

Experimental investigation of the peltier mini cooler

Mr. Naveen. B¹, Mr. Vikas. G², Mr. Lawrence J Fernandes³, Mr. Kiran Prakasha A⁴

Abstract—This article illustrates regarding the design and construction of Portable mini refrigerator using peltier module, with an interior cooling, a box made of acrylic sheets of (15*12*10)in inches. The Peltier module is equipped with control switch, which was found to be satisfactory to meet the required precision of +/- 2 degree Celsius put forth in requirements. There is no need of refrigerants since we are using Peltier Module. The Peltier chip (TEC chip) is a thermo-element that utilizes the Peltier effect to implement a heat pump. It has two plates — one cold and the other hot. Between the plates, there are several thermocouple are connected together. Cooling Fan is used to reduce the heat dissipation. We have tested the cooling effect and the time taken to cool or freeze 1ltr of water bottle and sample testing on different cold drinks is done. Also the preferred medicine to preserve at particular temperatures

Index Terms— Peltier Chip, TEC Chip, Celsius Degree, Temperature, Module, Portable, acrylic

1 INTRODUCTION

Conventional cooling systems such as those used in refrigerators utilize a compressor and a working fluid to transfer heat. Thermal energy is absorbed and released as the working fluid undergoes expansion, compression and changes phase from liquid to vapor and back respectively. Peltier coolers offer several advantages over conventional systems. They are entirely solid devices with no moving parts; this makes them rugged, reliable and quiet. They use no ozone depleting chlorofluorocarbons, potentially offering a more environmentally responsible alternative to conventional refrigeration. Refrigeration is the process of heat removal from a space in order to bring it to a lower temperature. My Project uses "Peltier cooling module" which works on thermoelectric refrigeration, aims to provide cooling by using thermoelectric effects rather than the more prevalent conventional methods like 'vapour compression cycle' or the 'vapour absorption cycle'. Peltier coolers are used as a cooling element in laser diodes, CCD cameras, portable picnic coolers laser diodes, microprocessor, blood analyser's and portable picnic coolers.

The Structure of Peltier Module A typical thermoelectric module consists of an array of Bismuth Telluride semiconductor pellets that have been "doped" so that one type of charge carrier— either positive or negative— carries the majority of current. The pairs of P/N pellets are configured so that they are connected electrically in series, but thermally in parallel. Metalized ceramic substrates provide the platform for the pellets and the small conductive tabs that connect them.

- Mr. Naveen. B is currently working as assistant professor in the department Mechanical engineering in Sahyadri College of Engineering and management, E-mail: author_naveenmyself@ymail.com
- Co-Author name is Mr. Vikas. G, Mr. Lawrence J F, Mr. Kiran Prakasha are currently working as assistant professor in the department Mechanical engineering in Sahyadri College of Engineering and management.

2 LITERATURE REVIEW

Prof. Rajendra. P. Patil et al.[1] In the field of military and medical science there are refrigerators used to cool samples or specimens for preservation. They include refrigeration units for storing blood plasma and other blood products, as well as vaccines and other medical or pharmaceutical supplies. They differ from standard refrigerators used in homes or restaurant because they need to be very hygienic and completely reliable. However, in case of transportation of component from one place to another place there is no refrigeration system. Due to such problem, portable refrigeration system is to be used. Thermoelectric refrigeration is new alternative because it can convert waste electricity into useful cooling, is expected to play an important role in meeting today fossil energy challenges. Therefore, thermoelectric refrigeration is greatly needed, particularly for developing countries where long life and low maintenance are needed.

Shaik Ahmad et al.[2] Environment friendly solutions are becoming more prominent as a concern regarding the state of our deteriorating planet. This paper introduces a new method of Refrigeration system which removes heat from the space in order to bring it to a lower temperature than surrounding temperature. This system uses "Thermoelectric cooling module(TEC)" which works on thermoelectric refrigeration, aims to provide cooling by using thermoelectric effect which states that when D.C voltage is applied across two junctions of dissimilar electrical conductors, heat is absorbed from one junction and heat is rejected at another junction which creates a temperature difference.

Xiaoqin Sun et al.[3] As the computer systems process data more rapidly, large amounts of heat are generated in very small areas. Thermal management of the central processing unit has become crucial to avoid malfunction and failure of critical hardware. A thermoelectric cooling (TEC) system is proposed to remove the heat that is generated by electronic device in this paper. To improve the performance of this sys-

tem, a gravity assistant heat pipe (GAHP) is attached on the hot side of the thermoelectric cooling module, serving as a heat sink.

Anu Rai.P and Balakrishnan [4] The present air conditioning system produces cooling effect by refrigerants like Freon, Ammonia, etc. Using these refrigerants can get maximum output but one of the major disadvantages is harmful gas emission and global warming. These problem can be overcome by using thermoelectric modules (Peltier effect) air-conditioner and their by protecting the environment. The present paper deals with the study of Thermoelectric air conditioner using different modules are discussed.

Sudhanshu Sharma et al.[5] Thermoelectric devices are solid-state devices. Semi-conductor thermoelectric power generations, based on the Seebeck effect, and semi-conductor thermoelectric cooling, based on the Peltier effect, have interesting capabilities compared to conventional power generation and cooling systems. The absence of moving components results in increase in reliability, a reduction in maintenance, and an increase of system life; the modularity allows for application in wide range without significant losses in performance; the absence of working fluid avoids environmental dangerous leakages; and the noise reduction appears also to be an important feature.

Hayder Al-Madhhach[6] The key objective of this study is to analyze the heat transfer processes involved in the evaporation and condensation of water in a water distillation system employing a thermoelectric module. This analysis can help to increase the water production and to enhance the system performance. For the analysis, a water distillation unit prototype integrated with a thermoelectric module was designed and fabricated. A theoretical model is developed to study the effect of the heat added, transferred and removed, in forced convection and laminar flow, during the evaporation and condensation processes. The thermoelectric module is used to convert electricity into heat under Peltier effect and control precisely the absorbed and released heat at the cold and hot sides of the module, respectively. Temperatures of water, vapor, condenser, cold and hot sides of the thermoelectric module and water production have been measured experimentally under steady state operation. The theoretical and experimental water productions were found to be in agreement. The amount of heat that needs to be evaporated from water-vapor interface and transferred through the condenser surface to the thermoelectric module is crucial for the design and optimization of distillation systems.

M. BALA KUMARAN et al.[7] This paper studies a refrigeration system by using thermoelectric effect (peltier), a module for controlling the temperature within an enclosed structure that is provided in the system. It consists of controller system, transducers, cooling fan and sensing element. The desired temperature which was about 5°C for 10 liters of loads as similar as normal refrigerators, the various parameters of this

module are of cooling fan voltage (CFV), Peltier Voltage (PV) and ambient temperature (Ta). The results show that the COP was increasing from 0.14 to 0.47 with the gradual decrease of temperature in the cooling region from 303 K to 284 K. The thermoelectric effect of refrigerator increased with a higher amount of heat rejected from the heat sink.

N K KAPHUNHKUI et al.[8] 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.

C. Selvam et al.[9] In this work, a novel technique to improve the performance of Peltier cooler under varying electric pulse conditions has been studied with the use of phase change material (PCM). The 2D heat transfer model of Peltier cooler along with heat sink has been developed and studied numerically. The results show that the cold side temperature of Peltier cooler with PCM has been reduced significantly from -14.5 °C to -17.5 °C under pulse operation as compared to the Peltier cooler without PCM under pulse operation. It is also found that, there is no significant reduction in COP of the Peltier cooler under pulse operation with PCM as compared to pulse operation without PCM. These studies have been carried out by varying the hot side heat transfer coefficient, fill volume of PCM in heat sink and the shape of the electric pulse. It has been observed that the super cooling of Peltier cooler increases with increase in fill volume of PCM. Furthermore, it has been found that the super cooling performance of the Peltier cooler is more predominant with the square pulse as compared to ramp and triangular pulses.

Manikandan. S et al.[10] The vacuum pump run efficiently by using condenser to remove moisture content for increase the life span of pump. In that same way we could modify some and studied, analyzed about various alternatives preferred for removing moisture control. So we implement the three methods as silica gel and zeolite adsorption and at last, the alternative method is Peltier cooler module technique. Here, we should use cooler for great efficient cooling to condensate and another side the equivalent amount of heating is occurred to increase the performance level of the vacuum pump after removing the moisture content. As the demand for the cool stor-

age systems can be used to the economic advantage over conventional cooling plants. The choice of the substances used largely depends upon the temperature level of the application. Phase change material (PCM) are one of the latent heat materials having low temperature range and high energy density of melting solidification compared to the sensible heat storage. The transformation is very importance for any another thermal energy transform. Then we preferred to use the suitable heat sink as the one of the transfer media that will be in correct proportion for placed the Peltier module in this functions.

Alok A Ghude et al.[11] The conventional air-conditioning system uses refrigerant that harms the environment and depletes the ozone layer. The commonly used refrigerants are CFC's and HFC's. Though HFC's has less effect over the ozone layer as compared to the CFC's but it still plays a role in depletion of ozone layer. A huge time would be required to make the complete system eco-friendly Moreover the other factors like extra power consumption, maintenance, service etc. lead to find an alternative for existing air-conditioning system. thermoelectric Hybrid air-conditioning system has a solution to these advantages. In our project main use of solar power which is nature's free gift is used to drive the thermoelectric module. The solar energy is converted into electrical energy through solar panel which is then given to the thermoelectric module. In case of insufficient solar energy, electrical energy can be used to charge the battery. As the electric current is given to the thermoelectric module due to Peltier effect temperature difference occurs. The blowers extract the heat from the cold side and the cold air is circulated in the conditioned space by changing the polarity hot air can be circulated in the conditioned space. So basically this is a year round air-conditioning which can be used for many purposes.

3 RESULT & DISCUSSIONS

Calculation on Coefficient of Performance:

$$COP = \frac{T_1}{T_2 - T_3}$$

Where,

COP - Coefficient of Performance

T₁ & T₃- Ambient Temperature

T₂ - Refrigerator Temperature

Time Taken (hour)	Refrigerator Temperature (T ₂) deg.	Coefficient of Performance
1h	30	1.515
2h	29	1.0066
3h	28	0.7525

4h	27	0.60
5h	26	0.4983
6h	24	0.37125
7h	22	0.295
8h	20	0.2441
9h	18	0.2078
10h	16	1.80625

As the Times goes increasing up, temperature is getting reduced, with the use of the more number of the Peltier module in all the directions, we can reduce the temperature to much more level, where we can use the module for medical preservation. In this regard, further making less dissipation we can make the cooler portable one as well as medicine preservative.

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