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Compressor-Less Refrigerator cum Oven

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Abstract -The impact of on-going progress in Science and Technology has created a variety of systems that can be used in the generation of power from Renewable Sources of energy and one of these is Solar Energy. The project which we have prepared utilizes solar energy with the use of Thermoelectric Module and Photovoltaic Module for generation of energy which we further use for cooling and heating effect. It is basically a portable cooler cum heater which is mainly designed for the convenience of the travelling people and the militaries. The most important utilization of this portable cooler is for the preservation of insulin in extreme conditions. The precise level of cooling power below which the thermoelectric method is preferable depends on a number of factors, but for most purposes it is ten watts and will remain in this region until there is a substantial improvement in the figure of merit of the thermo elements. A Thermoelectric module (TEM) is used instead of compressor so that it become portable, as it is based on the principles of Peltier effect. The use of Peltier effect is to create a heating side and a cooling side and also to maintain effectiveness. Thermoelectric cooler (TEC) is a solid state heat pump which uses the semiconductor materials, by Peltier effect, to provide instantaneous cooling or heating. It has the advantage of having no moving parts and thus maintenance free.The solar thermoelectric avoids any unnecessary electrical hazards and provides a very environment friendly product and also the thermoelectric refrigerator does not produce chlorofluorocarbon (CFC). It is pollutant free-contains no liquids or gases, portable, compact, creates no vibration or noise because of the difference in the mechanics of the system. It is a prototype and its components are available commercially.
Keywords- ***P.V- photo voltaic, C.O.P- coefficient of performance, T.E.C- thermoelectric cooler,T.E.M- thermoelectric module, S.T.C- standard test condition, D.C- direct current, A.C- alternating current, C.F.C-chlorofluorocarbon***

I. INTRODUCTION

With time many techniques, laws and methods have been discovered by scientists. The Seebeck and Peltier Effect account to be one of them. When a closed circuit of two dissimilar metals and two junctions is formed, a current will flow between the junctions or the circuit. This phenomenon is known as the Seebeck effect. The effect takes place when the temperature between the junctions shows difference. The greater the temperature difference, the more will be the electric current between the junctions. This is the fundamental principle used in the thermocouple. The combinations of metals or semiconductors affect the flow of current. Jean.C.Peltier, a French watchmaker and an amateur scientist discovered a reverse effect of the Seebeck. He discovered that using joined dissimilar metals heat pump can be made. He found that by the use of two dissimilar metals if current is passed between the junctions, the two junctions will create a temperature difference between them. One junction becomes hot and the other becomes cool. This is the basis on which our project works. The Peltier effect [4][8] is the heat liberation at one junction of thermocouple and heat absorption at the other, when an electric current flows into it. This effect is used in thermal analysis and also for heat flow compensation. With time many researches were conducted, many new theories and with them many new devices were put forth. Air Conditioner, Refrigerator etc. are few of them, where by the use of electricity, cooling is obtained. But in these devices cooling does not just takes place totally due to electricity (here for efficiency and fast rate of cooling Refrigerants), Compressors are used.

A. Refrigerants

A 'refrigerant' [1][5] is defined as any substance that absorbs heat through expansion or vaporisation and loses it through condensation in a refrigeration system. The term 'refrigerant' in the broadest sense is also applied to such secondary cooling mediums as cold water or brine solutions. Usually refrigerants include only those working mediums which pass through the cycle of evaporation, recovery, compression, condensation and liquefaction. These substances absorb heat at one place at low temperature level and reject the same at other place having higher temperature and pressure. The rejection of heat takes place at the cost of some mechanical work. Refrigerants are classified as 1) Primary- CO_2, SO_2, and NH_3 etc. 2) Secondary- ice, solid carbon dioxide etc. R-10, R-11, R-114, R-50 are few examples of refrigerants being used

The desirable properties of refrigerants are:-

Ease of handling

High C.O.P

Low power consumption

The undesirable properties of refrigerants are:-

Toxicity
Inflammability
Leak tendency
Reaction with material of construction

B. Compressors

The function of a compressor [1][2] is to take a definite quantity of fluid and deliver it at a required pressure. Here in the A.C and Refrigerators, the compressor is used for the circulation of air and refrigerants.
The desirable properties of compressor are:
The efficiency is increased
The undesirable properties of compressor are:-
It increases the weight of the system
More power is utilized for its working
Cost increases
To avoid the harmful effect of the refrigerants and to decrease the power consumption on working of the compressor, we have given the idea of a 'compressorless refrigerator cum oven' where we are neither using a compressor nor using the refrigerants. This idea is based on the application of the Peltier effect. We are applying the Peltier effect for the cooling of the system at one side and utilizing the other side as a heater. Thus doing two jobs at a time, i.e. this appliance will not only give cooling but also provide heating effect for our use. This project utilizes solar energy for its operation which makes it pollution free and environment friendly. For this, we are using a thermoelectric module, a solar panel, a charge controller and battery.

II. GEOMETRY OF THE PROJECT

First of all two compartments are made of the conducting material and coated with proper insulators. These are fixed as an assembly in a box made up of a proper material for ventilation and support (e.g. quark). Two thermoelectric modules are attached to the whole setup. Operating load can be taken from charge controller or through direct battery. A photo voltaic module attached with a charge controller is place in the sun at a proper position to get the most area of it in the sunlight. Thermoelectric semiconductor material used is Bismuth telluride. This charge controller is then attached to the battery. Now the whole setup is powered by the solar energy and working is obtained.

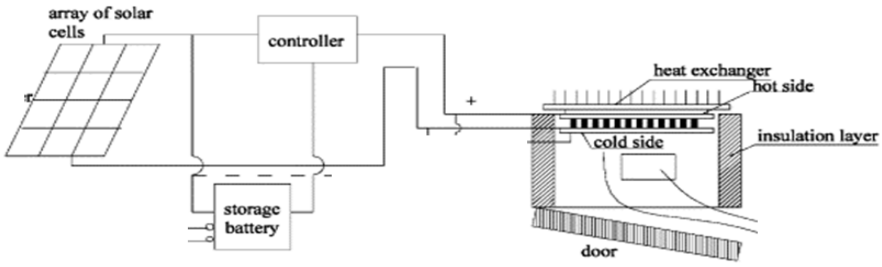

Fig.2.1

III. UTILIZATION OF THE PROJECT

A. Thermoelectric Cooling System

Advantages:-
These are environment friendly. (no C.F.C)
These are light in weight.
Give fast temperature response.
It is portable, small in size.
Can be used during travelling.

Can be used at military base.
Have no vibrations.
Creates no noise.

Applications:-
For preservation of insulin and other drugs.
For preservation of food stuffs.
For cold water.
For beverages.

B. Thermoelectric Heating System

Advantages:-
These are environment friendly. (no C.F.C)
These are light in weight
Give fast temperature response.
It is portable, small in size.
Can be used during travelling.
Can be used at military base.
Have no vibrations.
Creates no noise

Applications:-
For hot water.
For preparation of instant food.
For melting of chocolate.
At military base for cleaning of wounds with lukewarm water.

C. Coefficient Of Performance

The index of performance of heat pump and refrigerator is expressed in terms of coefficient of performance [2][3]. It is defined as, "the ratio of energy effect (output) desired to the energy input required". It does not have unit. COP for heating and cooling are different i.e. for heat pump and refrigerator.

$$(COP)_{Heat\ pump} = (COP)_{Refrigerator} + 1 \quad \text{, where}$$

$$(COP)_{Heat\ pump} = \frac{\text{Amount of heat supplied to hot body}}{\text{Work done}} = \frac{Q_2}{Q_2-Q_1} = \frac{T_2}{T_2-T_1}$$

$$(COP)_{Refrigerator} = \frac{\text{Amount of heat extracted from cold body}}{\text{Work done}} = \frac{Q_1}{Q_2-Q_1} = \frac{T_1}{T_2-T_1}$$

IV. EMERGING TECHNOLOGIES

A. Thermoelectric Module- Heat Pump

Fig. 4.1 Thermoelectric Module

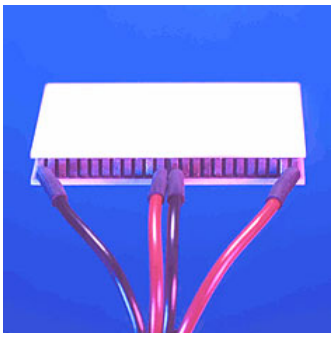

Fig. 4.2 Connections in module

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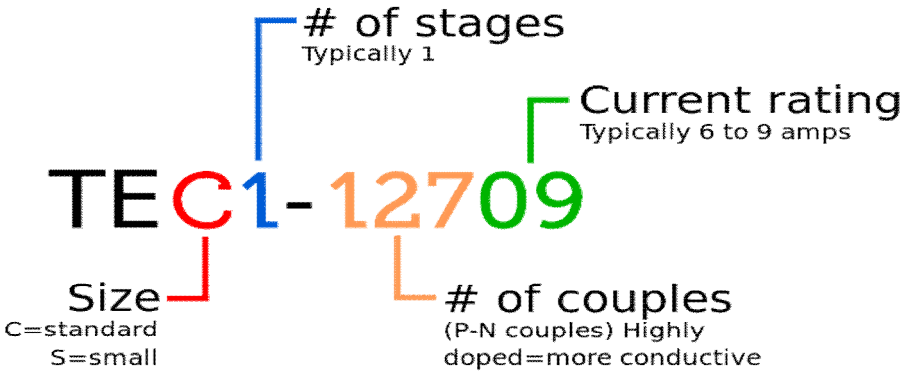


Fig .4.3 TEC

Thermoelectric modules (Peltier modules) are solid-state heat pumps that operate on the Peltier effect. Heat pump [3] is a thermodynamic system, which transfers heat from low temperature body and gives out the same to high temperature body. The function of heat pump is to supply more and more amount of heat to hot body from cold body. In heat pump, heat is pumped from heat sink or a cold body and is supplied to hot body, on consuming external work supplied. A thermoelectric module [6] consists of an array of p- and n-type semiconductor elements that are heavily doped with electrical carriers. The elements are arranged into array that is electrically connected in series but thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements.

B. Charge controller

Multi-layer timing for overload protection
Globally latest & advanced technology
Built with perfect blend of state of art of electronics & micro computing
Temperature compensation for better battery charging on various climate & terrain
Slim & Sleek look
Electronic blocking to save precious energy saved in battery

Fig.4.4 Charge Controller

C. Solar Panel

Fig.4.5 Solar Panel

A solar panel [10] is a set of solar photovoltaic cells electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cell. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. All the above three components are a concern of large study. Hence this project is made at a smaller scale for now. But the idea of the project will lead it to further progress

V. PROBLEMS ASSOCIATED WITH THE IDEA

The initial cost of the project is high.
The availability of the components is less.
The C.O.P is less compared to conventional type refrigerators.
Charging of the battery with solar panel takes time.

VI. UTILISATION IN THE INDUSTRIES

There are certain advantages possessed by compressorless refrigerator and oven that can occasionally sway a decision in their favour even for large scale applications. This compressorless refrigerator and oven avoids any unnecessary electrical hazards and provides a very environment friendly product. In this regard, the refrigerator does not produce chlorofluorocarbons (CFCs), which is believed to cause depletion of the atmospheric ozone layer. As from industry point of view, this project is of job production type.

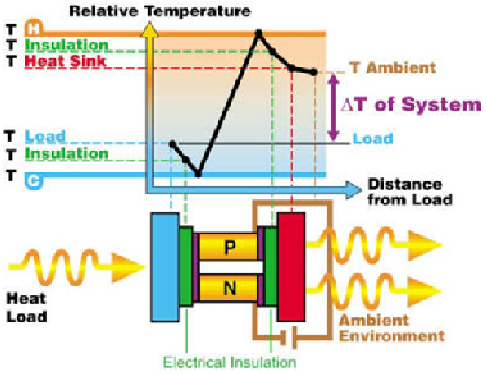


Fig.6.1 Current flow in p-n junction

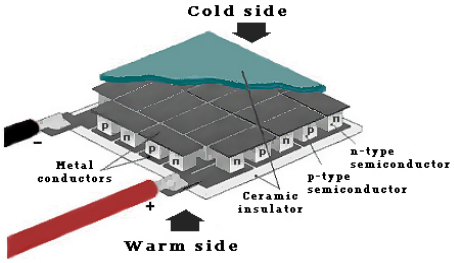


Fig.6.2 p-n type semiconductor material

VII. CONCLUSIONS

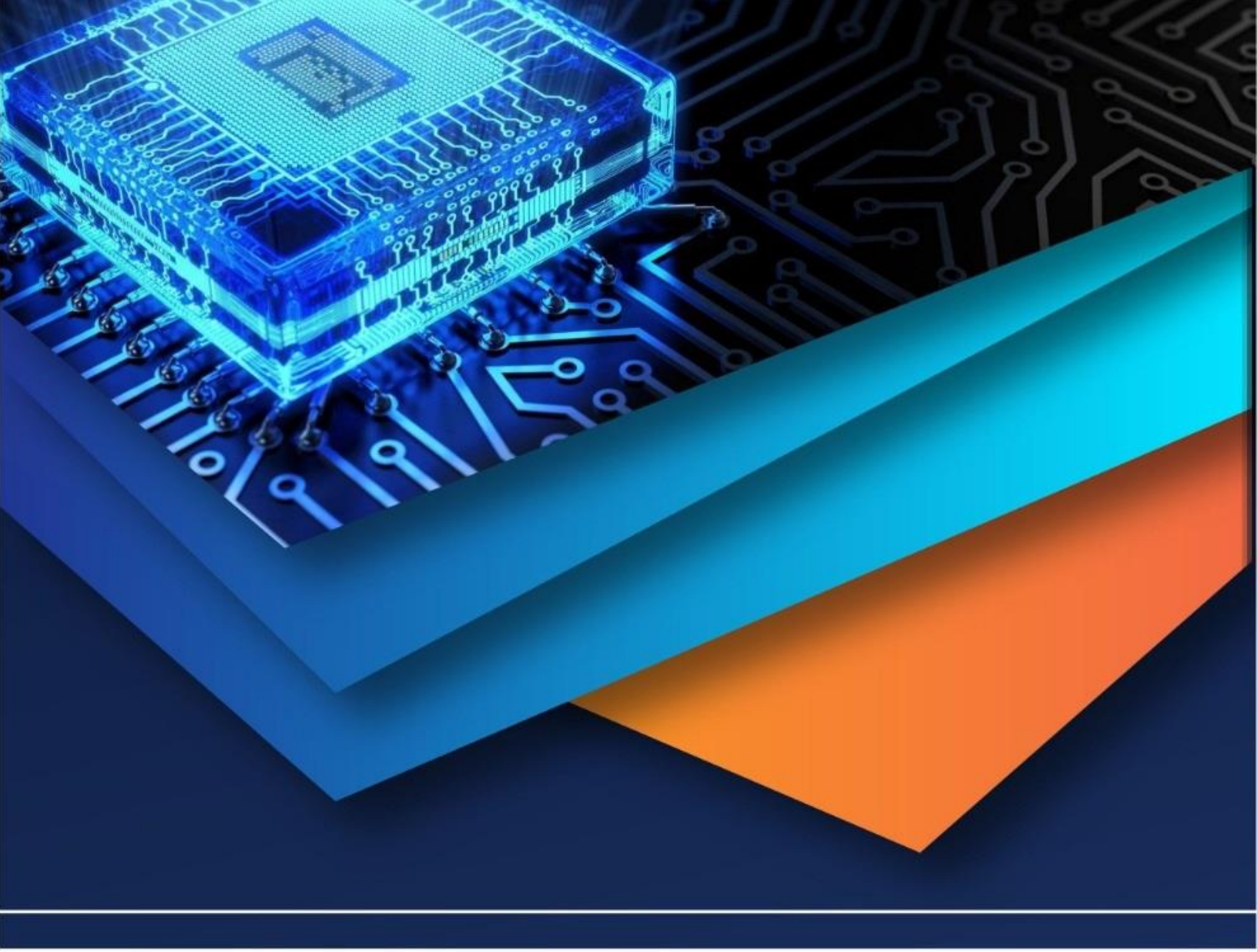
In conclusion, TECs are solid state heat pumping devices that reduce component (CPU) temperature, but they require some forethought to apply. If the TEC is misapplied, the unit may actually heat your CPU rather than cool it. The most important thing is that the heat sink and the TEC must be properly sized to suit the heat load. The heat sink must be at least good enough to keep the CPU at 15-18^{o} C only above ambient without the TEC. The TEC must have a maximum heat transfer capability

about 2 - 3 times more than the amount of heat that the CPU puts out. The coefficient of performance of this refrigerator is much smaller than that of a conventional compressor-type refrigerator when the required cooling capacity is high, whereas the coefficient of performance of the conventional unit falls off rapidly as the cooling capacity is decreased and that of thermoelectric unit remains constant. Thus a conventional refrigerator is preferred when the required cooling capacity is high and a thermoelectric refrigerator should be chosen when a low cooling capacity is needed. Recently, even disregarding the coefficient of performance, the cost of thermoelectric units (which is more or less proportional to their cooling capacity) makes them unsuitable for applications where a large cooling capacity must be provided unless economic considerations can be relegated to a position of secondary importance. As the cooling units are of small size, silent, contains no liquids or gases, have no moving parts and have a long life. It is very simple to control the rate of cooling by adjustment of the current, the response to changes in the supply is very rapid, while reversal of the direction of the current transforms a cooling unit into a heater with a coefficient of performance in excess of unity i.e. a heat pump for oven. In this work, a portable compressorless refrigerator unit was fabricated and tested for the cooling purpose. The refrigerator was designed based on the principle of a thermoelectric module to create a hot side and cold side. The cold side of the thermoelectric module was utilized for refrigeration purposes whereas the rejected heat from the hot side of the module was eliminated using heat sinks and fans. In order to utilize renewable energy, solar energy was integrated to power the thermoelectric module in order to drive the refrigerator and oven.

This is completely eco-friendly project Multipurpose and Portable

REFERENCES

[1] Rajput R.K., “Textbook of Thermal Engineering” and “Refrigeration books” pg. no.-1202, 1420, 1471-73.
[2] Khurmi R.S., Gupta J.K., “A Textbook of Refrigeration and Air Conditioning”, S.Chand Publications, pg.no.-38-67, 68-107, 654.
[3] Vinod Thombre-Patil, “Thermal Engineering”, Nirali Prakashan, pg. no. -1.34, 1.35.
[4] Kumar D.S., Nagraj Chaudhary, Rajput R.K. “Mechanical Measurement and Control”.
[5] List of Refrigerants, *Wikipedia, and the free encyclopaedia.*
[6] Tan Y.M., Fan W, ChuaK.M, Shi P.Z, “Fabrication of the Thermoelectric Cooler for device integration,”*IEEE Xplore, Electronic Packaging Technology Conference, Proceedings of 7th* , vol. 2, *EPTC 2005.*
[7] Goldsmid H.J., *International Cryogenics Monograph Series: Thermoelectric Refrigeration, Applications of Thermoelectric Refrigeration.* New York, U.S.: Springer-Verlag, 1964.
[8] Drebushchak V.A., *Journal of Thermal Analysis and Calorimetry: The Peltier Effect.* Netherlands*:* Springer, pp.311-315, Issue 1, vol .91, Jan 2008.
[9] Salas V., Olias E,Barrado A, Lazaro A, “Solar Energy Materials & Solar Cells ” *Review of maximum power point tracking algorithms for standalone photovoltaic systems* .Elsevier B.V., vol. 90, pp.1555-1578, Jul 2006.
[10] Desideri V, Proietti S, Sdringola P, *Solar –Powered cooling systems: Technical & economic analysis on industrial refrigeration and air-conditioning applications* .Elsevier B.V., vol.86, pp.1376-1386, Sep 2009.



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