DESIGN AND ANALYSIS OF THERMOELECTRIC REFRIGERATION SYSTEM USING PELTIER EFFECT

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ABSTRACT

Aim of the project is to reduce the usage of electricity and minimization of carbon dioxide evaporation compare with normal refrigerator. Thermoelectric refrigeration with thermosiphon system is done with the peltier module setup. In this project, battery is connected to the peltier module and followed with the fin which is inside the aluminium box. Thus the project has been done with the thermoelectric refrigerator with thermosiphon system using peltier module for room temperature 303K to cooling temperature 290K. Refregiration is a process of removing heat from a low temperature and transferring it to high temperature reservoir and transferring it to a high temperature reservoir. The work of heat transfer is traditionally driven by heat. Refregiration has had a large impact on industry, lifestyle, agriculture and settlement patterns. The idea of preserving food date back to atleast the ancient roman and chinese empires. In most developed countries, cities are heavily dependent upon refregiration in supermarkets, in order to obtain their food for daily consumption.

KEY WORDS: *Peltier, fin, thermosiphon.*

1. INTRODUCTION

As per globally increasing demand for refrigeration, food preservations, vaccine storage, air conditioning of the space, medical services, cooling of electronic device led consumption of more electricity and ultimately more release of CO2 in the environment causing global warming. By considering the above effects the Thermoelectric refrigerators (TERs) offer several advantages over vapor-compression refrigerators such as free of moving parts, acoustically silent, reliable, and lightweight. But because of their low efficiency and peak heat flux capabilities have precluded their use in more widespread applications. Peltier effect and Seeback effect were first discovered to present in metals as early as1820s–1830s, but the low thermoelectric performances of metal made these two effects fall on deaf ears all the time. Until 1950s, the advent of doped semiconductor materials with small band gap, large Seeback coefficients, good electrical conductivities, and poor thermal conductivities were found to have much bigger thermoelectric performances than the pure metals, thus revived the interest in this field.

2. OBJECTIVE

- To reduce the CO2 emission.
- To produce noiseless operation.
- To prevent the cooling produced.

3. PROBLEM IDENTIFICATION

- Cooling effect produced is less.
- Large amount of heat is produced.
- Need to preserve the cooling produced

4. WORKING PROCEDURE

Peltier module is connected to the battery. The function of the battery is to turn on or off the power of electricity flowing through wires. Wires are used to join parts of a circuit. Electricity flows through wires. Its main function is to provide the power they need to work. So that heating effect is produced on one side and cooling effect is produced on the other side. Peltier effect *is* the cooling of one junction and the heating of the other when electric current is maintained in a circuit of material consisting of two dissimilar conductors; the effect is even stronger in circuits containing dissimilar semiconductors. Fin and fan setup is used to dissipate the heat produced by the peltier module. A Fin Fan Cooler is a type of heat exchanger used to cool different processes. Using a series of fans, fin fan coolers move low temperature atmospheric ambient air inside the aluminium box. Like all heat exchangers, they are often used in situations where a process generates excess heat that can't be used in other ways. The cooling effect is produced inside aluminium plates covered with wooden box. Aluminium is one of the lightest engineering metals, having a strength to weight ratio superior to steel. By utilising various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminium is being employed in an ever-increasing number of applications. Aluminium plates are used to preserve the cooling produced by the peltier module.

5. DESIGN OF THERMOELECTRIC REFRIGERATION SYSTEM

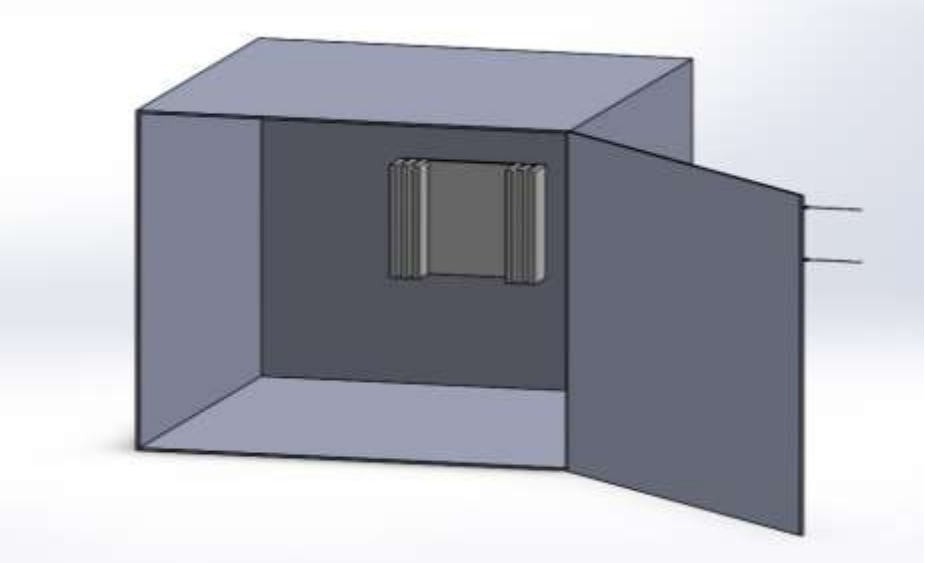

Fig 5.1 Solidworks model of thermoelectric refrigeration system

6.MATERIAL SELECTION

6.1 PELTIER MODULE

Thermoelectric coolers operate according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. A voltage is applied across joined conductors to create an electric current. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. Heat is deposited at the other junction.The main application of the Peltier effect is cooling. However the Peltier effect can also be used for heating or control of temperature. In every case, a DC voltage is required. Cooling occurs when a current passes through one or more pairs of elements from n- to p-type; there is a decrease in temperature at the junction ("cold side"), resulting in the absorption of heat from the environment. The heat is carried along the elements by electron transport and released on the opposite ("hot") side as the electrons move from a high- to low-energy state.

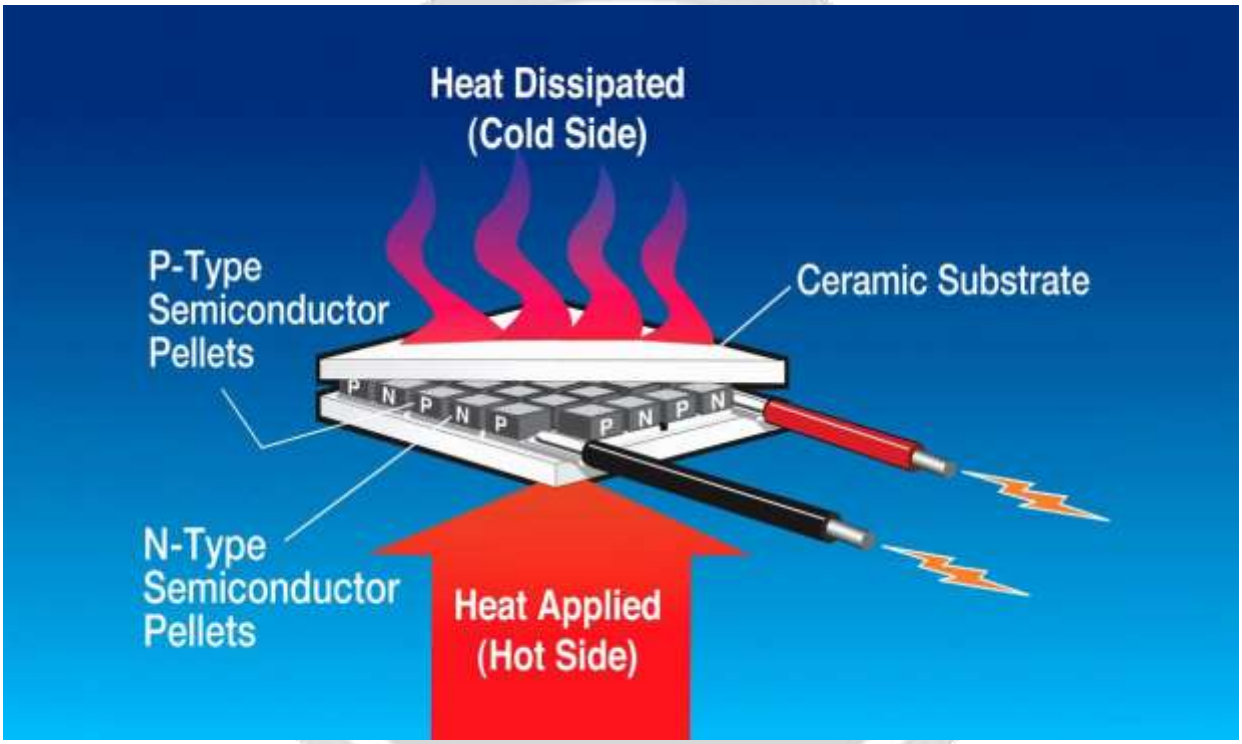

Fig 6.1 Peltier module

6.2 FIN

Fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object, increases the surface area and can sometimes be an economical solution to heat transfer problems.

6.3 ALUMINIUM

Aluminium or aluminum is a chemical element with symbol Al and atomic number 13. It is a silvery-white, soft, nonmagnetic and ductile metal in the boron group. By mass, aluminium makes up about 8% of the Earth's crust it is the third most abundant element after oxygen and silicon and the most abundant metal in the crust, though it is less common in the mantle below. The chief ore of aluminium is bauxite. Aluminium is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation.

6.4 FAN

A Fin Fan Cooler, also known as an Air Cooled Heat Exchanger, is a type of heat exchanger used to cool different processes in the refining, petrochemical, and chemical processing industries. Using a series of fans, fin fan coolers move low temperature atmospheric ambient air over multiple rows of finned tubes in order to cool internal process fluids. Like all heat exchangers, they are often used in situations where a process generates excess heat that can't be used in other ways.

6.5 THERMOMETER

A thermometer is a device that measures temperature or a temperature gradient. A thermometer has two important elements: (1) a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer or the digital sensor in an infrared thermometer) in which some change occurs with a change in temperature, and (2) some means of converting this change into a numerical value. Thermometers are widely used in industry to monitor processes, in meteorology, in medicine, and in scientific research.

Some of the principles of the thermometer were known to Greek philosophers of two thousand years ago. The modern thermometer gradually evolved from the thermoscope with the addition of a scale in the early 17th century and standardisation through the 17th and 18th centuries.

6.6 BATTERY

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved additionally to include devices composed of a single cell.

7. ANALYSIS FOR HEATFLUX AND THERMAL GRADIENT

7.1 Thermal gradient of fin

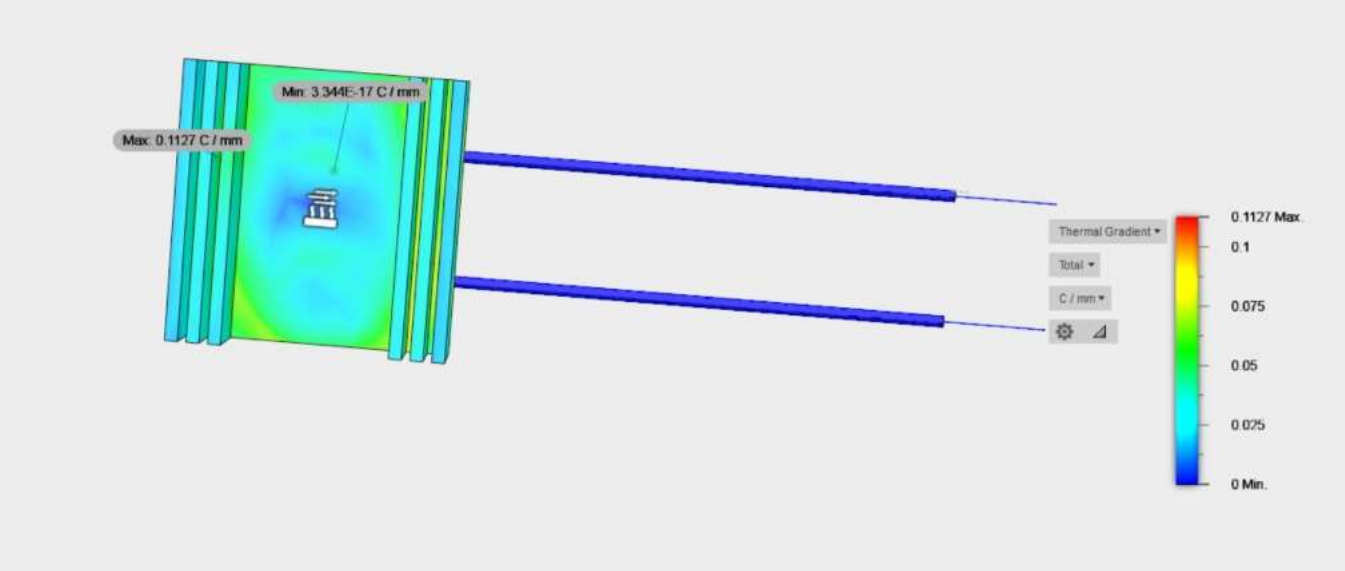

Fig 7.1 Shows the maximum thermal gradient obtained for the fin is around 0.1127 ºC/mm.

7.2 Heat flux of fin

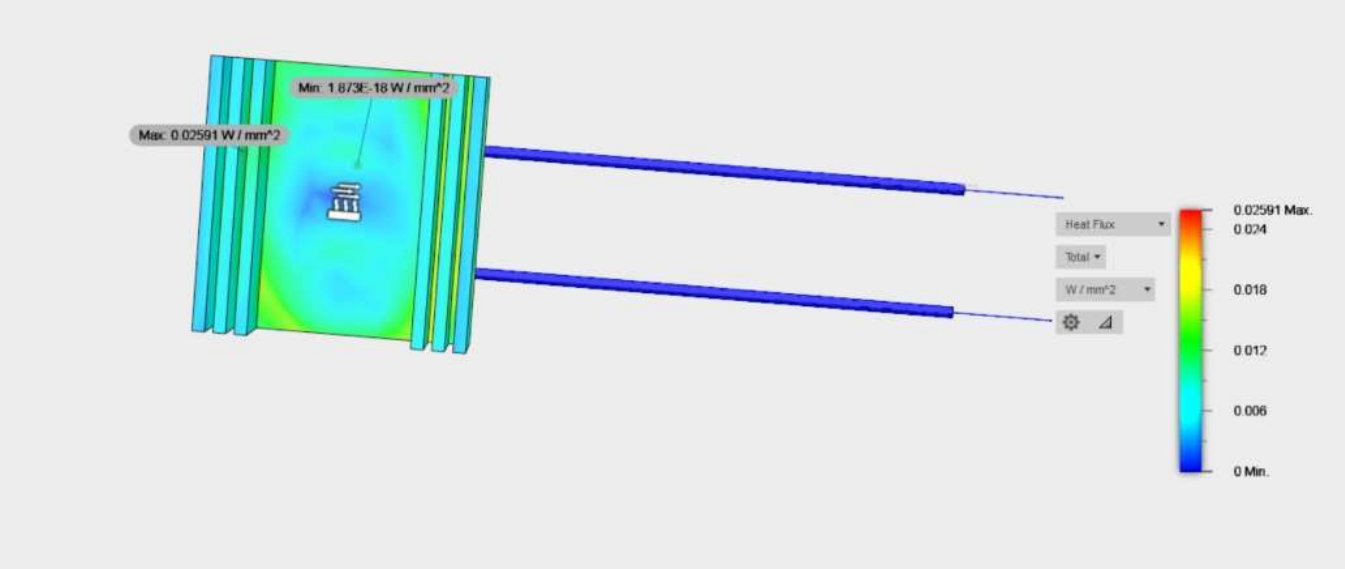

Fig 7.2 Shows the maximum heat flux obtained for the fin is around 0.02591 W/mm^2.

8. CONCLUSION

This is one of the advantageous project which uses low power to drive refrigerator. This project work has provided us an excellent opportunity and experience, to use our limited knowledge. Thermoelectric refrigeration is one of the key areas where researchers have a keen interest. Some of the recent advancements in the area surpass some of the inherent demerits like adverse COP. Thus the project has been done with the thermoelectric refrigerator with thermosiphon system using peltier module. By using autodesk 360^{o} heat flux and thermal gradient of the fin is analysed, the maximum cooling produced is around 16ºC. Heat flux and thermal gradient are compared between the actual and theoretical values.

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