Design and Fabrication of Peltier Cooling System

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Abstract— This project 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 and this model is that a thermoelectric cooling system refrigerates without use of mechanical devices (Conventional Condenser fins and Compressor) and without refrigerant. The system consisted of the refrigeration chamber, thermoelectric modules, heat source and heat sink. A result which is a criterion of performance of such device is a function of the temperature between the source and sink. 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 and compression and changes phase from liquid to vapor and back, respectively. Semiconductor thermoelectric coolers (also known as Peltier coolers) offer several advantages over conventional systems. They are entirely solid-state 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.

Key words: Peltier module, heat sink, cooling fan, cabinet, 12 volt transformer

I. INTRODUCTION

This is introducing our new project "DESIGN AND FABRICATION OF PELTIER COOLING SYSTEM", which is equipped by heat sinks, peltier (thermoelectric module) element, etc.It is the project 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 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. 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 moved through the module from one side to the other. One module face will be cooled while the opposite face is simultaneously heated.

II. PROJECT OBJECTIVE

1) To finds out the cooling rate.
2) To find out power consumption.
3) To analyze overall efficiency.
4) The materials used and the manufacturing techniques for this prototype are intended to be as simple and cheap as possible, which will play an advantage should this product be rolled out in large numbers into the market.
5) The discussion of this report will include the positive aspects of the project and its flaws, and will explain how the latter can be overcome should this project continue in the future.

III. METHODOLOGY

1) Study of various conventional refrigeration system.
2) Collecting data from the literature survey.
3) Design and fabricate the refrigeration system.
4) Data comparison with conventional refrigeration

IV. CONSTRUCTION DIAGRAM

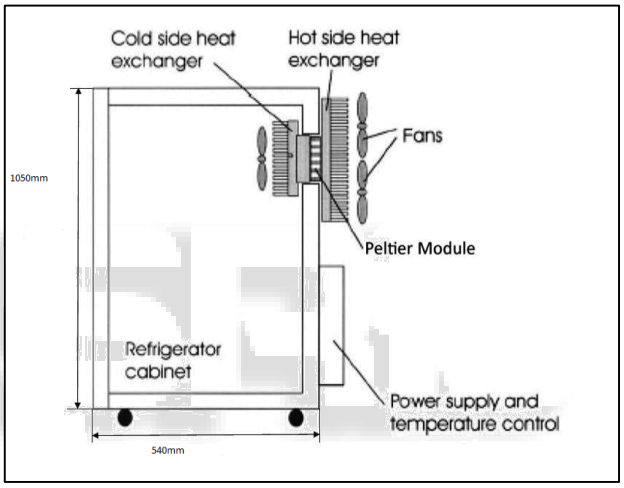

Fig. 1: Construction Diagram

V. WORKING PRINCIPLE

Two unique semi-conductors, one n-type and one p-type, are used because they need to have different electron densities. The semi-conductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors there is a flow of DC current across the junction of the semi-conductors causing a temperature difference. The side with the cooling plate absorbs heat which is then moved to the other side end of the device where the heat sink is. TEC are typically connected side by side and sandwiched between two ceramic plates. The cooling ability of the cabinet is obtained with cooling plate.

This was subsequently called the Peltier effect and is the basis for the cooling technology used in this project, due to advantages in size and simplicity. Figure shows a cross sectional sketch of a Peltier module. Hot and cold junctions are found on the hot and cold side respectively marked by red and blue. The module itself consists of alternating p- and n-type semiconducting materials layered between two ceramic plates. The semiconducting materials make the module a thermoelectric generator if a resistive

load is connected to the electrical connections, or as a Peltier element when connected to a current source as in the case of this project. Due to the high thermal conductivities of the semiconducting materials, heat is easily conducted from the hot to the cold side of the module. As a result, when there is a large temperature difference between the cold and hot sides, the Coefficient of Performance (COP) of the module decreases as more electrical energy is consumed to maintain the temperature gradient. The internal resistance of the materials in the module also varies according to the junction temperatures, and likewise the current drawn through the module at a given voltage.

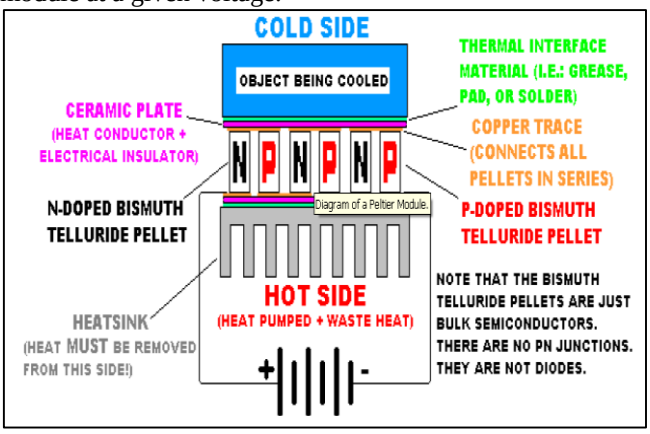

Fig. 2:

Fig... "Thermoelectric module details". A pair of adjacent thermo element legs joined at one end by a conducting metal strip forming a junction between the legs. Thus, the legs are connected in series electrically but act in parallel thermally. This unit is referred to as a thermoelectric couple and is the basic building block of a thermoelectric (or Peltier) cooling module. The thermo element materials are doped semiconductors, one n-type with a majority of negative charge carriers (electrons) and the other p-type with a majority of positive charge carriers (holes). The majority of commercially available thermo electric cooling modules are assembled from n-type and p-type thermo elements cut from bismuth telluride (Bi2Te3) based bulk materials.

This is the main element in this project which provides the cooling and heating effect required

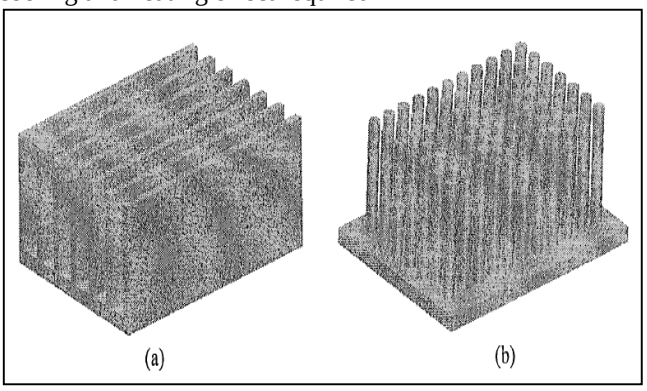

Fig. 3:

Fig. "Rectangular flat and pin type heat sinks "Figure Rectangular straight/flat heat sinks and figure no. Pin fin heat sinks shows the types of heat sink. The heat sink increase surface area of cooling or heating substance.

Heat sinks with natural or forced convection air cooling has been used for many years to transport heat from the chip or a TEC module to the ambient temperature. The base plate of the heat sink is in thermal contact with the chip or the hot side of the TEC module and the fins act as extended surface to transport heat to the ambient temperature. Rectangular flat or pin fins are commonly used in cooling electronics. Air flow can either be lateral (duct flow) or can impinge from the top through the passages between the fins. The thermal performance of the heat sink depends on many parameters: geometric parameters such as base plate thickness, height, thickness and spacing between the fins; material properties and the number of fins. The orientation of the flat fin heat sink at natural convection also has an effect on thermal performance. Several studies have been performed to optimize a heat sink. Horizontal base plate for natural convection and found that natural convection heat transfer rate improves with increasing fin height for fixed fin spacing and fixed number of fins.

VI. REVIEW OF LITERATURE

Edson Nigeria *"Performance analysis of a thermoelectric air conditioning"* 2004. Paper analyze to evaluate the performance of the device thermoelectric refrigeration are the coefficient of performance, the heat pumping rate and the maximum temperature difference between the hot side and the cold side of the thermoelectric module. Knowing the inlet and outlet temperatures of the air to be conditioned, the type and temperature of the air whirlpool, the parameters of the thermoelectric materials and the thermal load it is possible to determine the power to be provided, the total area and the thermoelectric material length for the maximum heat transfer and maximum COP conditions. From these values, the quantity of material, the number of required associations, the size of the system be determined. The COP is strongly influenced by the "figure of merit" of the semiconductor material and it is still under the founded values for the equivalent vapor compression cooling system. The development of new thermoelectric materials with large figure of merit and appropriate technology could make a breakthrough the applications of thermoelectric devices in many fields.

Manoj S. Raut, *"Thermoelectric Air Cooling for Cars"* May 2012 Paper described the conventional compressor run cooling devices have many drawbacks to energy efficiency. Introducing the new TE system overcome all the disadvantages of existing refrigeration system. A Thermoelectric Air cooling for car prototype was designed and built which can be used for personal cooling in site the car. Six TECs were used for achieving the cooling with a DC power supply through car battery. It had been shown from testing results that the cooling system is capable of cooling the air when recirculating the air inside the car with the help of blower. TEC cooling designed was able to cool an ambient air temperaturefrom32°C to 25.8°C. Cooling stabilizes within three minutes once the blower is turned ON. The system can attain a temperature difference of set target which was 7°C. Accomplishing the set target establish the success of the project.

Surith Nivas M1, *"Photovoltaic Driven Dual Purpose Thermoelectric Refrigerator for Rural India"* June-2013 Paper described the Photovoltaic driven TE refrigerator some fundamental aspects of the direct using thermoelectric conversion. By using solar cell dual effect

can be produce such as cooling and heating. By using a temperature sensor inside the cabinet surface, we get the corresponding temperature values for each instant which are displayed in an LCD (Liquid crystal display). The graph between temperature produced inside the cabinet against corresponding time interval are also presented and results are in line with the predictions. The advantages of the thermoelectric heater cum refrigeration on comparison with the existing heater and refrigeration system

Benziger B, Anu Nair." Thermoelectric Air-Conditioner Using Peltier Modules, 2015 Paper described 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 is discussed. Thermoelectric cooling systems have advantages over conventional cooling devices, such as compact in size, light in weight, high reliability, no mechanical moving parts and no working fluid.

Sagar D. Patil , Kiran D. Devade "Thermoelectric Refrigeration Applications and Technology" Refrigerator and air conditioners are the most energy consuming home appliances and forthis reason many researchers had performed work to enhance performance of the refrigeration systems.

Most of the research work done so far deals with an objective of low energy consumption and refrigeration effect enhancement. Thermoelectric refrigeration is one of the techniques used for producing refrigeration effect. Thermoelectric devices are developed based on Peltier and Seebeck effect which has experienced a major advances and developments in recent years. The coefficient of performance of the thermoelectric refrigeration is less when it is used alone, hence thermoelectric refrigeration is often used with other methods of refrigeration. This paper presents a review of some work been done on the thermoelectric refrigeration over the years. Some of the research and development work carried out by different researchers on TER system has been thoroughly reviewed in this paper. The study envelopes the various applications of TER system and development of devices. This paper summarizes the advancement in thermoelectric refrigeration, thermoelectric materials, design methodologies, application in domestic appliances and performance enhancement techniques based on the literature.

VII. CONCLUSION

We are proud that we have completed the work with the limited time successfully. 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 travelers to store the medicine. Temperature was controllable via changing 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).This project which helps to know how to achieve a low cost cooling machine and reduce the use of greenhouse gases. The application of peltier module has reduced our project size as well as cost and its operation is smooth and eco-friendly. The project can be modified and developed according to the application of the users but the main disadvantage of using the TE module that it cannot be used for bigger purposes because of its less efficiency.

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