

Compact Thermoelectric Refrigerator

Mr.Prashant S. Mohite¹, Mr.Nitin N. Mane², Mr.Akash A. Abdar³,
Mr.Akshay A. Sakat⁴, Mr. Digvijay M. Mane⁵, Mr. Pratik S. Shewale⁶

¹(Assistant Professor, Mechanical Engineering Department, AGTT's Dr. DaulatraoAher College of Engineering, Karad.)
²³⁴⁵⁶ (UG Student, Mechanical Engineering Department, AGTT's Dr. DaulatraoAher College of Engineering, Karad.)

Abstract:

In recent years, with the increasing awareness towards environmental degradation, thanks to the assembly, use, and disposal of Chloro-Fluoro Carbons (CFCs) and Hydro Chlorofluorocarbons (HCFCs) as heat carrier fluids in typical refrigeration and acquisition systems has become an issue of nice concern and resulted in intensive analysis into the event of novel refrigeration and area conditioning technologies. Thermoelectrical refrigeration is one of the techniques used for built-up refrigeration result.

The range of thermoelectric products is kind of massive, and is ever increasing with the imaginations of style engineers for heating and cooling applications. However, TE cooling is specifically the abstraction of heat from electronic parts. Over the past four decades, improvement within the conversion potency has been marginal.

According to a field survey on State Transport drivers and conductors, Private Travel’s drivers and conductors, we came to know that they face problems in summer days with cold water storage for drinking purposes. The objective of this project is to design and develop a working thermoelectric refrigerator with an interior cooling volume of 7ber that utilizes the Peltier effect to cool down and uphold at selected temperatures from 5°C to 15°C. The design requirements are to cool this volume to the temperature within a time period of 2 and 1/2 hrs.

Keywords —Refrigeration, Thermo-electrical system, Peltier effect.

I. INTRODUCTION

In recent years, with the increasing awareness towards environmental degradation, thanks to the assembly, use, and disposal of Chloro-Fluoro Carbons (CFCs) and Hydro Chlorofluorocarbons (HCFCs) as heat carrier fluids in typical refrigeration and acquisition systems has become an issue of nice concern and resulted in intensive analysis into the event of novel refrigeration and area conditioning technologies. Thermoelectrical cooling provides a promising various R&AC technology thanks to its distinct benefits. Icebox and air conditioners square measure the notable energy-consuming household machines and for this reason, several researchers had performed work to

emphasize the performance of the refrigeration systems. Most of the analysis work done to date deals with the associate objective of low energy consumption and refrigeration result improvement. Thermoelectrical refrigeration is one of the techniques used for manufacturing refrigeration result. Thermoelectrical devices square measure developed supported Peltier and Seeback result that has knowledgeable about major advances and developments in recent years. The constant of performance of thermoelectrical refrigeration is as smaller amount once it’s used alone, thus thermoelectrical refrigeration is commonly usedwith different strategies of refrigeration.

The conservative cooling systems are used currently need the refrigerant whose naturalaction

takes place in heat exchanging and the mechanical device necessary for the compression of the refrigerant. The mechanical device required a lot of power and a house. The refrigerant is additionally noteco-friendly and will increase worldwide warming and also the major explanation for layer depletion. An Eco-friendly icebox depends on the PELTIER impact and an electricity device referred to as a Peltier device is engaged for cooling purposes. Within the MEF-Refrigerator there's no would like of mechanical device and refrigerant. Semiconductor electricity coolers (also called Peltier coolers) off temperature management ($\pm 0^{\circ}\text{C}$) are often achieved with Peltier coolers. However, their potency is low compared to traditional refrigerators. Thus, they're employed in niche applications wherever their distinctive blessings outweigh their low potency though some massive-scale applications are thought of (on submarines and surface vessels). Peltier coolers are usually employed in applications wherever tiny size is required and be too nice, like for cooling electronic parts.

The range of TE products is kind of massive, and is ever increasing with the imaginations of style engineers for heating and cooling applications. However, TE cooling is specifically the abstraction of heat from electronic parts. Over the past four decades, improvement within the conversion potency has been marginal. The challenge has been the development within the performance of the thermometer maters, which may lead to a breakthrough in terms of the potency of the TE device. Associate degree increasing surge within the demand of refrigeration has been noticed e.g. air-conditioning, food preservation, immunizing agent storages, medical services, and cooling of electronic devices, LED to associate degree twelve increase within the ingesting of electricity that could be a conducive issue for heating and global climate change. TE refrigeration could be useful various because it will use waste electricity for any cooling applications and meeting our gift energy challenges. Further, these are entirely solid-state devices, and the absence of moving components makes them jagged, dependable, and noiseless. Additionally to the present, these useno gas

depleting chlorofluorocarbons, doubtless giving a lot of environment-friendly various to traditional refrigeration. However, their potency is squat compared to traditional refrigerators. The objective of this project is to style an electricity icebox to regulate the temperature within 5°C to 15°C .

II. LITERATURE REVIEW

In view of proposed dissertation work concerned, following few of the researchers have done their experimental study and investigated results which have been reviewed as follows:

MathieuCosnier [1] showed an experimental and numerical study of a thermoelectric air-cooling and Air-heating system. They have grasped a cooling power of 50W per module, with a COP between 1.5 and 3 By supplying an electrical intensity and upholding the 5°C temperature difference between the hot and cold sides.¹

SuwitJugsujinda [2] showed a study on studying thermoelectric refrigerator performance. The thermoelectric refrigerator (TER; 25 x 25 x 35 cm³) was built using a thermoelectric cooler (TEC: 4 x 4 cm²) and provided with electrical power of 40 W. The TER was diminished from 30°C to 20°C for 1 hour and slowly decreasing temperature for 24 hrs. The extreme COP of TEC and TER were 3.0 and 0.65.²

Wei He [3] conducted and did Numerical study of Theoretical and experimental investigation of a thermoelectric cooling and heating system driven by solar. The thermoelectric device works as a Peltier cooler when electrical power provided by PV/T modules applied on it. In Summerseason. The smallest temperature 17 degree C is achieved, with COP of the thermoelectric device higher than 0.45.³

Riff and Guoquan [4] conducted an investigational study of proportional investigation of thermoelectric air conditioners versus vapour compression and absorption air conditioners. Three types of domestic air conditioners are compared and compact air conditioner was built.⁴

Shen, Xiao [5] investigated a new thermoelectric radiant air-conditioning system (TE-RAC). Based on the analysis of a commercial thermoelectric module they have obtained a maximum cooling COP of 1.77 when applying an electric current of 1.2 Amp and maintaining cold side temperature at 20°C.⁷

III. PROBLEM IDENTIFICATION

The conventional cooling systems are used nowadays require the refrigerant whose phase change takes place in heat exchanging and compressors are required for the compress of the refrigerant. The compressor required more power and space. Because of this reason in some applications where size or weight is a constraint we need a compact size refrigerator.

According to a field survey on State Transport drivers and conductors, Private Travels drivers and Conductors, we came to know that they face problems in summer days with cold water storage for drinking purposes. They usually wrap a wet cloth around the water bottle and cans. As time passes it gets warmer and again they have to soak the cloth in water to get water to cool down. To overcome this, we intended to build a compact thermoelectric refrigerator that can be used for multiple purposes. Also in rural areas, there is a tradition of a weekly market and it becomes difficult to store Veggies and fruits in the summer season as they get deteriorate early than other seasons.

The compact Eco-friendly refrigerator is centred on the PELTIER EFFECT and a thermoelectric device called Peltier device is used for cooling purposes. In the Refrigerator there is no need for a Compressor and refrigerant.

IV. OBJECTIVE OF PROJECT

The objective of this project is to design and develop a working thermoelectric refrigerator with an interior cooling volume of 7 litre that utilizes the Peltier effect to cool down and uphold at selected temperatures from 5°C to 15°C. The design requirements are to cool this volume to the temperature within a time period of 2 and ½ hrs.

In circuit diagram we will see that, the peltier is placed between the hot facet heat sink and fan and cold facet heat sink and fan. Each the peltier device and fans unit connected to the 12V power supply. Here the current provided is DC (Direct Current) as a result of the peltier device could be a conductor. The red wire is positive and therefore the black is negative, because when the peltier gets the provided with power it's one end gets hot and therefore the different gets cold that is that the basis of the operating of the working of thermoelectric refrigerator.

Material used for fabricating Compact Thermoelectric Refrigerator

Peltier Module: The thermoelectric Module: The thermoelectric module consists of pairs of P-type and N-type semi-conductor thermal component forming thermocouple junction that are connected electrically nonparallel and thermally in parallel. In cooling application, Associate in Nursing electrical current is provided to the module, heat is wired from one surface to the opposite, and therefore the result's that one surface of the module becomes cold and other surface hot. Thermoelectric module could be an electricity (D.C) device.⁷

Heat Sink: the heat sink typically product of metallic element, is to bear with the new face of a thermoelectric module. Once the positive and negative module leads are connected to the various positive and negative terminals of an instantaneous Current (D.C) power supply, Bat is rejected by the modules hot facet, the heat sink expedites the removal of heat. Common heat sinks uses free convection, forced convection and fluid cooled system.

Cooling Fan: It cools the actual space by taking out the new air from that specific space. In thermo electrical refrigeration method the fan is employed on each side i.e. cold and hot surface. The New surface fan takes away the heat from the new surface and discharges it to the environment by the help of cold surface fan. In thermoelectric refrigeration fins also are hooked up to the fans for a lot of economical cooling.

Temperature Sensor: The temperature detector could be a device that used to sense the temperature of the refrigeration box and provides us the correct information concerning the speed of cooling of the box. It's very important device that is offers precise data concerning the cooling rate of the box and it conjointly helps to calculate the potency of the device i.e. thermoelectric cooler.

Insulating Materials used for fabrication are:

1. Plywood
2. Styrofoam or Thermocol
3. WPC (Wood Plastic Composite)

V. WORKING PRINCIPLE

In TE-Refrigerator the peltier device is used which works on peltier effect.

The Seebeck Effect: It is the reverse of the Peltier Effect. By applying heat to two different conductors a current can be generated.

Where is that electrical field?

A typical thermoelectric cooling part is shown. Bismuth Telluride (Atomic number 83 chemical compound) used as a semiconductor is sandwiched between 2 conductors, typically copper. A semiconductor (called a pellet) is employed as a

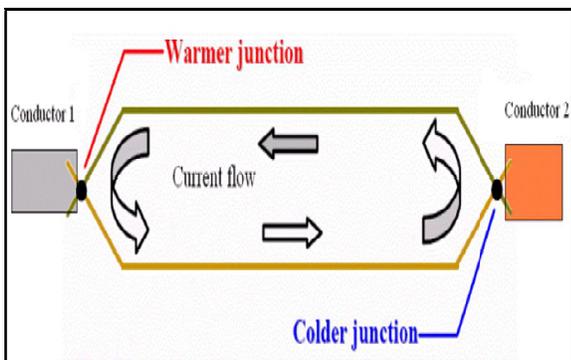


Figure 1: Peltier Effect

result of they will be elevated for pumping heat and since the kind of charge carriers at intervals these are chosen. The semiconductor during this example

N kind (doped with electrons) so, the electrons move towards the positive terminal of the battery.

When P type semiconductor (doped with holes) is employed instead, the holes move during a direction opposite the electric current flow. The Heat is additionally transported during a direction opposite the electric current flow and within the direction of the holes. Basically, the charge carriers direct the direction of heat flow.

VI. OBSERVATION AND RESULTS

Heat Transfer through Composite Wall = 2.72 Watts.

Observes Statistics:

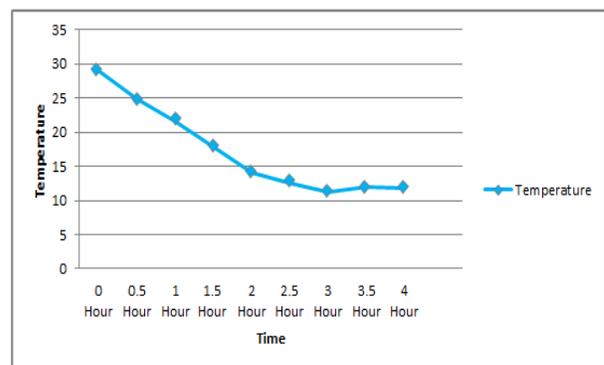


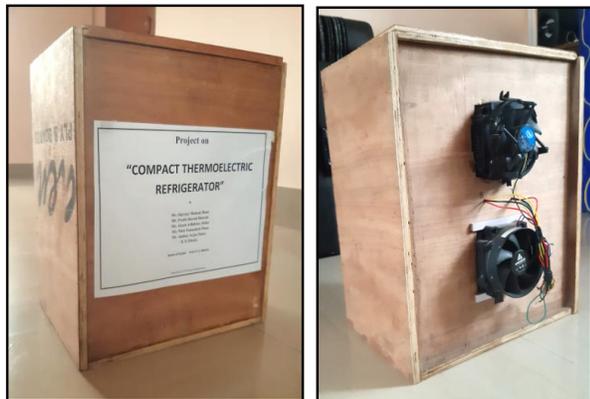
Figure 2: Graph showing Temperature decrease as increase in Time.

As time increases temperature decreases and maintain at lower temperature while in action which is basic goal of our project.

Time (Hrs.)	0	0.5	1	1.5	2	2.5	3	3.5	4
Temp (°C)	29	24.8	21.7	17.9	14.1	12.5	11.3	12	11.8

Table 1: Table showing Temperature and Time for taken Observations

Actual Project Images



refrigerate and maintain a particular temperature from 5°C to 15°C. The design requirements are to cool this volume to temperature within a time period of 3 and 1/2 hrs.

REFERENCES

- [1] ElCosnier W., Gilles M., Lingai., An experimental and numerical study of a thermoelectric air-cooling and air. Heating system. International journal of refrigeration, 31,1051-1062, (2008).
- [2] Sujin.,Vora and Sectawan.. Analyzing of Thermoelectric Refrigerator Performance. Proceedings of the 2ndInternational Science, Social-Science, Engineering and Energy Conference, 25,154-159 (2000).
- [3] Wei, Jinzhi. Jingxin&Chen.. Theoretical and experimental investigation on a thermoelectric cooling and heating system driven by solar. Applied Energy. 107. 89-97, (2013).
- [4] Riffat and Guoquan. Comparitive investigation of thermoelectric air-conditioners versus vapour compression and absorption air-conditioners. Journal of Applied Thermal Engineering, 24. 1979-1993, (2004).
- [5] Riffat and Qiu., Design and characterization of a cylindrical water cooled heat sink for thermoelectric Airconditioners. International journal of energy research, 30, 67-80.(2005).
- [6] Astrain D., Vian J.G., & Dominguez M., Increase of COP in the thermoelectric refrigeration by the optimization of heat dissipation Applied Thermal Engineering, 23.2183 2200,(2003).
- [7] Shen., Xiao., Chen & Wang., Investigation of a novel thermoelectric radiant air-conditioning system. Journal of Energy and Buildings, 59, 123-132.(2012).
- [8] Virjoghe.,Diana., Marcel & Florin., Numerical simulation of Thermoelectric System. latest trends on systems,15(2),630-635,(2009).
- [9] Maneewan.,TipsaenpromandLertsatitthanakorn., Thermal comfort study of a compact thermoelectric air conditioner. Journal of electronic materials, 39(9), 1659-1664, (2010).
- [10] ManojS.&Walke.. Thermoelectric Air Cooling For Cars. International Journal of Engineering Science and Technology 40(5), 2381-2394,(2011).

VII. CONCLUSIONS

There are many different kinds of cooling devices on the market to get rid of the heat from industrial enclosures. However, as the technology advances, thermoelectric cooling is rising as a very viable technique that may be advantageous within the handling of bound small-to-medium applications because the potency and effectiveness of thermoelectric cooling steady will increase, the advantages that it provides as well as self-contained, solid-state construction that eliminates the necessity for refrigerants or connections to chilled water provides, superior flexibility and reduced maintenance prices through higher dependability can increase yet.

Thermoelectric refrigeration is one of the key areas wherever researchers have a keen interest. A number of the recent advancements within the space surpass a number of the inherent demerits like adverse COP. Cascaded module design has outlined new limits for its application. Furthermore, a recent breakthrough in organic molecules as a thermoelectric material guarantees a bright future for TER. With additional and additional countries showing interest in Montreal and Kyoto protocol, TER is gaining additional attention as reasonable, reliable and inexperienced refrigeration different. From his style, we tend to develop an operating thermoelectric cooler with a cooling volume of seven litres that utilizes the Peltier result to