Design Of Thermo Electric Refrigerator

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Abstract- *This paper examines the Thermo electric refrigeration based on thermo electric cooling and peltier effect and also described the study of thermo electric module, advantages and its various applications. In this module we used n- type and p- type semi conductors these are sandwiched between the two dissimilar materials one is for heat absorbing and another is for heat rejecting. When the dc supply is applied to this module, the potential difference occurs in different temperatures at the two junctions. By using this module we can generate electricity through seebeck effect. Thermo electric cooling system have advantages such as compact in size, light in weight, high reliability, and there is no mechanical components and no working fluid likerefrigerator for refrigeration. We have seen TEC is used in various places such as external cooling jackets in fire fighters, night vision goggles, spacecooling system, telecommunication organisations and R&AC industries for application purpose.*

Keywords- thermo electric module, peltier effect, seebeck effect,refrigeration,and applications

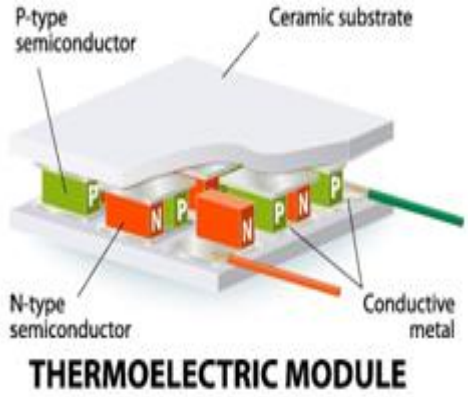
I. INTRODUCTION

As before invention of the thermo electric cooler or module, conventional vapour compression refrigeration system plays an important role in the society but the vapour compression system release CFC, HFC and some global warming gases causes to green house effect. And also vapour compression refrigeration system occupies very large space and It has more components. Those are compressor, condenser, expansion valve and evaporator. Those mechanical components are plays main role on vapour compression refrigeration system but some draw backs occurs at that time researches are going on better alternative for the CFC refrigerants still on the hunt. Although thermo electric property was discovered, thermo electric module working based on peltier effect. The applications of thermo electric module vary from small refrigerator and electronic package cooling, water chillers, cold plates, portable insulin cooling, portable beverage containers etc.

1.1Thermo electric cooling module basis on peltier effect.

The thermo electric cooling mainly working based on peltier effect in 1834French watch makers and jean peltier found that an electrical current would produce a temperature gradient at a junction of two dissimilar metals.

The thermo electric module gives the instantaneous cooling effect when dc applied it gives low efficiency as compared to vapour compression refrigeration system but it has portable and control the temperature at certain places. In thermo electric module two dissimilar materials are there those are made with bismuth telluride or any other materials one is for heat absorbing and other is for heat rejecting, p-type semi conductors are sandwiched between the two dissimilar materials and coated with ceramic material at outside of the module. And the module is electrically connected then the dc applied to that module, one side of the module cold and other side is hot because of properties of materials and passage of electron on the P&N type semi conductors.



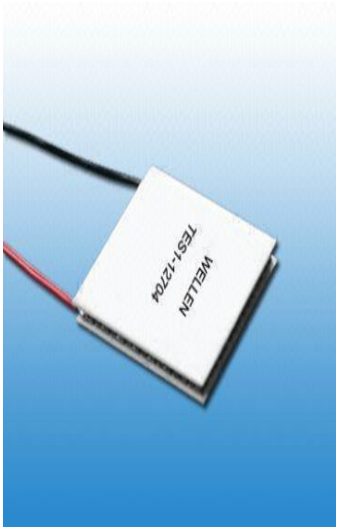


Fig.1 thermo electric module

1.2. Block diagram of thermo electric cooler

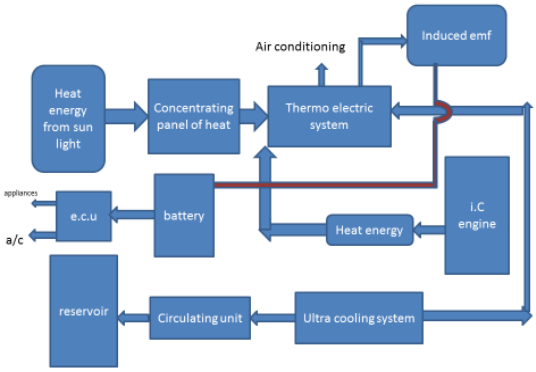


Fig.2 block diagram of thermo electric cooler

TYPES OF THERMO ELECTRIC MODULES are:

- Single stage thermo electric cooling
- Multi stage thermo electric cooling

Single stage thermo electric compressor is used for the high efficiency and many more applications single stage thermo electric cooling is better to choose for industrial applications space applications etc.

SEEBECK EFFECT:

The THOMAS SEEBECK was found this method in 1821.By using this module we can generate the power generation when we maintain temperature difference $\Delta T=70^0c$. then we can get 12v power with help of thermo electric cooling when the difference between the two temperature the EMF will generate that causes to power generation on the seebeck effect .

1.3. THERMO ELECTRIC REFIRGERATION:

In thermo electric refrigeration the thermo electric module gives instantaneous cooling when dc applied it gives temperature gradient at certain closed places. In this system having one heat sinks and air blowers are used for the refrigeration purpose. It can be portable less space occupies less current consumption and it gives good efficiency for refrigeration in certain places.

1.4. Working principle:

The working principle of thermo electric cooler or module is very simple as compared to the vapour compression system.In thermo electric cooler, when the direct current is applied to the module, the temperature difference will occurs, one side is cold junction and other side is hot junction.At the cold junction, the heat is absorbed by electrons as they pass from p-type semi conductor to the n-type semi conductor. At the hot junction, heat energy is expelled to heat sink as electrons moves from n- type semi conductors to p-type semi conductors.

Schematic of a Thermoelectric Cooler

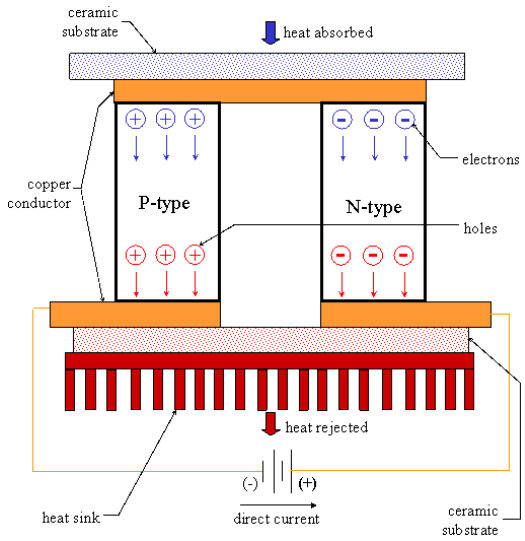


Fig.3working principle of thermo electric cooler

In vapour compression system, must be need mechanical component to work the vapour compression refrigeration, but in thermo electric module, dc supply thermo electric materials are enough.

II. CURRENT WORK

Objective of project is to develop the thermo electric refrigeration system of cooling chamber. It is necessary to design thermo electric refrigeration capable of maintaining the temperature o the materials 10^0 to 15^0c for a long duration. The system has to work used to alternative sources like solar energy and battery also. It has to controls the radiation.

2.1. Designing of thermo electric module

The material used for assembly components deserves careful thought. The heat sink and cold side mounting surface should be made out of materials that have a high thermal conductivity (i.e copper or aluminium) to promote heat transfer.However, insulation and assembly hard ware should be made of materials that have low thermal conductivity (i.e polyurethane foam and stainless steel) to reduce heat loss. In thermo electric module two junctions are there those are hot and cold junctions. In hot junction surface fix with heat sink to reject heat. When DC supply applied to the module by removing the heat through heat sink from the hot side is equal to the chillness producing from cold side.

- Components required for construction of thermo electric refrigeration
    a) Thermo electric module

b) Heat sinks
c) Air blowers
d) Rectangular Closed chamber

The thermoelectric module is fixed with heat sinks and air blowers as shown in below fig.

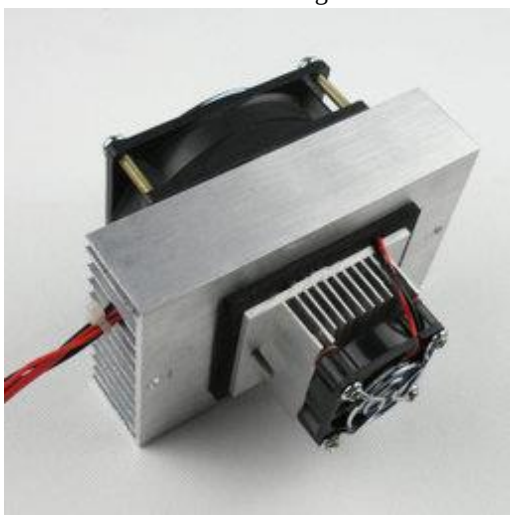


Fig.4 thermo electric module with heatsinks and blowers

The total system is fixed on the wall of the chamber as the cold junction phase is inner side and hot junction phase is outside of the chamber and close the chamber. The DC supply applied to the thermo electric cooler, it gives the temperature difference. Inside of the chamber temperature goes on decreasing and outside temperature is ambient temperature. By using thermo electric cooler we can control the inside temperature of the chamber up to 0^0c.

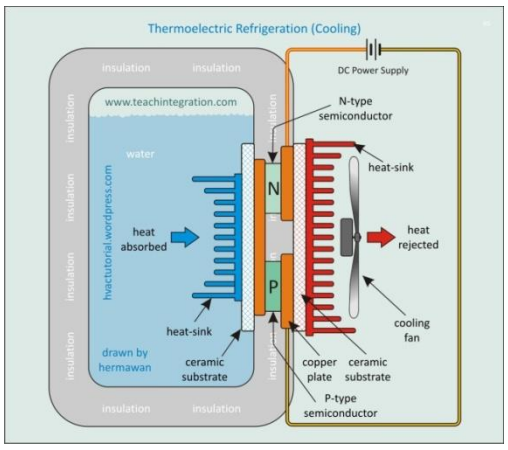


Fig.5 Thermo electric refrigeration

Coefficient of performance of thermo electric cooler: The selection of thermo electric cooler will based on cop factor. Cop=ratio of the thermal output power electrical output power of the thermo electric cooler.

$Cop = Q_c/P_e$

III. RESULTS AND GRAPHS

Here we are going to discuss about the results and graphs of the thermo electric cooling system

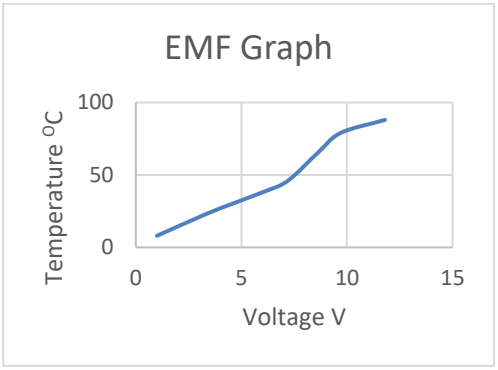


Fig.6 comparison between temperature& voltage

Here we are going to be calculating the amount of EMF induced on the system in this system must be observe the temperature difference between hot and cold junctions. The temperature difference of minimum of 70^0c, maximum of 12v we can produce thorough the system. Where the temperature difference increasing, voltage production also increasing when up to 12v.

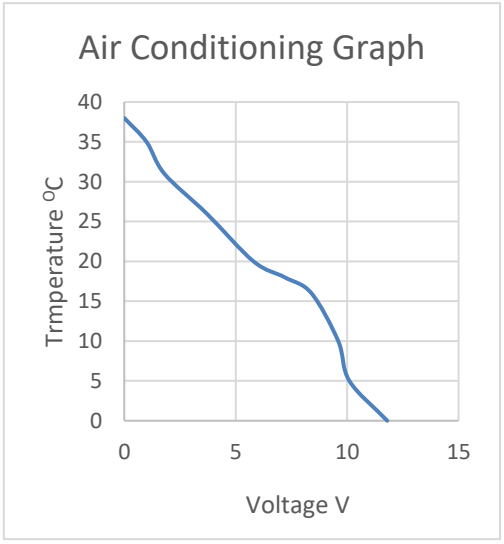


Fig.7 comparison between temperature & voltage

The thermo electric cooling system is fixed to the cabin when the supply of voltage to the system, by consuming the voltage the chillness produced inside the cabin. The temperature inside the cabin is going to be 0^0c by consuming maximum voltage of 11.8v 16^0c to 18^0c temperature can be achieved by the consumption of 7.2v to 8.4v

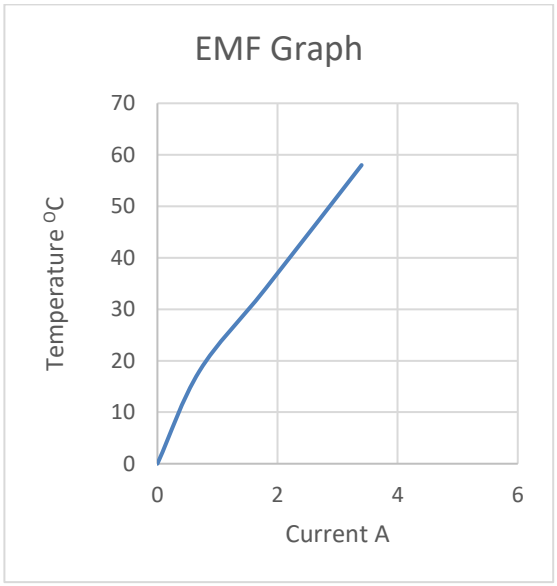


Fig.8 comparison between temperature & current

For the calculation of amount of emf induced by the system should be done by applying the load. Here we going to be 7amps battery to charge. The graph shows that the by maintaining 72^0c temperature difference, we are going to achieve the maximum of 4.5 amps.

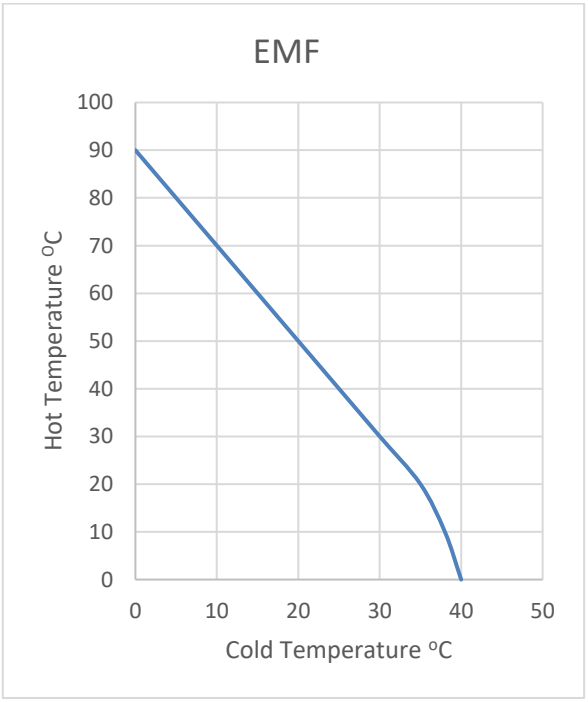


Fig.9 comparison between hot temperature& cold temperature

Here the temperature difference between the hot and cold junction is 90^0 when the cold junction side the temperature decreasing from 40^0 to 0^0c and hot junction side the temperature increasing from 0^0 to 90^0. Due to the temperature difference the emf will be generated.

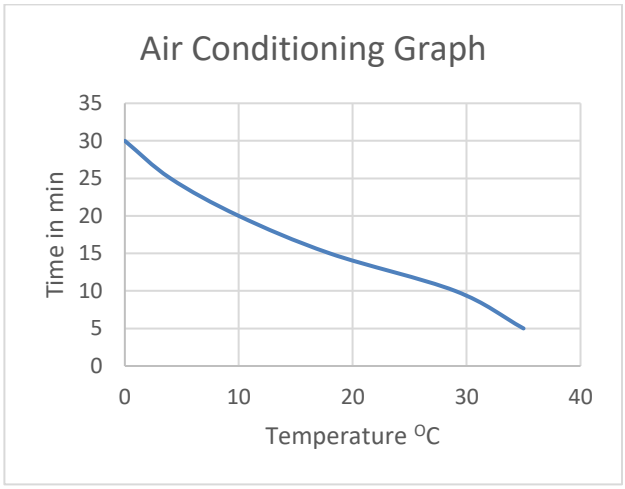


Fig.10 comparison between time in minutes &temperature

In this graph we are going to know about the how much time required to produce the chillness on the cabin considering every five minutes, in 15 to 20 minutes it will reach 16^0 to 18^0, and for reaching the 00c the minimum time we need 30 minutes.

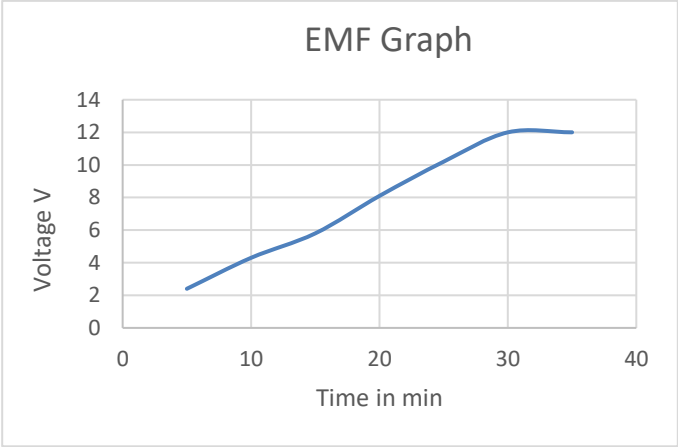


Fig.11 comparison between volume & time

Amount of voltage produce per 5 minutes is recorded as shown in graph. Starting 5 minutes from 2.4 volts at the end is 10.2 volts in 25 minutes. We can get 12v we need to operate the system for the 30 to35 minutes.

Applications

1. As a power generator
   Due to the temperature difference, the thermal energy is converted in to the electrical energy which is a solid state device. It works on the seebeck effect. It is used in industries, defence, aero space etc.

2. Power generation using solar energy
   Solar energy is a un conventional source and clean source. By using solar thermal collector and thermo electrical generator will produce electrical energy.

3. As a AC & refrigerator
   It is quality different than vapour compression refrigerator system. In this one no pipe, no joints & no mechanical components. It has only direct supply of voltage to the device, the device will give chillness is one side and hot is another side. It is used as mini refrigerator.
4. Condensation of H_2O
   By using this device we can produce water in desert places. In deserts less water and high humidity is there by using this device. We can produce water less maintenance less cost also.
5. Utilisation in medical sciences.
   This device used for the storage of medical insulin etc.
   AND OTHER APPLICATIONS are
   Laser cooling
   Car batteries
   Cooling car seats
   Cool satellites and space craft etc.

Advantages

- Cost of device is les
- No mechanical components
- No pipes, gauges and joints
- Refrigerant not required
- Light weight
- Portable device
- Transport is very easy
- Thermal electric cooler controlled by voltage/current
- Small size
- Occupies less space
- It can be cooling below the ambient temperature
- It can generate power
- Power consumption is less
- Givers better result

Disadvantage

- Low efficiency
- Able to dissipate limited amount of heat flux

IV. CONCLUSION

This project is examines the design of thermoelectric cooler ad power generation system, application of thermo electric cooler on different sectors. Thermo electric devices are using in many areas those are space, medical laboratories, cooler, AC's and defence etc. In future generation, this technology is very useful for low cost maintenance, light in weight, less space occupies and portable. Implementing this technology we can use in many more applications and etc.
This technology is not widely popular because of main disadvantage is low efficiency but it works in any orientation and environmentally friendly.

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