International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 2, April, 2014

Research Paper

DESIGN, ANALYSIS AND FABRICATION OF THERMOELECTRIC SOLAR AIR CONDITIONING SYSTEM

Alok A Ghude[1]*, Nilesh V Belokar[1], Abhijeet Deshmukh[1], Amulya Thaokar, Akik Dande[1], Likhil Mondhe[1] and G D Gosavi[2]

Corresponding Author: **Alok A Ghude, ✉ alokghude@gmail.com*

The conventional air-conditioning system uses refrigerant that harms the environment and depletes the ozone layer. The commonly used refrigerants are CFC's and HFC's. Though HFC's has less effect over the ozone layer as compared to the CFC's but it still plays a role in depletion of ozone layer. A huge time would be required to make the complete system eco-friendly Moreover the other factors like extra power consumption, maintenance, service etc. lead to find an alternative for existing air-conditioning system. Thermoelectric Hybrid air-conditioning system has a solution to these advantages. In our project main use of solar power which is nature's free gift is used to drive the thermoelectric module. The solar energy is converted into electrical energy through solar panel which is then given to the thermoelectric module. In case of insufficient solar energy, electrical energy can be used to charge the battery. As the electric current is given to the thermoelectric module due to Peltier effect temperature difference occurs. The blowers extract the heat from the cold side and the cold air is circulated in the conditioned space by changing the polarity hot air can be circulated in the conditioned space. So basically this is a year round air-conditioning which can be used for many purposes.

Keywords: HFC's, Themoelectric module, Solar panel, Peltier Effect, Polarity

INTRODUCTION

Every day, the world produces carbon dioxide that is released to the earth's atmosphere and which will still be there in one hundred years time. This increased content of Carbon Dioxide increases the warmth of our planet and is the main cause of the so called "Global Warming Effect".

Seeing the today's scenario there is a current global need for clean and renewable energy sources. The first problem is that the fossil fuels are depleting in a rapid rate and are harder to retrieve. The consequence is that we can be facing an energy crisis in the future is we are not careful today. To avoid this doom scenario we need to find alternatives and used them to their full potential.

The second problem is that the fossil fuels that are widely used today are harmful for the environment. The earth is warming up

[1] Students, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, Maharashtra, India

[2] Assistant Professor. Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, Maharashtra, India

and climates are changing. There are parts in the world were there be more rain and sunshine and others parts will become dryer then they already are. Another negative effect is that the ozone layer is getting thinner which also leads to a warming up of the earth. These two effects complement each other and make it even more crucial to make another step in a different direction. This step will lead us to the use of renewable energy.

The solution for the above problems can be resolved by renewable energy. The sun is probably the most important source of renewable energy available today. Scientists and engineers today seek to utilize solar radiation directly by converting it into useful heat or electricity.This Electric energy provided by the sun can be used for various purposes like cooking, comfort, various home appliances etc. Among these comfort is gaining importance in today's century.

Air conditioning today is no longer a luxury-it is necessity. When one hears the term air conditioning, usually the first thing that comes to mind is cold air. Actually, a true air conditioning system automatically controls the temperature, humidity, purity and air-circulation of the air. In automotive application, air conditioning is any system that cools and dehumidifies the air.

Today's present AC system is very efficient and reliable but it has some demerits.. HFC used in this system is hazardous for environment, human body and responsible for the global warming. Maintenance cost and repairing cost of this system is very high. This system requires very large space .In this system, if any component fails to perform well then the whole system will either will not function properly or not function at all.

As a Mechanical engineer we must try to overcome these problems. We come up with the new innovation and technology as the Solar thermoelectric Air condition System.

COMPONENTS

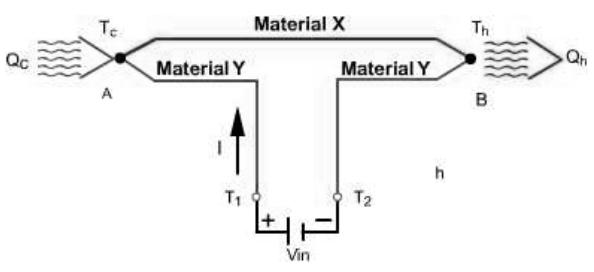
- Solar Panel
- Charge controller
- Thermoelectric plate
- Fins
- Blowers
- Fasteners
- Epoxy Paste
- Electric Circuit
- Battery

WORKING PRINCIPLE

A thermoelectric (TE) cooler, sometimes called a thermoelectric module or Peltier cooler, is a semiconductor-based electronic component that functions as a small heat pump. By applying a low voltage DC power source to a TE module, heat will be moved through the module from one side to the other. One module face, therefore, will be cooled while the opposite face simultaneously is heated. It is important to note that this phenomenon may be reversed whereby a change in the polarity (plus and minus) of the applied DC voltage will cause heat to be moved in the opposite direction.

Peltier Effect: When current is passed through a junction of two different metals, the heat is either evolved or absorbed at the junction.

Figure 1: Peltier Effect



If a voltage (Vin) is applied to terminals Tl and T2 an electrical current (I) will flow in the circuit. As a result of the current flow, a slight cooling effect (Qc) will occur at thermocouple junction A where heat is absorbed and a heating effect (Qh) will occur at junction B where heat is expelled. Note that this effect may be reversed whereby a change in the direction of electric current flow will reverse the direction of heat flow. The Peltier effect can be expressed mathematically as:

Qc or Qh=pxy x I

Where: pxy is the differential Peltier coefficient between the two materials, x and y, in volts I is the electric current flow in amperes Qc, Qh is the rate of cooling and heating, respectively, in watts.

BLOCK DIGRAM

Figure 2: Block Diagram of Thermoelectric Solar Air-Conditioning System

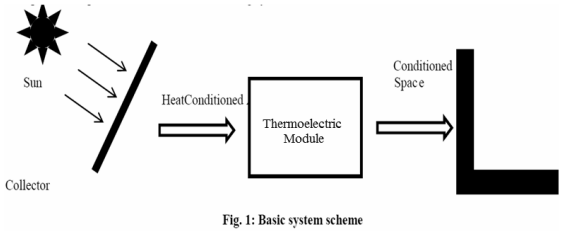


Fig. 1: Basic system scheme

The above figure shows the basic layout of thermoelectric solar air conditioning system. Sun rays falls on solar collector which eventually converts the solar energy into electricity. That electric current is given to thermo electric module and the temperature difference occurs at two junctions. The heat is extracted from the cold junction by blowers and is given to the conditioned space.

CONSTRUCTION AND WORKING

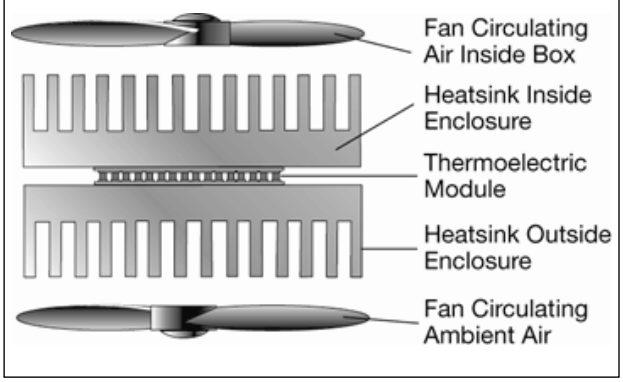
The Solar thermoelectric Air conditioning system consist of

- Thermo-electric plate
- Solar panel
- Battery
- Heat sink
- Electric blower

Thermoelectric plate is sandwiched between two heat sink made up of aluminium with a suitable pressure depending upon the material of thermo electric plate. The various types of material available are bismuth, potassium, platinum, rhodium nichrome etc. The two blowers are mounted on the either side of the heat sinks.

When the voltage is applied to the thermoelectric plate through the battery one side of thermo electric plate gets hot and other side gets cold. The blower that is mounted on cold side takes the air from atmosphere and that air passes over the heat sink which in turn becomes cold and is supplied to the conditioning area. The blower mounted on the other side takes away the heat from the hotter side and releases into the atmosphere. And if the polarity of the thermoelectric plate is changed with the help of electric switch the hot side becomes cold and vice-versa. With the help of this heating effect can be obtained in the passenger compartment. The dummy model is shown in the figure below.

Figure 3: Thermoelectric Module



CALCULATIONS

Calculation for the Project Module with following Specifications.

Couples: 127

Current: 3 amp

Dimension: 4×4 mm

Qmax= 33.4 W

Imax= 3.9 amp

Vmax= 15.4 Volts

ΔT= 68 Degrees

Now, conversions of the constant for Project Module.

The temp of the hot side observed as 32 and that of cold side is 22.

ΔT= 10 C

$$Snew = Sm \times \frac{Nnew}{71}$$

$$= 0.02902 \times \frac{127}{71}$$

$$= 0.05298\ V/_{OK}$$

$$RMnew = Rm \times \frac{6}{Inew} \times \frac{Nnew}{71}$$

$$= 1.349 \times 2 \times \frac{127}{71}$$

$$= 4.826\ Ohm$$

$$Knew = Km \times \frac{6}{Inew} \times \frac{Nnew}{71}$$

$$= 0.2913 \times 0.5 \times \frac{127}{71}$$

$$= 0.2605\ W/_{OK}$$

As our module is a single stage module.

The following calculations can be done.

1. temperature difference across the module:

   $\Delta T = Th - Tc = 32 - 22 = 10°C$

2. Heat pumped by the module in Watts:

   $Qc = (Sm \times Tc \times I) - (0.5 \times I2 \times Rm) - (Km \times Dt)$

   $= 21.7445\ W$

3. Electrical power input

   $Pin = V \times I$

   $= 36\ W$

4. The practical coefficient of performance of the module

   $$COP = \frac{Qc}{Pin}$$

   $$= \frac{21.7445}{36}$$

   $$= 0.6040$$

FUTURE SCOPE

There are two ways to install thermoelectric coolers. The first involves mounting the cooler units directly in the walls, floor and ceiling of the compartment. This assumes that the exposed thermoelectric cooler area is large enough to allow the heat transfer to & from the compartment to be accomplished by natural convection. This approach is attractive in that no other heat exchangers, blowers or ducts need to be present to consume power. A drawback of this method is that more coolers are required to compensate for the lower heat transfer coefficient. Secondly, if either side of the thermoelectric cooler became obstructed or dirty, its effectiveness drops dramatically.

A second method of installing thermoelectric coolers involves the use of auxiliary heat transfer. This approach cools the hot side of the pump with water-glycol solution which, in turn, is cooled in a heat exchanger by outside air. A secondly smaller heat exchanger, is added to allow the cooling of inside air.

CONCLUSION

In today's scenario air-conditioning is not considered as part of luxury but its necessity in day to day for a healthy life, so it cannot be considered as an option. But seeing the global warming today environment safety can also not be neglected. Though the COP of the system is low but other advantages took over it and further research can increase the COP. So Thermoelectric Solar Air conditioning is a better alternative to the current mechanical system which is eco-friendly.

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