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A Review on Thermoelectric Refrigerator

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ABSTRACT: The increase in demand for refrigeration globally in the field of air-conditioning, food preservation, medical services, vaccine storages, and for electronic components temperature control lead to the production of more electricity and consequently an increase in the CO₂ concentration in the atmosphere which in turn leads to global warming and many climatic changes. Thermoelectric refrigeration is a new alternative because it can reduce the use of electricity to produce cooling effect and also meet today's energy challenges. Therefore, the need for thermoelectric refrigeration in developing countries is very high where long life and low maintenance are needed. The objectives of this study is to develop a working thermoelectric refrigerator to cool a volume of 40 Lit. that utilizes the Peltier effect to cool and maintain a selected temperature range of 5 °C to 25 °C.

KEYWORDS: Peltier module, Cooling fan , Heat Sink , AC to DC Converter, MDF Sheet, Foam Sheet, DC to DC Converter

I.INTRODUCTION

Refrigeration is the process of heat removal from a space in order to bring it to a lower temperature than surrounding temperature. In this context our project topic, "Thermoelectric Refrigerator" which works on "Peltier effect" aims to provide cooling by using thermoelectric effect rather than the more prevalent conventional method like "vapor compression cycle" or the "Vapour absorption cycle".

Due to the increasing demand for refrigeration in various fields led to production of more electricity and consequently more release of harmful gas like CO₂ all over the world which is a contributing factor of global warming on climate change. Thermoelectric refrigeration is a new alternative method. The thermoelectric modules are made of semiconductor materials electrically connected in series configuration and thermally in parallel to create cold and hot surfaces. Although they are less efficient than the vapour compression system, they are very light, low in cost, silent in operation, and are environmentally friendly. The objectives of this project is to design and develop a working thermoelectric refrigerator that utilizes the Peltier effect to refrigerate and maintain a temperature between 5 °C to 25 °C. The design requirements are to cool the volume to a temperature within a short time and provide retention of at least next half an hour. And a thermosiphon cooling system is used for cooling the hot side of TEC module. It will be used in remote locations in the world where there is no grid electricity, and where electrical power supply is unreliable when a solar panel charger is added for battery charging. A thermoelectric module thus uses a pair of fixed junctions into which electrical energy is applied causing one junction to become cold while the other becomes hot. Because thermoelectric cooling is a form of solid-state refrigeration, it has the advantage of being compact and long lasting.



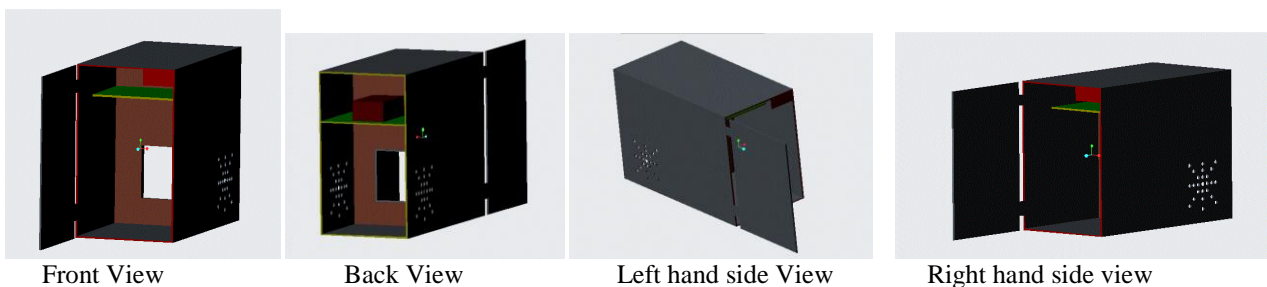
II.LITERATURE SURVEY

Manoj Kumar Rawat.et.al,“A Review On Developments Of Thermoelectric Refrigeration And Air Conditioning Systems: A Novel Potential Green Refrigeration And Air Conditioning Technology”,Central Mechanical Engineering Research Institute,(CSIR-CMERI), Volume 3,ICERTSD 2013, ISSN 2250-2459.

Mayank Awasti.et.al, “Design and Development Of thermoelectric Refrigerator”, Int. J. Mech. Eng. And Rob . Res. 2012 ,Vol. 1 No.3, Oct 2012,ISSN – 2278-0149.Antony Varghese.et.al, “Design and Fabrication of Thermoelectric Refrigerator with Thermosiphon System”,International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-2, Issue-4,2016, ISSN: 2395-3470.

III .PROPOSED SYSTEM DEVELOPMENT

The working area of refrigerator is 216×260×100 mm. Hence the calculated volume is 8.58 lit. In designing a thermoelectric cooling system, one of the most critical processes is to reach an understanding of the thermal load. With this vital information, we can able to choose the best TE device or heat exchangers for the job. Each of the thermoelectric cooling system has a unique capacity for moving heat. In order to achieve the performance objectives estimate of the amount of heat must be removed from the thermal load is calculated. Once the module is selected, thermosiphon system for heat dissipation from the hot side of the module is designed based on the amount of heat that has to be removed. The following figure shows the THERMO-ELECTRIC REFRIGERATOR . This refrigerator is made up of three materials known as: 1) Acrylic Sheet 2) MDF Sheet 3) Foam Sheet



Design of thermoelectric refrigeration has been explained in detail also the theoretical physical characteristics of thermoelectric cooling module used. We have been designed and developed an experimental prototype of thermoelectric refrigeration system working on DC voltage. The developed experimental prototype having a refrigeration space of 8.58 liter capacity is refrigerated by using the Peltier module (Supercool : PE-063-10-13, $Q_{max}=19W$) and a heat sink fan assembly used (Model No: TDEX6015/TH/12/G, $R_{th}=1.157\text{ }^{\circ}C/W$) to increase heat dissipation rate from hot side of Peltier module.

The experimental result shows a temperature reduction of $13^{\circ}C$ without any heat load and $9^{\circ}C$ with 100 ml water kept inside refrigeration space in 50 minute with respect to $33^{\circ}C$ ambient temperature. Also the COP of refrigeration cabinet has been calculated and it is 0.33. The developed thermoelectric refrigeration system is having potential application of storage and transportation of life saving drugs and biological materials at remote areas of our country where grid power is unavailable.

IV.CONCLUSION

The coefficient of performance of this refrigerator is much smaller than that conventional compressor type refrigerator when the required cooling capacity is high, where as the coefficient of performance of the conventional unit falls off rapidly as the cooling capacity is decreased and the thermoelectric unit remains constant.

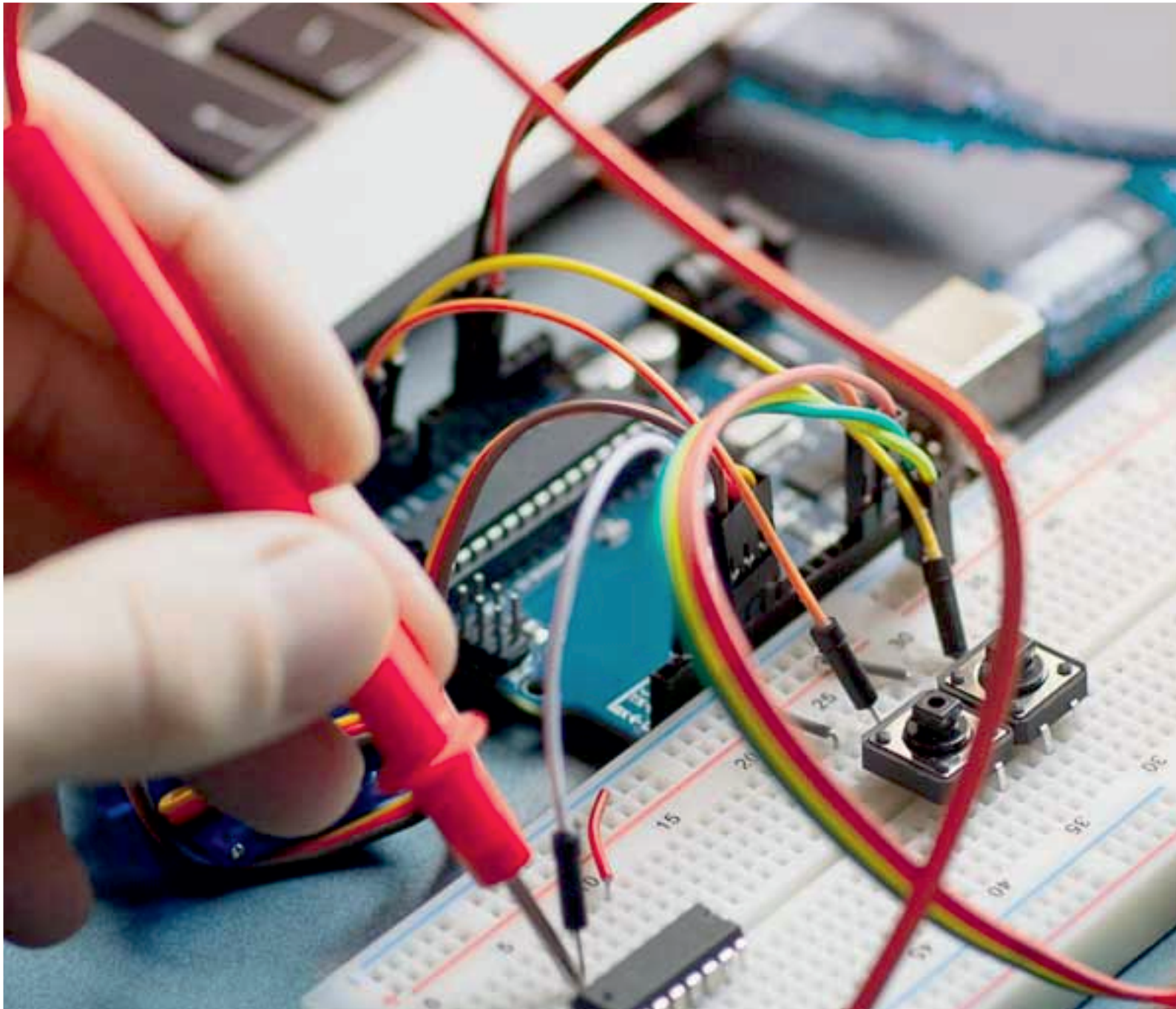
Thus a conventional refrigerator is preferred when the required cooling capacity is high and a thermoelectric refrigerator should be chosen when a low cooling capacity is needed. The cold side of the thermoelectric module was utilized for the refrigeration purposes where as the rejected heat from the hot side of the module was eliminated using heat sinks and fans.

As the cooling unit are small size, silent, contains no liquid or gases, have no moving parts and having along life. It is a very simple to control the rate of cooling by adjustment of the current, the response to change in supply is very rapid, while reversal of the direction of the current transforms a cooling unit into a heater with a coefficient of performance in excess of unity i.e. a heat pump for oven. In this work, a portable compressor less refrigerator unit was fabricated and tested for cooling purpose. This is completely eco-friendly project multipurpose and portable.



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