International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 06 | June -2020 ISSN: 2582-3930

THERMOELECTRIC AIR CONDITIONING

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Abstract-In present scenario, HVAC system (commonly used in the air conditioners) is very efficient and reliable but it has some demerits. It has been observed during the last two decades that the O3 layer is slowly destroyed because of the refrigerant (CFC and HFC) used for the refrigeration and air- conditioning purposes. The common refrigerant used is HFC's which are leaked and slowly ascend into the atmosphere. When they reach to O3 layer they act on O3 molecules and the layer of O3 is destroyed. A single molecule of HFC can destroy thousands of O3 molecules and that's why it has created a threat for the not only to maintain earth eco system stable but also to existence of earth.Thermoelectric phenomena, the idea emerges from the thermocouple which imparts concept of gaining potential difference by maintaining two junctions at different temperatures. The maintenance of temperature at two different junctions causes power generation, refrigeration and air conditioning respectively and vice versa. Find this is also a way to overcome the environmental pollution caused by conventional system due to the direct conversion of temperature difference into voltage gradient without any mechanical systems. The purpose of this paper is utilisation of thermo electric phenomena by applying pettier effect in various sectors. In This paper we have also mention the application of thermoelectric phenomena which is playing a vital role room conditioning for industries, domestic areas and all sorts of areas along with the ultra-cooling system for maintaining the two junctions at different temperatures.

Keywords- Peltier effect, thermoelectric phenomena, thermocouple, thermoelectric, thermoelectric module, potential difference, voltage gradient, seebeck effect.

INTRODUCTION

The basic concept behind the thermoelectric phenomenon is converting thermal energy into electrical energy and vice versa. The thermoelectric device is termed as thermoelectric generator (TEG) when it is generating the energy, since the thermal energy known itself as a temperature difference across the TEG. When device is performing in a cooling or heating medium the thermoelectric device is named as a thermoelectric cooler(TEC).

Thermoelectric cooling is commonly referred to a cooling technology using thermoelectric coolers. TECs has advantages of high reliability, no mechanical moving parts, compact in size, light in weight and no working fluid. In addition it has a advantage that it can be powered by direct current (DC) electric sources, When a voltage / DC current is applied to two dissimilar conductors a circuit can be created that allows for continuous heat transport between the conductors junctions this is the principle of thermoelectric air-condition. Air conditioning is a process of removing heat from a room or any other applications. There are many ways of producing a cooling effect like by vapour compression and vapour absorption air condition. These air conditioner produce cooling effect by using refrigerants like Freon and ammonia etc. It gives maximum output but one of the disadvantage is it produce harmful gases to the atmosphere. The harmful gases are like chlorofluro carbon and some other gases are present.

By using thermoelectric peltier modules air-conditioners we can overcome the existing air-conditioning system by modifying it to protect the environment from harmful gases.

OBJECTIVES

1) To make a environment friendly Air conditioner.
2)Reduce the use of refrigerant which have adverse effect on environment.
3)Reducing the use of component like compressors, condensers etc.
4) Reducing the noise.

CONSTRUCTION

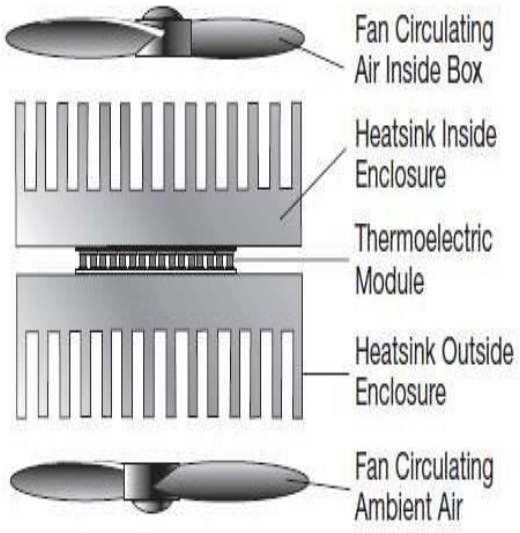

Fig-1: Schematic construction of Thermoelectric AC

Above fig shows a schematic constructional figure of thermoelectric cooling/AC which shows the components peltier, heat sink, fans etc.

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). It can be used either for heating or for cooling, although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools. The main components used in a Thermoelectric AC are explained below.

1) Switched Mode Power Supply(SMPS)
2) Peltier
3) Heat sink
4) Temperature controller
5) Fans
6) Transformer & Digital thermometer.

WORKING

The working of thermoelectric AC is mainly based on the working of peltier or peltier effect When a voltage is applied to the free ends of the two semiconductors of peltier there is a flow of DC current across the junction of the semiconductors causing a temperature difference. The side with the cooling plate absorbs heat from the heat sink attached which is then moved to the other side of the device where another heat sink is placed and thus cooling effect is generated across the peltier. This cooling effect is passed to the occupant with the help of cooling fans or blower used . The direction of heating and cooling is determined by the polarity of the applied voltage.

CALCULATIONS

We know that Qc is given as,

$Qc = m\ Cp\ \Delta T$

Qc = cooling load

m = Mass flow rate of air given by ($m = \rho \times Q$)

ρ = Density of air at 35oC was taken as 1.1455 kg/m3.

Q= Volume flow rate ($Q = V \times A$).

V = Volume of air passing through the duct.

A = Cross sectional area of the square duct (side2)

Cp = Specific heat of air at 350 C. was taken as 1006.7 J/kgK.

ΔT = The difference between the ambient temperature and the temperature of the load to be cooled.

Now we know,

Velocity of air = 2.87 m/s

But as a flow pattern is provided in duct there is a bit reduce in velocity of air to 2 m/s

Therefore, V =2 m/s

Density of duct (ρ) = 1.1455 kg/m3

Area of duct = (side2) = (0.12)2 = 0.0144

Therefore, Volume flow rate (Qc)=V × A

$= 2 \times 0.0144$

$= 0.0288$ m3/s

Now, Mass flow rate of air (m) = $\rho \times Q$

$=1.1455 \times 0.0288$

m = 0.0329904kg/s

we know, Cooling load

$Qc = m\ Cp\ \Delta T$

$= 0.0329904 \times 1006.7 \times (35-29)$

$= 199.20W$

Now,

COP of thermoelectric AC =

$$\frac{\textbf{cooling load}}{\textbf{power supplied}}$$

$$COP = Qc/P$$

Where, $P = V \times I = 12 \times 29 = 348W$

$$V = 12V\ \&\ I = 29\ Amp$$

$$COP = 199.20/348$$

$$COP = 0.5724$$

This is not a actual COP of the system. It can be higher, as the power input designed is higher than the calculated Qc.

CONCLUSION

A Thermoelectric Air cooling & heating system was designed and built which can be used for personal cooling & heating. Four TECs were used for achieving the cooling with a DC power supply through external power supply (dimmer stat). It had been shown from testing results that the cooling system is capable of cooling & heating the air when re circulating the air with the help of blower.TEC cooling designed was able to cool an ambient air temperature from32.5°C to 22.1°C. Cooling stabilizes within ten minutes once the blower is turned ON (with a velocity of 2.5 m/s). The system can attain a temperature difference of set target which was 6°C. Accomplishing the set target establish the success of the project. All the components in the project had been tested individually and the results were found to be positive. The prototype can be made compact by selecting as single TEC of higher power (.i.e. of 200W or more). It can be done by choosing a better cold side heat sink that has twisted channels or pipes for circulating the air for a longer time. As an alternative for normal axial fan used in this project, if a blower fans is selected, the cooling system would provide better airflow. Even as shown in the appended figure we can mount no of TEC cooling in Well-known TEC brands (.i.e. Melcor, Ferro TEC etc) must be chosen if there is only one high power TEC selected for the cooling system. Bigger hot side heat sink has to be selected accurately based its calculated thermal resistances for best cooling efficiency. With a single TEC, one hot side and a cold side heat sink a smaller personal TEC cooler which gives comfort can be fabricated and can be installed on roof for individual cooling by changing the airflow and some mechanical or electronics section modification, the TEC air cooling for car can be used for heating applications too.

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