AIR REFREGERATION USING PELTIER TILE

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Abstract: This paper describes design and construction of a PELTIER AIR CONDITIONER with a table fan (400mm). The Peltier Tile was equipped with heat sink which was found to be Adequate to meet the required precision of +/- 20 degrees Celsius put forth in the project requirements. One litre of water was placed inside the tank to test the Performance of the device which was then passed into the Copper tube coiled on table fan. We tested the maximum Performance of the device by cooling air down to -3 degrees Celsius from ambien .We have also tested condition of air by Switching off the peltier system.

Keywords: Refrigeration, Thermoelectric system, Peltier effect.

I . INTRODUCTION

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 vapour 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. They can be extremely compact, much more so than compressor-based systems. Precise temperature control (< ± 0.1 °C) can be achieved with Peltier coolers. However, their efficiency is low compared to conventional refrigerators. Thus, they are used in niche applications where their unique advantages outweigh their low efficiency. Although some large-scale applications have been considered (on submarines and surface vessels), Peltier coolers are generally used in applications where small size is needed and the cooling demands are not too great, such as for cooling electronic components.

The objectives of this study are design and develop a working thermoelectric air cooler, cooling of air that utilizes the Peltier effect to cool down and maintain a selected temperature from 5 °C to 25 °C. The copper tube is wound on the front of the table fan which helps in convection between water in the tube and flowing air. The design requirement, options available and the final design of thermoelectric air cooler for application are presented.

II .BACKGROUND

Peltier History

Early 19th century scientists, Thomas Seebeck and Jean Peltier, first discovered the phenomena that are the basis for found that if you placed a temperature gradient across the junctions of two dissimilar conductors, electrical current would flow. Peltier, on the other hand, learned that passing current through two dissimilar electrical conductors, caused heat to be either emitted or absorbed at the junction of the materials.

It was only after mid-20th Century advancements in semiconductor technology, however, that practical applications for thermoelectric devices became feasible. With modern techniques, we can now produce thermos electric efficient solid-state heat-pumping for both cooling and heating; many of these units can also be used to generate DC power at reduced efficiency. New and often elegant uses for thermo-electrics continue to be developed each day.

Peltier structure:

A typical thermoelectric module consists of an array of Bismuth Telluride semiconductor pellets that have been carrier–either positive or negative–carries the majority of current. The pairs of P/N pellets are configured so that they are connected electrically in series, but thermally in parallel. Metalized ceramic substrates provide the platform for the pellets and the small conductive tabs that connect them.

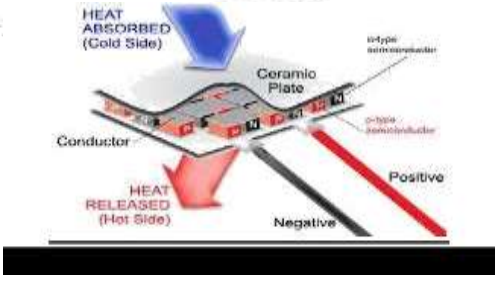

Figure 1: Peltier Structure

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. The device working on this principle known as Peltier module. The "hot" side is attached to a heat sink so that it

remains at ambient temperature, while the cool side goes below room temperature.

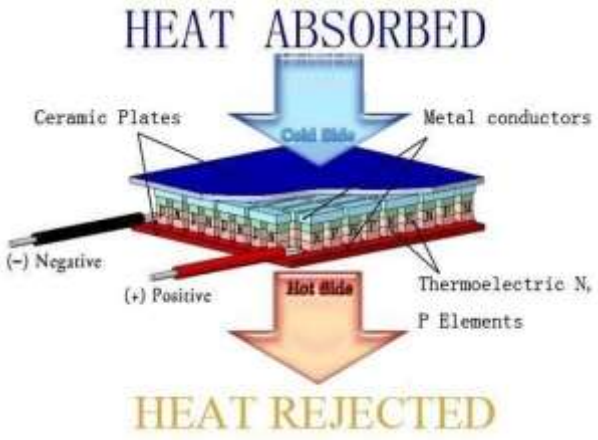

Fig 2: Working of Peltier module

These modules can be used for refrigeration purposes. The time required to get the desired cooling effect is long. In "Portable Peltier Air Conditioner" Peltier plates are used as a cooling unit in combination with conventional desert cooler. This provides better results than conventional desert cooler in terms of air temperature and relative humidity.

III. SYSTEM DESCRIPTION

In this system a central cooling unit which consists of Peltier module attached to an plastic tank. The plastic water block is filled with water (coolant). The peltier cooling unit is used to cool this water, which is further pumped to the copper coil (Heat Exchanger) attached to the table fan. This coil is placed in front side of the blade of table fan. When the water is made to flow through the coil it carries the heat and decreases the temperature of the air coming out of the fan to a considerable limit and cooling is obtained.

All the arrangement is done according to the requirement. When the Peltier module is supplied with required input supply the cooling side of a peltier module viz. in contact with the water present in sump, due to the cooling action of peltier the water gets cooled. After this when the fan start working pump present in sump pumps water to the coil. This coil cools the incoming air to it by the mean of convection. In sump Peltier plate and aquarium pump are arranged with cooling block . Water at the sump is cooled. The small aquarium pump present in sump pumps this water to heat exchanger tube with help of connecting tubes which is placed if front of the fan which further cools air coming out of fan and reduces its moisture also. Water after circulating through the heat exchanger tube flows to the sump again which makes complete cycle. This process is continued as a result of which the temperature of the room goes decreasing.

This system offers following advantages :

A Thermoelectric module works without any moving parts so they are almost maintenance free.

The thermoelectric cooling system is much smaller and lighter.

- A Thermoelectric module attached to the heat sink has the ability to reduce the temperature below the ambient value.
- Thermoelectric module can heat or cool depending upon the polarity of the applied power. This quality eliminates the necessity of providing separate heating and cooling functions within the same system
- Dehumidification and humidification unit Highly efficient
- during dry as well as humid weather.

This system offers following disadvantages

- Peltier modules are usually small and are not generally used for large scale refrigeration.
- Peltier Coolers also require supply of electricity to work efficiently
- Expensive in the long run.
- Requires a bit of time to cool water in cooling box.

IV. FABRICATION

The primary components of the refrigeration system are:

a) Peltier Plate

The thermoelectric plates that can be used here are TEC12706, TEC-12709, TEC-12712, TEC-12715 and TEC-12730[7]. These are the most reliable and widely used plates in . It is generally powered up by a 12V DC supply. A Switch Mode Power Supply (SMPS) is best suited to power up the plate. The CPU Cooler is pasted to the hot side of the plate by means of thermal paste.

b) Table FAN

Table fan blows air at a high speed by sucking air from room or atmosphere and blowing it on another side.

Fig 3: Table Fan

c) Heat Exchanger

The heat exchanger tubes used in this system should be made of Copper. This ensures greater efficiency during heat transfer between the tubes and the air that passes through it. A typical copper tube is shown below.

Fig.4 Heat Exchanger(Copper tubes)

d) Heat Sink

Heatsink made of Aluminium is pasted to the hot and cold junction of the thermoelectric plate by means of thermal paste. The thermal paste is used specifically in order to prevent any losses in the heat transfer between the thermoelectric plate and the heatsink. The radiator fan is used to take away the heat from the fins of the Aluminium heatsink from hot side. The arrangement of the Aluminium heatsinks and the radiator fan is attached to a tank.

Fig 5: Heat Sink e) Submersible Pump

A submersible pump is placed inside the liquid cooling block. It pumps the water from the liquid cooling block to the Aluminium heat exchanger tubes. The water then flows into the sump of the evaporative cooler by gravity.

Fig 7: Submersible Pump

V. PERFORMANCE ANALYSIS

The output of Peltier Plate Air Conditioner is:

a) Lower room temperature is achieved.

b) Humidity of cooled air coming out of Peltier plate air conditioner is less than conventional fan.

These results are verified by comparing the results of

a) Room temperature using Peltier Plate air conditioner and conventional fan.

b) Humidity of air coming out of air conditioner and conventional desert cooler.

CONCLUSION

The cost of the normal air conditioner is around Rs. 28,000 but cost of making Peltier plate air conditioner is quite low. The effectiveness of Peltier plate air conditioner is better than conventional fan cooler in terms of humidity and temperature which is proved with this experiment. With further improvement in design the performance of Peltier plate air conditioner can be improved.

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