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Review on Design and Analysis of Evaporator Used in Household Refrigerator using Thermoelectric Module

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ABSTRACT: The growing global demand for refrigeration in the areas of refrigeration, air conditioning, food storage, vaccine warehouses, medical services and cooling of electronic devices has led to the production of more electricity and consequently to higher CO₂ emissions worldwide, a contributing factor to global warming. Thermoelectric refrigeration is a new alternative because it can convert wasted electricity into useful cooling, which should play an important role in meeting today's energy challenges. Therefore, thermoelectric refrigeration is extremely necessary, especially for developing countries where the service life is long and low maintenance. The objectives of this study are the design and development of an 18 liter functional thermoelectric refrigerator internal cooling volume that uses the Seebeck effect to refrigerate and maintain a temperature. The design requirements are to cool this volume to temperature within one hour and achieve the COP. The design requirements, available options, and final design of the thermoelectric refrigerator for the application are presented. ANSYS software analysis is required. Thus, you discover the optimum temperature to achieve the maximum heat transfer and cooling rate.

KEYWORDS: COP, Energy saving, Earth Heat exchanger (Heat Pipe), Peltier module (thermoelectric module), Temperature Gradient, VCC.

I. INTRODUCTION

REFRIGERATION:-

Refrigeration, or the process of cooling, is the removal of unwanted heat from a selected object, substance, or space and transferring it to another object, substance, or space. Heat removal lowers the temperature and can be achieved through the use of ice, snow, chilled water, or mechanical refrigeration. The term refrigeration refers to the cooling of a space, substance or system to lower and/or maintain its temperature below ambient temperature (while the exhaust heat is rejected at a higher temperature). Refrigeration has many applications, including domestic refrigerators, industrial freezers, cryogenics and air conditioning.

Thermoelectric refrigeration finds applications in electronic systems and computers to cool sensitive components such as power amplifiers and microprocessors. TER can also be used in a satellite or space application to control temperature extremes that occur in components on the sunlit side and to heat components on the dark side. TERs are used to minimize thermal noise, thereby optimizing image sensitivity and contrast. The coefficient of performance (COP) of compression refrigerators decreases as its capacity decreases. Therefore, when it is necessary to design a small capacity refrigerator, TER is always preferable. In addition, better control of the ambient temperature is the main advantage of the TER. Therefore, TER is a good option for food storage and pharmaceutical cooling applications. The increasingly global problem with the rapidly developing economy and the consequent shortage of energy for residences, some countries are setting minimum requirements for energy efficiency.

The air conditioning system is a very important device to ensure the comfort of the human being, even in industrial applications. But this device requires a larger amount of electricity. The ever-increasing energy demand weighs heavily on further economic development as India is poor in energy resources so there is minimal electricity consumption during the operation of air conditioners. How to reduce energy consumption using new energy saving technologies and equipments is an important task these days. Many methods and ideas such as evaporative cooling, thermoelectric cooling, earth heat exchanger, etc. They have been proven to minimize electricity consumption in air conditioning



applications. In air conditioning systems with high outdoor air requirements such as air conditioning systems for clean rooms, considerable energy savings are possible by using the Peltier module and the floor heat exchanger (heat pipe). The bottom temperature becomes more stable with increasing depth; the ground temperature is almost constant at around 2 to 3 m all year round. This unchanged temperature remains higher than the outside temperature in winter and lower than the outside temperature in summer. When atmospheric air flows through buried pipes, the air is cooled in summer and warmed in winter. Earth has a high heat storage capacity and low thermal conductivity. Due to its low thermal conductivity, it transports heat slowly; Its temperature changes slowly on the order of months and even years, depending on the measurement depth. Therefore, the earth is warmer than the surrounding air in winter and cooler than the surrounding air in summer. This constant Earth temperature provides a free renewable energy source that can easily provide enough electricity to cool an average suburban home. The thermoelectric effect is the direct conversion of temperature differences into electrical voltage and vice versa. Once it has been decided that the thermoelectric cooler should be considered for the cooling system, the next step is to select the thermoelectric module or cooler that can meet a specific set of needs. Modules are available in a variety of sizes, shapes, operating currents, operating voltages and heat pump power ranges. The heat pipe is composed of an evaporator section and a condenser section in the longitudinal direction. If external geometric requirements make it necessary; An additional adiabatic section can be installed to separate the evaporator and condenser. The cross-section of the heat pipe consists of the vessel wall, the wick structure, and the vapor space. The performance of a heat pipe is often expressed in terms of "equivalent thermal conductivity".

II. LITERATURE REVIEW

Fabrication and Testing of a Thermoelectric Cooling System by Sudhanshu Paul, et.al. was designed and built to be used for both residential and industrial refrigeration purposes. It can also be used very well for cooling and heating in automobiles by simply reversing the polarity. A Peltier was used to achieve cooling with a DC power supply by power supply (SMPS). The test results showed that the cooling system is able to cool the air inside the camera with the help of the heatsink and the air intake fan working together, or the heatsink working individually. The TERS with the fan on is better able to cool the air in the chamber by lowering the temperature from 32°C to 13°C.

Thermoelectric Cooler Fabrication" by Shaikh Sahil, et al. The aims of this study are to develop a functional thermoelectric refrigerator for cooling a volume of 40 L, using the Peltier effect to cool and maintain a selected temperature range from 5 0 C to 25 0 C. The design requirements are to cool this volume to temperature in a short time and hold it for at least the next half hour. The design and fabrication of the thermoelectric cooler for the required applications are presented. The system cannot process load fluctuations. Extensive modifications must be incorporated before it can be released for efficient use in the field. This is one of the beneficial projects that drives the refrigerator with low power. Working on this project gave us an excellent opportunity and experience to use our limited knowledge. Refrigeration is one of the key areas in which researchers have great interest. Some of the recent advances in this area outweigh some of the inherent disadvantages, such as B. the unfavorable COP. The cascading modular architecture has set new limits for your application. In addition, recent advances in organic molecules as a thermoelectric material ensure a bright future for TER.

Low cost refrigerator using thermoelectric effects and phase change materials by Adithya Venugopal, et.al. This paper presents the mechanical design of modern refrigerators that use compressor-based refrigeration and cannot maintain efficiency at reduced capacity. In this context, the project aims to provide an alternative and more efficient cooling option by using the thermoelectric effect compared to the conventional methods prevailing today. They offer several advantages over compressor-based refrigeration systems, such as B. easy miniaturization, noise reduction, portability, etc.

Design and development of thermoelectric refrigerators Dongare VK, et.al. The objectives of this study are the design and development of an 18-liter functional thermoelectric refrigerator internal cooling volume that uses the Peltier effect to refrigerate and maintain a temperature of 33°C to 22°C. The design requirements are to cool this volume to temperature in a period of one hour and to obtain a COP between 0.2 and 0.6. The design requirements, available options, and final design of the thermoelectric refrigerator for the application are presented. The system performance coefficient for TEC1 12706 is calculated by the average of the Lens. It is observed that the thermoelectric refrigeration policeman with TEC1 12706 is lower than the VIDETROR font.

III. PROBLEM DEFINITION

- The comparison of COP with simulation.
- The Comparative analysis of thermoelectric refrigeration with household refrigeration.
- There is an optimum temperature need to find where cooling rate must be maximum.

IV. PRINCIPLE OF OPERATION

The thermoelectric effect is the direct conversion of temperature differences into electrical voltage and vice versa using a thermocouple. A thermoelectric device creates voltage when there is a different temperature on each side. The Seebeck effect is the electromotive force that develops between two points of an electrically conductive material when there is a temperature difference between them. Seebeck EMF is called Seebeck EMF. The relationship between the EMF and the temperature difference is the Seebeck coefficient. The Seebeck effect is a classic example of electromotive force (EMF) and leads to currents or voltages that can be measured in the same way as any other EMF.

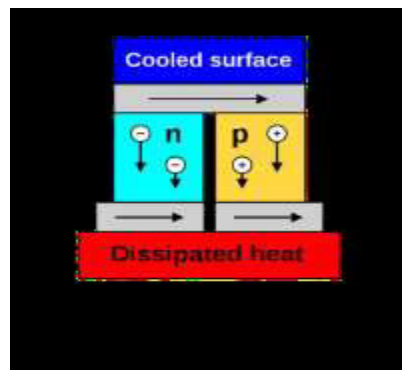


Fig 1.1: Principle of Seebeck Effect

V. SCOPE

With the increasing demands on machining, new cooling systems are required. Besides traditional cooling methods, thermoelectric cooling is an innovative idea to compete with the available cooling systems for cooling. Cooling has increased tremendously these days. In addition, coolant used during normal temperature operation may not be as effective as chilled coolant. Design of a thermoelectric refrigeration system for cooling the refrigerant in the evaporator, evaluation of the COP changes and the cooling rate. An analysis will improve all of this to find the optimum temperature and heat transfer point with the thermoelectric module.

VI. CONCLUSION

A hybrid domestic refrigerator is being developed that combines vapor-compression and thermoelectric technologies, adding a new compartment to the original commercial VCR refrigerator, powered by the thermoelectric refrigerator (TER). The performance of the TER cooler is tested for different values of the input voltage for the Peltier module and fans with different configurations for the heatsinks mounted on both sides of the Peltier module. Thermoelectric heating and cooling system for water cooler and heater (water dispenser) works in satisfactory condition.

This system produces hot and cold water at the same time. It is a solid state heat transfer system that does not require the use of refrigerants. When the valve on the cold side opens, you get both water at the same time when you don't need them. therefore, there are no CFC emissions. It is effective in arranging paper and maintaining the temperature difference minimizes the cost.

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