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Thermo Electric Refrigerator (TER) - Advancement in Refrigeration Cycle Using Peltier Effect

Joemax Agu[1], Kaleeswaran[2], Nandhakumari[3], Stalin Durai[4]
[1](Faculty of Mechanical Engineering, KGiSL Institute of Technology, India)
[2](Faculty of Mechanical Engineering, KGiSL Institute of Technology, India)
[3](Faculty of Mechanical Engineering, KGiSL Institute of Technology, India)
[4](Faculty of Mechanical Engineering, KGiSL Institute of Technology, India)

ABSTRACT: *The concept of this research work is to create portable thermoelectric refrigeration system. It is able to maintain particular temperatures between 10 °C and 20 °C. The system components are thermoelectric module which works as a cooling tower as well as a transformer for power supply. Cooling is done by the modules which work similar to conventional refrigerators. The design of the system is based on the principles of thermoelectric effect (i.e. Peltier effect) to create a cold end and a hot end. The heat is engrossed from the low temperature to high temperature of the module and it is released to the surroundings with the help of heat sinks and fans. The preliminary setup was made after getting baseline inputs from the thermoelectric refrigeration systems. Based on the heat and power data, the thermoelectric module is selected. The ability of the system to maintain the desired atmospheric temperature was derived. The obtained results exhibited that the system can maintain the storage temperature at 10°C and 20 °C under ambient temperature up to 30 °C with minimum power consumption of 65 Watt.*

KEYWORDS *– Atmospheric, Peltier, Refrigeration, Storage, Temperature*

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I. INTRODUCTION

The conventional refrigerator requires the liquid refrigerant to extract heat from the chamber by using the help of a compressor. It requires more energy consumption and volume. The liquid refrigerant is toxic and causes global warming and ozone layer depletion. In order to overcome this challenge we are considering Thermo electric Refrigerator (TER). This refrigerator works on the principle of Peltier effect and this device is also called as Thermo electric refrigerator, it is used for cooling process. In the TE Refrigerator there is no usage of refrigerant and compressor. Peltier coolers (also known as semiconductor thermoelectric coolers) are controlled by Peltier module. However, their efficiency is lower when compared to conventional refrigerators. Hence, they were utilized in small applications because of their optimum usage apart from their low efficiency. Despite some applications have been considered (space probes, laboratory instruments and laser diodes), Peltier coolers are generally applied for domestic purpose effects.

Jonathan Michael Schoenfeld et al 2008, done the research, in which two general areas were focused on increasing the performance of TER; one of which focuses on thermoelectric semiconductors and another one explains about heat dissipation techniques. The main concentration is on developing superior thermoelectric properties with advanced thermoelectric materials. As the outcome suggest an increase in the optimum Coefficient of performance (COP) of a TER. Most common thermoelectric semiconductor is present in TERs is Bismuth Telluride (Bi_2Te_3).

Bass et al 2004, identified the usage of Multi-Layer Quantum Well (MLQW) thermo electrics for cooling purpose. It is noted that the manufacturing expense of the module is an additional load to the equipments. Behind this increase in COP provided to improve the properties of thermoelectric device, Tellurium is the main component in Bismuth Telluride, it increases performance but additional cost, and it leads to a replacement for thermoelectric device. Many researches is still on board to develop an advanced nanotechnology thermo electric device.

Chain and Chen et al 2011, investigated the usage of water cooled micro channel heat sink in which silicon wafer glass plate is used to cover the micro channel. Fabrication of four micro channel heat exchangers with different number of ports was used. Water has been pumped to remove the heat from the hot section of the TER module. 4 cm x 4 cm TE module was placed on the top of the micro channel. Their research suggested increasing the aspect ratio of the micro channel ports by reducing thermal resistance and by using more conductive material like copper.

Riff et al 2005, investigated TE refrigerator with water and an air cooled heat sink. The observations are, the thermal resistance of an air cooled heat sink higher than water cooled heat sink, with values as low. As suggested it is difficult to fabricate a curved surface TE module. The present research comprises of increasing the basic performance and wide applications to the industry and also to execute minimal economy loss. Design construction of a TER which is attempted with minimal environmental pollution.

II. NEW MODEL DESIGN

2.1 MODULE SELECTION

The selection focuses on specific application hence special care is required in order to evaluate total refrigeration use. Standard module is used for common designs and in case of special applications modification has to be made on design so as to adjoin electrical and mechanical properties. Peltier module has been utilized in this research. The total cooling system is dynamic and system performance is a function of correlated parameters.

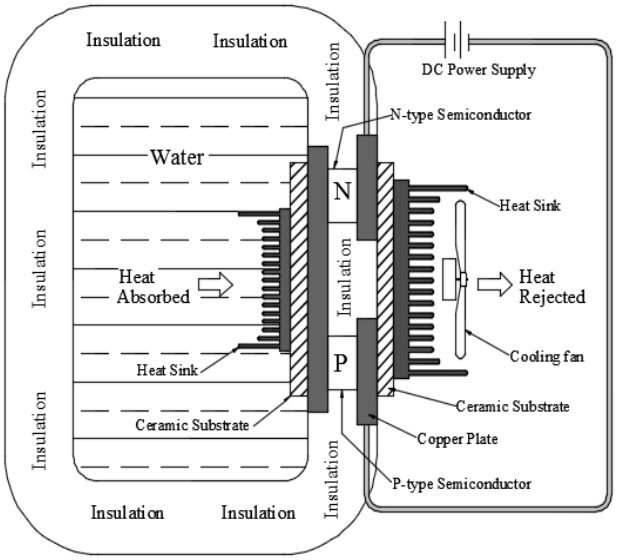

Fig. 1: Thermoelectric refrigeration system

2.2 COMPONENTS USED

P-type and N-type semiconductors were used in thermo electric modules which are connected electrically in series and thermally in parallel. Because of their solid state construction thermo electric modules are more reliable. The selection is made since it provides long quality assurance in service and maintenance of modules. Gaurav Maradwar et al 2014, in cooling application, an electrical current is passed to the module, heat is extracted from one side to the other, and it results in one side of the module which becomes extremely cold and the other side becomes hot.

Aluminum is used to fabricate the heat sink which is in contact with the hot side of module. When positive and negative module leads were connected to respective positive and negative terminals of DC power source, heat is extracted from the hot side of the module, the heat sink accelerates the extraction of heat. Onoroh et al 2013, the intermediate stages in the heat removal process is done by heat sink and heat flows directly into a heat sink and then is transferred to an external medium.

The cold side is also made of aluminum which connects with the cold side of a TER module, when positive and negative module leads are connected to the respective positive and negative terminals of DC power source, heat is extracted from the cold side of the module. The hot side of a module is normally placed in contact with the object being cold. Inspection is done with the help of spacer block even though which is optional to maintain adequate air gap between the heat sink and the object which is being cooled.

2.3 REFRIGERATION BOX

Cooling chamber is made with the help of aluminium composites. The design was made such a way that the outer portion of the refrigeration box is made of wooden ply so as to withstand the cooling temperature and the inner portion is insulated as shown in figure.

Fig. 2: Refrigeration Box

2.4 PELTIER REFRIGERATION CIRCUIT

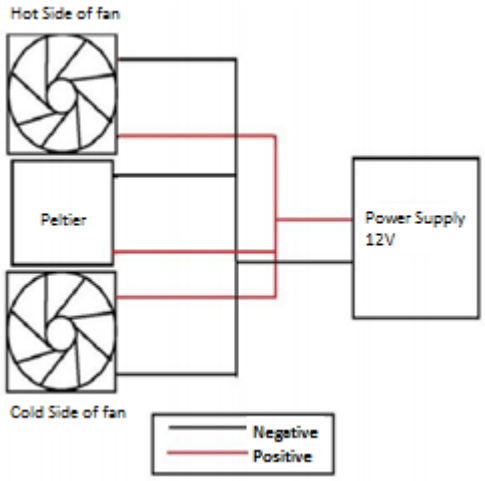

Fig. 3: Refrigeration Box

In circuit diagram figure 3 the Peltier is placed in between the hot portion of the fan and the cold side of the fan. Both the Peltier devices and the fans are connected to the 12V power supply. Since Peltier is a semiconductor device direct current is utilized for its capability. Different colored wires were used to denote the positive and negative terminal. In this system, as Peltier receives power supply at one of its end and gets hot , other end gets cold which is the basic principle of working of our TER.

III. EXPERIMENTAL ANALYSIS

The initial pre setting temperature of the refrigeration box is kept as 30.6^0C. The investigation was made with three trials at different conditions, it was observed for cooling rate of TER for about 45 minutes. As a result the temperature of the refrigeration box which has been declined from 30.6^0C to 21.1^0C. Thus the temperature has a declining rate fall of 9.5^0C in stipulated 45 minutes.

Table 1: Observation on Time and Corresponding Temperature

TIME (Min)	TEMPERATURE (°C)
0 (Room Temp)	30.6
5	25.5
10	23.4
15	23.2
20	22.7
25	22.3
30	22
35	21.5
40	21.2
45	21.1

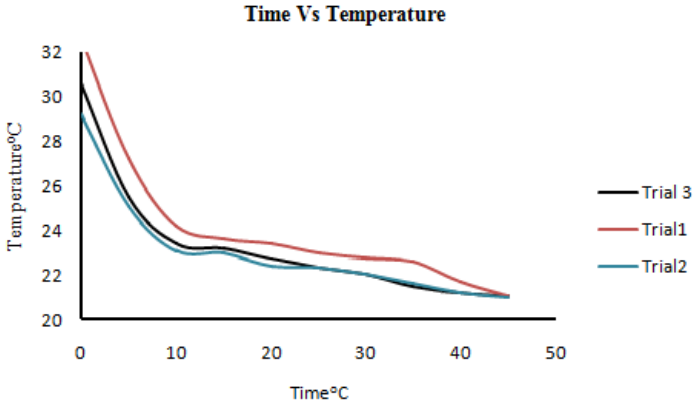

Fig. 3: Time and Temperature Corelation

IV. CONCLUSION

The proposed design of Peltier system achieved the desired temperature reduction and better refrigeration in different temperatures. However, maximum efficiency could not be achieved due to different environmental conditions and the material usage. . The present design and concept is utilized to maintain a particular temperature. The current design of TER system is unable to bear variable power fluctuations. More type of advanced modifications can be installed in this machine in order to handle different components before introducing to industrial applications. Thermoelectric refrigeration is one of the recent emerging areas of the field of refrigeration. Since no types of harmful gases are introduced, TER can gain more advantage as it is reliable and a green refrigeration alternative which is eco friendly in use. Even though there are different types of cooling modules available in global market to remove the heat from closed systems, but as the advancement in technology, thermoelectric cooling is emerging as a most useful method.

REFERENCES

[1]. Jonathan Michael Schoenfeld, Master of Science,2008 "Computational Model for Refrigerators Based on Peltier Effect Application", Applied Thermal Engineering, Vol. 25, No. 13, pp. 3149-3162.
[2]. Bass et al. (2004), Multi-layer quantum well (MLQW) thermo electrics in a cooling application International journal of research in aeronautical and mechanical engineering ISSN (online): 2321-3051
[3]. Chain and Chen "Performance Prediction and Irreversibility Analysis of a Thermoelectric Refrigerator with Finned Heat Exchanger", ACTA PHYSICA POLONICA No.03. (2011). Vol. 120.
[4]. Riff at and Qiu "Air conditioning systems with an air and water cooled heats sink" International Journal of Emerging Technology and Advanced Engineering Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, ISSN 2250-245.
[5]. Zhang H Y, "A General Approach in Evaluating and Optimizing Thermoelectric Coolers", Int. Journal of Refrigeration, Vol. 33, No. 10, pp. 1187-1196. (2010).
[6]. Gaurav Maradwar, "Fabrication And Analysis Of Problems In Thermoelectric Refrigerator" International Journal Of Core Engineering & Management (IJCEM) Volume 1, Issue 2, May 2014, ISSN:2348 9510
[7]. Onoroh Francis, Chukuneke Jeremiah Lekwuwa, "Performance Evaluation of a Thermoelectric Refrigerator" International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 7, January 2013, ISSN: 2277-3754
[8]. Nambiraj N Gopikumar S, Jeyaram A, Vethamoorthy A, Thangaraj M, Sheik Arafath I, Effective Utilization of Natural Fibers (Sisal, Jute and Banana) in Framing Composite Material for Replacement of Compressed Wood, Asian Journal of Science and Technology 2018, 9 (04), 7976 – 7980.

Books:

[9]. C. P. Arora," Refrigeration & Air Conditioning" 2nd Edition, TMH Publication, ISBN 0-07- 463010-5