Solar Operated Solid State Refrigeration using Peltier Effect

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Abstract— The research as we say project mainly focused on maintaining the temperature 40° C to 90° C at particular area. The refrigeration dome by using of peltier module which is in solid state. The system consist solid chamber, thermoelectric module that is peltier module, FD fan, and aluminum fins Result shows that coefficient of refrigeration (C.O.P)which is a criterion of performance of such device is function temperature between the source and sink .for maximum efficiency the temperature difference is to be kept to barest minimum. The research aims to design and build a miniature prototype of thermoelectric cooling system for a conventional air conditioned to provide air conditioning to reduce the consumption of electricity and to reduce the pollution.

Key words: Thermoelectric Cooler Module, Heat Source, Heat Sink, Peltier Effect, Thermoelectric Cooling Materials, Refrigeration Load, Coefficient of Performance

I. INTRODUCTION

The Peltier effect is named after Jean Charles Peltier (1785-1845) watchmaker and part time physicist who first observed it in 1834. Jean Charles. A thanase Peltier found that the application of a current at an interface between two dissimilar materials results in the absorption/release of heat. The Peltier effect had no practical use for over 100 years until dissimilar metal devices were replaced with semiconductor Peltiers which could produce much larger thermal gradients. The reverse of the Seebeck effect is Peltier effect(Discovered by Thomas Johann Seebeck in 1821)a temperature difference causes diffusion of electrons from the hot side to the cold side of a conductor. The motion of electrons creates an electrical current, the voltage is proportional to the temperature difference as governed by:$V=\alpha$ (Th-Tc). Thermoelectric refrigeration system powered by solar photo voltaic (PV) cell generated DC voltage is suitable for Indian climate conditions and applicable for rural health centers. For utilizing solar energy efficiently and cost effectively, proper design of reliable solar devices and system have to be attempted to suit the radiation climate and socioeconomic condition.

Thermoelectric refrigerator sometimes called a thermoelectric cooler module or Peltier cooler is a semiconductor based electric component that functions as a small heat pump. By applying a low voltage direct current (DC) power source to a thermoelectric cooler module, heat will be moved through the module from one side to the other [1]. One module face, therefore, will be cooled while the opposite face simultaneously is heated. Both thermoelectric refrigerators and mechanical refrigerators are governed by the same fundamental laws of thermodynamics and both refrigeration systems; although considerably different in form, function in accordance with the same principles. In a mechanical refrigeration unit, a compressor raises the pressure of a refrigerant and circulates the refrigerant through the system. In the refrigerated chamber, the refrigerant boils and in the process of changing to a vapor, the refrigerant absorbs heat causing the chamber to become cold. The heat absorbed in the chamber is moved to the condenser where it is transferred to the environment from the condensing refrigerant. In a thermoelectric cooling system, a doped semi-conductor material essentially takes the place of the refrigerant, the condenser is replaced by a finned heat sink, and the compressor is replaced by a Direct Current (DC) power source. The application of Direct Current (DC) power to the thermoelectric cooler modules causes electrons to move through the semi-conductor material [4].

II. METHODS TO USE THE PELTIER EFFECT

As we see in introduction Peltier effect can produce heating as well as cooling effect. We can use this effect as produce direct effect for cooling or heating and can use peltier module in existing system to increase the performance or COP of the system. From above application w can subdivide the use of Peltier effect as Direct use & Integrated use of Peltier Effect.

1) Integrated Use of Peltier Effect
2) Direct use of Peltier Effect
3) Integrated Use of Peltier Effect

Thermoelectric systems show excellent efficiencies at small temperature lifts. While the applications of this advantage are limited, it can be used potentially quite beneficially in vapor compression systems [2]. In a conventional vapor compression system, with a traditional condenser that includes a subcooler, liquid refrigerant leaving the subcooler only can be cooled to the temperature level of the heat sink. Using a thermoelectric element for subcooling, the liquid refrigerant can now be subcooled significantly at a COP that exceeds that of the original vapor compression system. Figure 2 shows a schematic of the vapor compression cycle with the thermoelectric subcooling element indicated after the condenser.

A. Refrigeration

An American society of refrigeration engineer has defined refrigeration as “the science of providing and maintaining temperature below that surrounding atmosphere.”

The purpose of Refrigeration is

1) To slow down rates of detrimental reactions
2) Microbial spoilage
3) Enzyme activity
4) Nutrient loss
5) Sensorial changes

Functions of Components of a Vapor Compression Refrigeration System

1) Evaporator

- Extract heat from the product/air and use it as the latent heat of vaporization of the refrigerant

2) *Compressor*
   – Raise temperature of refrigerant to well above that of surroundings to facilitate transfer of energy to surroundings\ in Condenser
3) *Condenser*
   – Transfer energy from the refrigerant to the surroundings (air/water) Slightly sub-cool the refrigerant to minimize amount of vapor generated as it passes through the expansion valve
4) *Expansion valve*
   – Serve as metering device for flow of refrigerant Expand the liquid refrigerant from the compressor pressure to the evaporator pressure (with minimal conversion to vapor)

III. SOLAR OPERATED REFRIGERATION BY PELTIER EFFECT

The construction set up for this system require
Following parts:-

1) Solar panel
2) charge control circuit
3) Battery
4) Control switch
5) Peltier

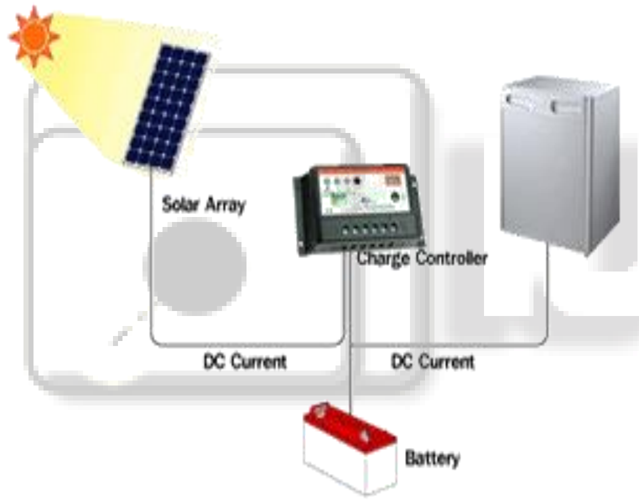

Fig. 1: Block Diagram Of Peltier Effect

A. *Working*

The principle of power generation behind the solar cells consists of the utilization of the photovoltaic effect of semiconductors. When such a cell is exposed to light, electron-hole pairs are generated in proportion to the intensity of the light.

Solar cells are made by bonding together p-type and n-type semiconductors. The negatively charged electrons move to the n-type semiconductor while the positively charged holes move to the p-type semiconductor.[6] They collect at both electrodes to form a potential. When the two electrodes are connected by a wire, a current flows and the electric power thus generated is transferred to battery banks connected to it. Solar charge controller is used to supply constant current to batteries. From battery the supply is given to the thermoelectric module which produces refrigeration effect in the cabinet using peltier effect. So required refrigeration effect can be obtained by supplying voltage from battery.[3]

The cooling effect is given by:-

Area of peltier is directly proportional to the area which is being cooled.

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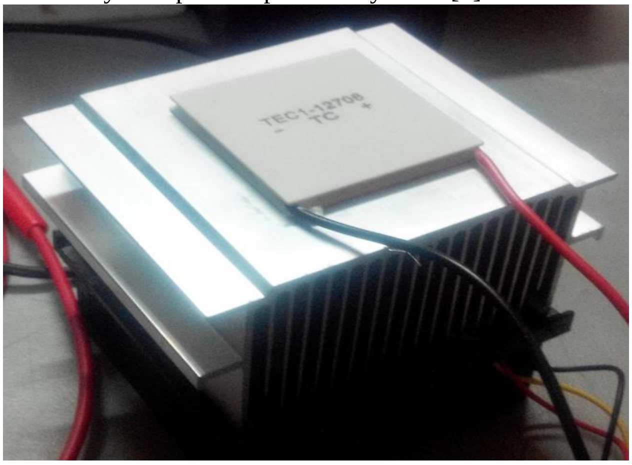

Fig .2: Working Model Of Peltier

B. *Cost Estimation*

No	Component	Cost (in rupees)	Quantity
1	Solar panel	4000/-	1
2	Charge Control circuit	3000/-	1
3	Battery(12V)	2000/-	1
4	Control switch	1000/-	1
5	Peltier	1500/-(each)	4
6	Aluminum fins	500/-	2
7	DC fan	200/-	2
8	Fabrication structure	3000/- Total : 15200/-	

Table 1.

IV. APPLICATIONS

Commercial devices based on thermoelectric Materials have come up in a big way recently. In addition to the benefits thermoelectric offer over the conventional devices, the most effective use of this project is it can be used to store polio drops as there is no as such facility and other applications are Microprocessor cooling Laser diode temperature stabilization, Temperature regulated flight suits

V. CONCLUSION

Thermoelectric and thermoelectric cooling is being studied exhaustively for the past several years and various conclusions have been conceived regarding the efficient functioning of thermoelectric Refrigerators. Thermoelectric refrigerators are greatly needed, particularly for developing countries, where long life, low maintenance and clean environment are needed. In this aspect thermoelectric cannot be challenged in spite of the fact that it has some disadvantages like low coefficient of performance and high cost. The various aspect about this project is that there is no as such moving parts so this project is based on solid state only and has no moving parts, as there is no moving parts so this model does not require maintenance as required for a model having moving parts and as it requires a very low maintenance so the proposed model has a long service lifetime as if will be used for preservations of medicine so it has various aspects about the project.

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