances and also the quality we have done to our ability and skill making maximum use of available facilities In conclusion remarks of our project work, let us add a few more lines about our impressive project work.

The portable refrigerator has no moving parts, fluid, or refrigerants. In particular, its size is very small so it is convenient for travellers to store the medicine. Temperature was controllable via changing a the input voltage/ current so we can maintain the medicine as desired level of temperature and the cost of the device is very low. This system achieves 40% to 60% of cooling effect compare to conventional refrigerator. For the above reasons this is most effective for poor people (by the cost) and travelling people ( because of size).

## REFERENCES

- [1] S.B. Riffat, Xiaoli Ma, “Thermoelectrics: a review of present and potential applications” in Elsevier Journal of Applied thermal engineering volume 23 (2003) pages913 – 935.
- [2] Wei He, GanZhanag, Xingxing Zhang, Jie Ji, Guiqiang Li, Xudong Zhao, “Recent development and application of thermoelectric generator and cooler” in Elsevier Journal of Applied Energy volume 143 92015) pages 1 – 25.
- [3] Wei He, Jinzhi Zhou, JingxinHou, Chi Chen, Jie Ji, “Theoretical and experimental investigation on a thermoelectric cooling and heating system driven by solar” in Elsevier Journal of Applied Energy volume 107 (2013) pages 89 – 97.
- [4] Manoj Kumar Rawat, HimadriChattopadhyay, SubhasisNeogi, “A review on developments of thermoelectric Refrigeration and air conditioning system: a novel potential green refrigeration and air conditioning technology” International Journal of Emerging Technology and Advanced Engineering Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 362 – 367.
- [5] Wang Huajun, Qi Chengying, “Experimental study of operation performance of a low power thermoelectric cooling dehumidifier” in International Journal of Energy and environmental Volume 1, Issue 3, 2010 pages, 459 – 466.
- [6] Manoj S. Raut, Dr. P. V. Walke, “ Thermoelectric Air Cooling For Cars” ISSN: 0975 – 5462, May 2012, P – 2394.
- [7] SurithNivas M1, “ Photovoltaic Driven Dual purpose thermoelectric Refrigerator for Rural India”, June – 2013, ISSN 2278 – 7763, P – 111.
- [8] Rehab Noor Mohammed, “ Study of Thermal Performance of Thermoelectric Cooling System”, Unpublished.
- [9] Y.Y. Hsiao, W.C. Chang, S.L. Chen, “A mathematic model of thermoelectric module with applications on waste heat recovery from automobile engine” in Elsevier Journal of Energy volume 35 (2010) pages 447 – 1454.
- [10] Edson Nogueira Jose Rui Camargo, “Performance analysis of a thermoelectric air conditioning” Rev. cienc. Exatas, Taubate, 2003/2004, p. 9-11.
- [11] Hsin – Hung Chang, “A New Design of Mobile Thermoelectric Power Generation System” International Journal of Electrical, Computer, Electronics and Communication Engineering Y 2013, P – 13128.
- [12] D. Astrain, A. Martinez, A. Rodriguez (2012), “Improvement of a thermoelectric and vapour compression hybrid refrigerator Applied Thermal Engineering” 39, 140e150.
- [13] Onoroh Francis, Chukuneke Jeremiah Lekwuwa, Itoje Harrison John (2013), “Performance Evaluation of a Thermoelectric Refrigerator, International Journal of Engineering and Innovative Technology” (IJEIT), 2, 7.
- [14] Gao Min, D. M. Roew (2006), “Experimental evaluation of prototype thermoelectric domestic – refrigerator”, Applied Energy 83, 133 – 152.
- [15] D. Astrain, J. G. Via'n, J. Albizua (2005), “Computational model for refrigerators based on peltier effect application, Applied Thermal Engineering”, 25, 3149 – 3162.