EXPERIMENTAL ANALYSIS OF THERMO ELECTRIC REFRIGERATION BY USING THE SOLAR POWER

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ABSTRACT

Experimental prototype of thermoelectric refrigeration system working on solar photo voltaic cells generated DC voltage. The developed experimental prototype having a refrigeration space of 1.36 liter capacity is refrigerated by using heat sink fan assembly to increase heat dissipation rate from hot side of cooling module.

The experimental result shows a temperature reduction without any heat load and with 30.4^{0}C water kept inside refrigeration space in 30 minute with respect to 37.2^{0}C ambient temperature. Also the COP of refrigeration cabinet has been calculated. The developed thermoelectric refrigeration system is having potential application of storage and transportation of life savings drugs and biological materials at remote areas of our country where grid power is unavailable. The projects supports both heating and cooling. The project has various applications like, military or aerospace, medical and pharmaceutical equipment etc. thus it proves to be very helpful.

Keyword: -*Thermoelectric module,*

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1. INTRODUCTION

Thermoelectric refrigerators (TER), also known as Peltier refrigerators. They are solid state heat pumps that utilize the theory of Peltier effect to remove heat. When the current is passed through the terminal one side of the module absorbs the heat result in decrease in temperature produces refrigerating effect whereas other side emits the heat which provide heating effect then the heat can be dissipated to the atmosphere through forced or natural convection [14) The principle of peltier effect is the inverse of the principle of seeback effect.

If we look at the performance of a typical production TE module alone and assume that a perfect, 100% efficient heat transfer system were available, then the performance characteristics of the module alone would appear to compete with vapour compression systems favorably in refrigeration, particularly in smaller heat load applications. However, the reality is that once the same module becomes part of a complete standard TE system, resulting performance falls well short of module performance, providing no effective competition to vapour compression

According to Seeback effect, When two different metals or semiconductors are kept at different temperature and both are connected at one junction when the voltage is developed on the other junction

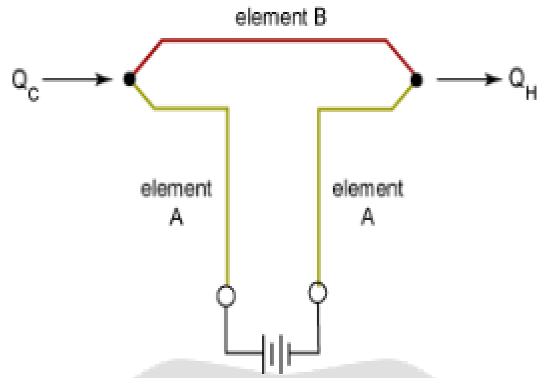
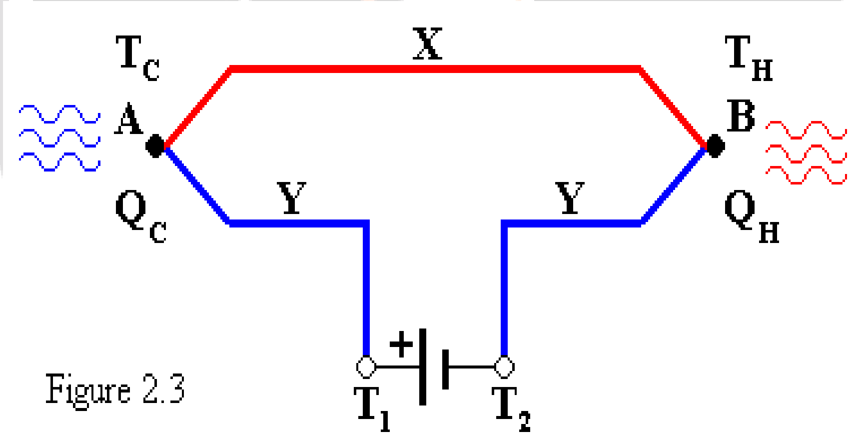


Fig 1.4 seeback effect

The thermocouple conductors are two dissimilar metals demoted x and Y materials. With heat applied to the end B of the thermocouple and the end A is cooled, a voltage will appear across terminals TI and T2. This voltage is known as the Seebeck e.m.f.

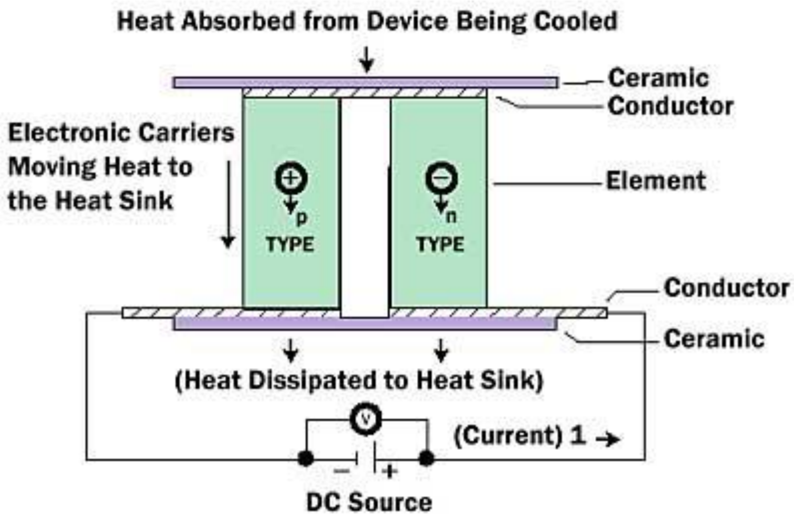
According to Peltier effect it is a phenomena in which temperature difference can be measured between two different metals or semiconductors connected at one junction when the electric current is passed through the other junction.



If a voltage is applied to terminals TI and electric current will now in the circuit. As a result of the current now, a slightly cooling effect will occur at thermocouple junction A where heat is expelled. Note that this effect will be reversed whereby a change in the direction of electric current flow will reverse the direction of heat flow.

1.3.1 Thermo electric module (TEM)

The Peltier effect occurs when a voltage is applied to two connected electrical conductors made of different materials. When the voltage is applied, a circuit can be created that allows for continuous heat transport between the cooductor's junctions



The opposite also applies such that a voltage can be generated by applying a temperature difference to the two connected electrical conductors, which is known as the seebeck effect This temperature difference results in a transfer of thermal energy across the electrical conductors and causes charge carriers to diffuse through the materials.

These charge carriers can be either electrons, or electron deficiencies called holes, and move within the crystals of the materials by way of electron now from the cold side to the bot side of the TE couple. The heat is transferred in the same direction as the charge carrier flow, from the cold side of the TE couple to the hot side.

2. LITERATURE REVIEW

The literature towards the design methodologies, analysis techniques proposed by different authors is collected and presented in the subsequent paragraphs.

S.B. Riffat (2003) proposed A novel thermoelectric refrigeration system which presents results of tests carried out to investigate the potential application heat pipes and phase change materials for thermoelectric refrigeration. The work involved the design and construction of a thermoelectric refrigeration prototype. The performance of the thermoelectric refrigeration system was investigated for two different configurations. The first configuration employed a conventional heat sink system on cold side of the thermoelectric cells. The other configuration used an encapsulated phase change material in place of the conventional heat sink unit. Both configurations used heat pipe embedded fins as the heat sink on the hot side. Replacement of the conventional heat sink system with an encapsulated phase change material was found to improve the performance of the thermoelectric refrigeration system.

SAM said (2015) presented an experimental investigation of a thermal powered ammonia-water absorption refrigeration system. The focus of this s lies on the design of the components of the absorption chiller, the ice storages and the collector field as well as the integration of the data acquisition and control unit ammonia water (NH3/H2O) absorption chiller was developed in the laboratory of the Institute of Thermodynamics & Thermal Engineering the University of stuttgart (Germany). The results of the experiments indicated a chiller coefficient of performance (COP) of 0.69 and a cooling capacity of 10,1 kw at 114/23- 2^0(C) representing the temperatures of the generator inlet, the condenser /absorber inlet and the evaporator outlet respectively. Even at 140/45/-4^0Cthe chiller was running with a cooling capacity of 4.5kW and a COP of 0.42.

Ioan Sarbu (2013) provided cooling by utilizing renewable energy such as solar energy is a key solution to the energy and environmental issues. This paper provides a detailed review of different solar refrigeration and cooling methods. There are presented theoretical basis and practical applications for cooling systems within various working fluids assisted by solar energy and their recent advances. Thermally powered refrigeration technologies are classified into two categories: sorption technology (open systems or closed systems) and thermo-mechanical technology (ejector system), Solid and liquid desiccant cycles represent the open system The liquid desiccant system has a higher thermal coefficient of performance (COP) than the solid desiccant system. Absorption and adsorption technologies represent the closed system.

Yu. Vorobiev (2006) explained a hybrid solar system with high temperature stage is described. The system contains a radiation concentrator, a photovoltaic solar cell and a heat engine or thermoelectric generator. Two options are discussed, one with a special PV cell construction, which uses the heat energy from the part of solar spectrum not absorbed in the semiconductor material of the cell; the other with concentration of the whole solar radiation on the PV cell working at high temperature and coupled to the high temperature stage. The possibilities of using semiconductor materials with different band gap values are analyzed, as well as of the different thermoelectric materials. The calculations made show that the proposed hybrid system could be practical and efficient.

3. CONSTRUCTION

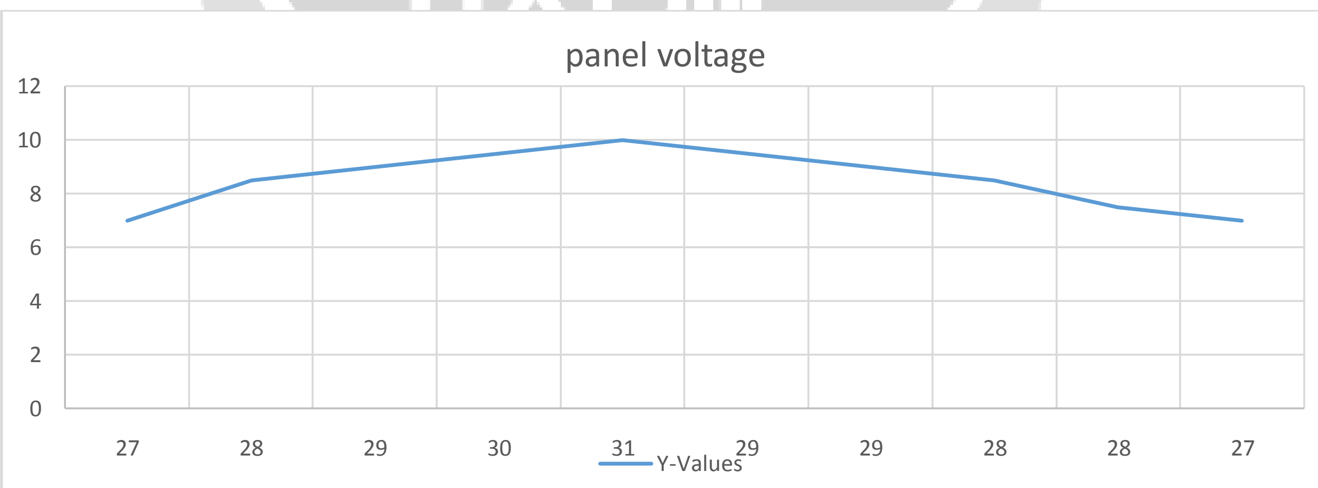
Here this system heat or cool the product using thermo-electric module. The construction set up for this system require following parts

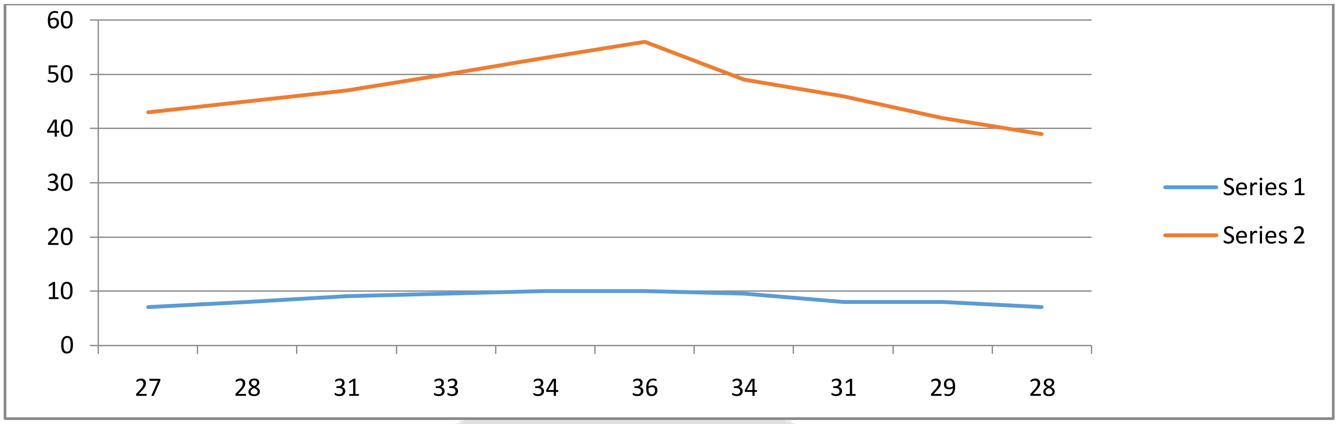
- Solar panel
- Charge controller
- Battery
- Exhaust fan
- Thermoelectric module
- Metal (aluminium box, sheets)
- Water storage tank

RESULT ANALYSIS

4.4.1 Comparison of panel temperature and voltage

From the graph 4.1 it is found that temperature of the panel gets increased with the increase in time. Also there is a significant difference in temperature levels between panel temperature and atmosphere temperature.





4.4.2 comparison of temperature and cooling capacity

From the comparison of cooling capacity is to incrase and decrases are day by day. The water temperature are decrease but the cooling capacity of the refrigerator.

Increase the hot days and cold days are decreases. The cooling capacity are compare the efficient of performance is the same category.

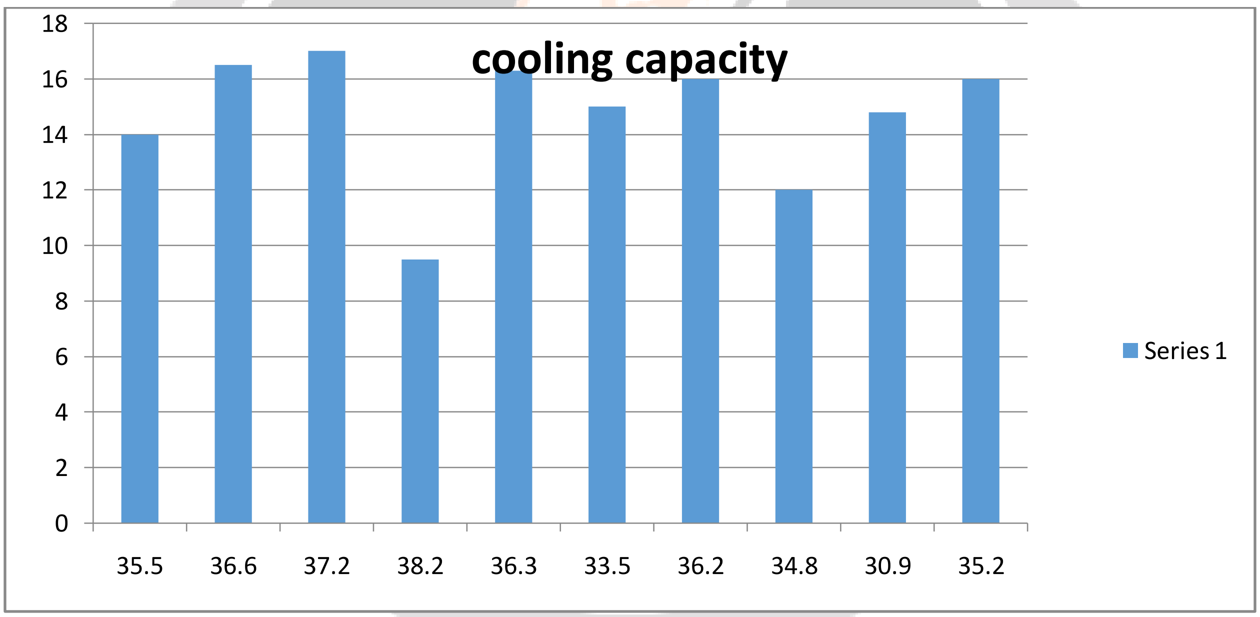


Fig 4.3 cooling capacity

4.4.3 Comparison of Temperature of COP

The co efficient of performance are increase the day to day at climate condition . the cold climate days are same amount decreases but hot climate days are increase the co efficient of performance from the results in can be observed that the results shows the COP increases during hot climate days and decreasing with cold climate conditions.

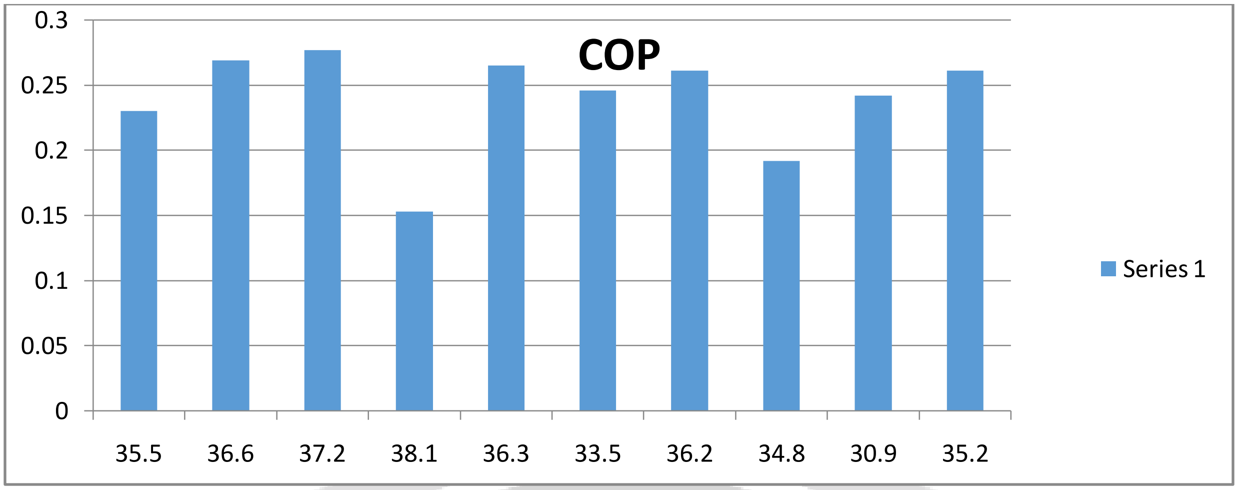
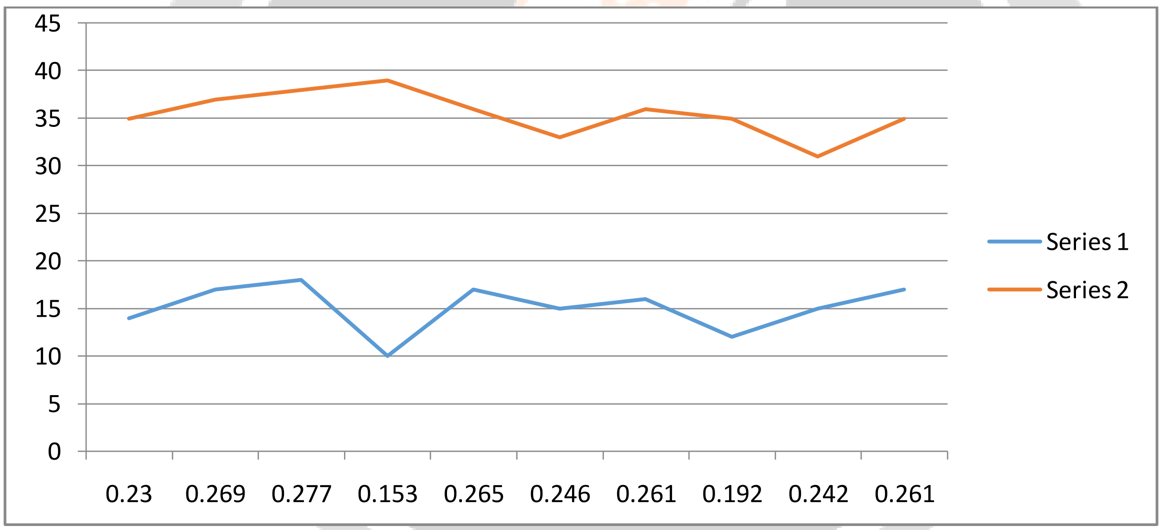


Fig 4.4. COP

4.4.4 Comparison of COP and Temperature and Cooling Capacity



COP

5. CONCLUSION

Solar powered 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 co efficient of performance and high cost. These contentious issues are the frontal factors hampering the large scale commercialization of thermoelectric cooling devices. The experimental results of developmental results of developed prototype of TER system shows that the increased performances. A temperature reduction at no load and with 30.4^{0}C water inside refrigeration space of developed TER has been experimentally found with respect to 37.2^{0}C ambient temperature in 40 minutes. Also the calculated COP of thermoelectric refrigeration cabinet. Also it has been experimentally found that the developed thermoelectric refrigeration system gives optimum performance and the system can continuously work for 15 hours when battery is fully charged with solar panel. The performance of TER system can be improved further with use of increased figure of merit peltier modules and efficient heat exchange technology.

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