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An Experimental Study of Solar Enabled Domestic Mini Refrigerator with the Use of Peltier Effect

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Abstract: ***In the recent years we have a problem of an energy consumption and environment pollution problems. The use of Chloro-Flouro Carbon(CFC) and another harm full refrigerant used in conventional systems. This system is producing the pollution its effected on ozone layer of earth HVAC system (commonly used in the air conditioners) is very efficient and reliable but it has some demerits. It has been seen that during the last one decades that the ozone layer is slowly destroyed reason of that is the refrigerant (CFC and HFC) used for the refrigeration and air-conditioning purposes. The general refrigerant used is HFC's which are leaked and slowly transmitted into the atmosphere. Even the percentage of HFCs are emitted into the atmosphere compared to CO2 is negligible but its global warming effect is few thousand times of CO2 The source of a renewable energy as solar energy. We have used this energy and convert into an electrical energy. We have store this energy and used in our system. This system make a cooling and heating of water and air by the use of Thermo-Electric cell. This system will easy to use in all seasons. This system is used in remote area when the electricity was not supply properly. The main purpose of this project is to reduce environment pollution and save the environment. And to make a remote area application***

Keywords: Energy consumption, Chloro-Flouro Carbon, HAVAC, Thermo-Electric cell, Refrigerator, Peltier effect.Thermo Electric Phenomena-Peltier Effect

I. INTRODUCTION

The thermo electric(TE) phenomena was discovered more than 150 years ago. Thermo-electric module it is a device that produce a cooling and heating effect. This device is discovered by the was named in honor of the French watchmaker Jean Peltier (1785–1845) who discovered it in 1834. It was found that if a current pass through the contacts of two dissimilar conductors in a circuit, a temperature differential appears between them. That result of a cooling and heating effect produce. Then this system called Paltier Effect. Thermoelectric model (thermoelectric modules) can transform electrical energy into a temperature gradient. This phenomenon was discovered by Peltier in 1834.

The application of this cooling or heating effect remained lowest until the growth of semiconductor materials. With the advent of semiconductor materials came the capacity for a wide type of practical thermoelectric refrigeration use. Thermoelectric refrigeration is attained when a direct current is passed through one or more pairs of n and p-type semiconductor materials. In the cooling direct current passes from the n to p-type semiconductor material. The temperature of the interconnecting conductor reduced and heat is absorbed from the environment**.** This heat absorption from the environment happens when electrons pass from a lower energy level to the p-type material through the interconnecting conductor to a higher energy level in the n-type material**.** The absorbed heat is transferred through the semiconductor materials by electron transport to the other end of the junction TH and release as the electrons return to a lower energy level in the p-type material. This is known as the Peltier effect.

II. LITERATURE REVIEW

From the relative paper reviewed, few papers selected based on the importance of the study context. Analysis of this paper is presented here.

A. The objective of this research is concentrate on development a solar drying technology with help of solar collector combined with TEG module. The system was developed and installed at School of Renewable Energy Technology Naresuan University, Phitsanulok Thailand. Temperature of the back side of solar collector power of TEG module air flow rate of blower were compared and analyzed. As the results, temperature at behind of solar collector was decreased with increasing the produced power of TEG module which corresponded with solar irradiance. Solar collector can be operated and produced hot air temperature about 70-80 OC supported to chamber for drying. TEG can be produced the electricity about 0.0813 V/module. The deference of temperature surface was 1.77 OC and the average temperature of back side 45.4 OC. The ambient temperature

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was 35.8 OC. In addition, the system can be used blower for controlling air flow rate by using electricity from TEG module. It can be summarized the solar collector can be combined with TEG module for producing the electricity to supply the blower within tunnel drying, including with a guideline for improve the performance of solar drying technology

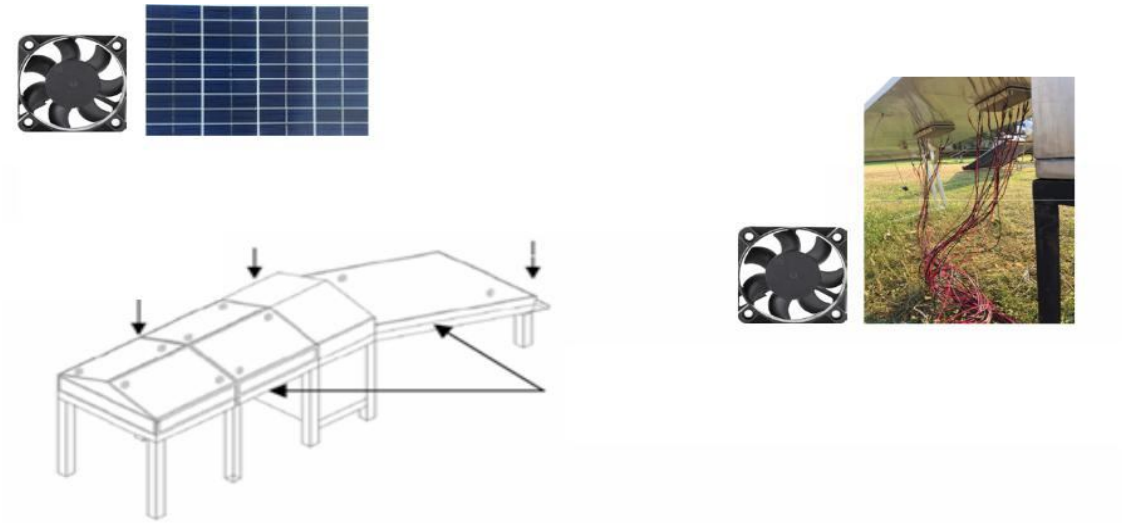


FIG.1 Concept of Development of solar collector combined with thermoelectric

B. Suwit Jugsujinda in this research author, shows that The refrigeration system of thermoelectric refrigerator (TER; 25 × 25 × 35 cm3) was developed by using a thermoelectric cooler and applied electrical power of 40 W. The TER has not cooling fan for the coldness circulates in the refrigerator. The temperature of TER was measured at ten points to check the cooling system. The current, differential temperature time and coefficient of performance (COP) were compared. TEC cold plate temperature (Tc) was decreased from 30 ºC to –4.2 ºC for 1 hr and continuously decreasing to –7.4 ºC for 24 hrs and 50 ºC for hot plate temperature (Th). The TER temperature was decreased from 30 ºC to 20 ºC in 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65, respectively. The relationship of time and temperatures of TER which was used the electrical power of 20, 30 and 40 W was shown in Fig. 2. Figure 2 (a-c) were shown the temperatures of T1-T7, cold side (Tc), and hot side (Th) of electrical power 20, 30 and 40 W, and Fig. 2 (d-f) were showed the difference temperatures cold side (Tc), and hot side (Th) of electrical power 20, 30 and 40 W, respectively.

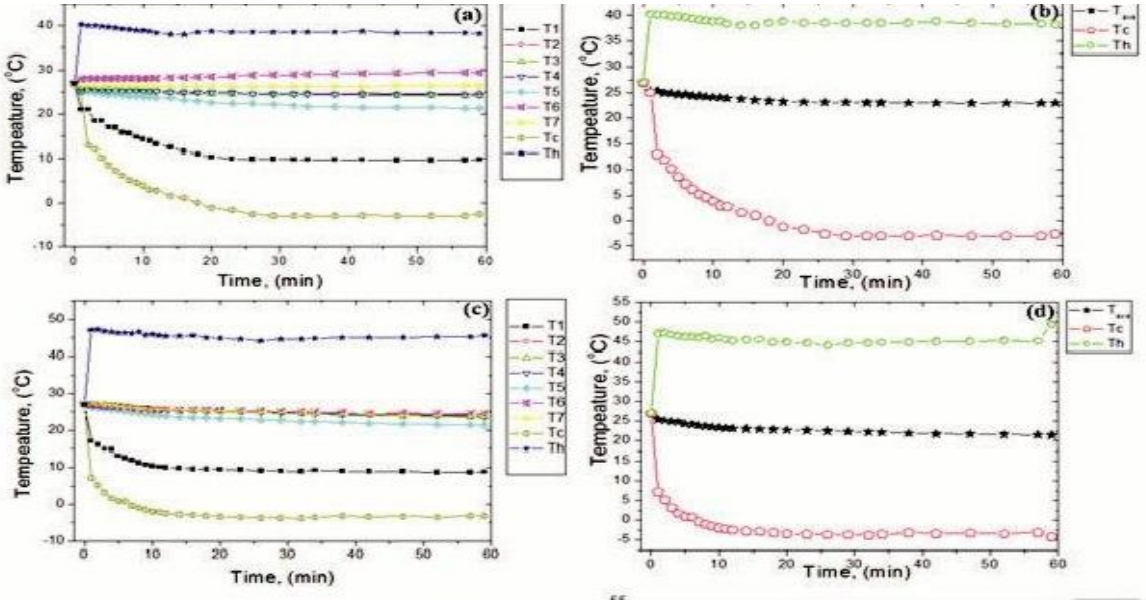


FIG.2 Time -Temperate diagram

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C. Simon Chinguwa A cool box for passenger car refers to a kind of box which is designed and fabricated using well insulating materials in order to ensure the coolness inside the cool box is always stable. Convectional refrigeration systems use Chloro Fluoro Carbons (CFCs) and Hydro-Chlorofluorocarbons (HCFCs) as heat carrier fluids. The use of such fluids has over the years raised some very serious environmental concerns which has resulted in extensive research into development of novel refrigeration technologies. Thermoelectric Refrigeration has developed as a promising refrigeration technology as it comes with better more distinctive advantages over conventional refrigeration systems. The research and development work carried out by different researchers on TER is thoroughly reviewed in this research. Having looked on these refrigeration systems Thermoelectric Cooler (TEC) refrigeration was used in the design of a 20 liter portable automobile refrigerator. In this design a Thermoelectric Generator (TEG) waste heat recovery system was designed to meet all the TEC refrigerator power requirements. Thus an internal combustion engine TEG system designed includes a stainless steel exhaust gas heat exchanger having an interior portion defined by a stainless steel wall and an exterior surface of the stainless steel wall distal to the interior portion. The exhaust gas heat exchanger receives a pressurized exhaust gas stream from the internal combustion engine and extracts thermal energy from the exhaust gas stream. The TEG modules converts thermal energy directly into electrical energy for TEC refrigerator consumption as well as storage for later use. So in this design a percentage of exhaust heat that could have otherwise be rejected into the environment is used in the generation of DC power to meet the TEC electrical power needs making this system an independent system altogether thereby reducing the number of mechanical loads on the vehicle itself

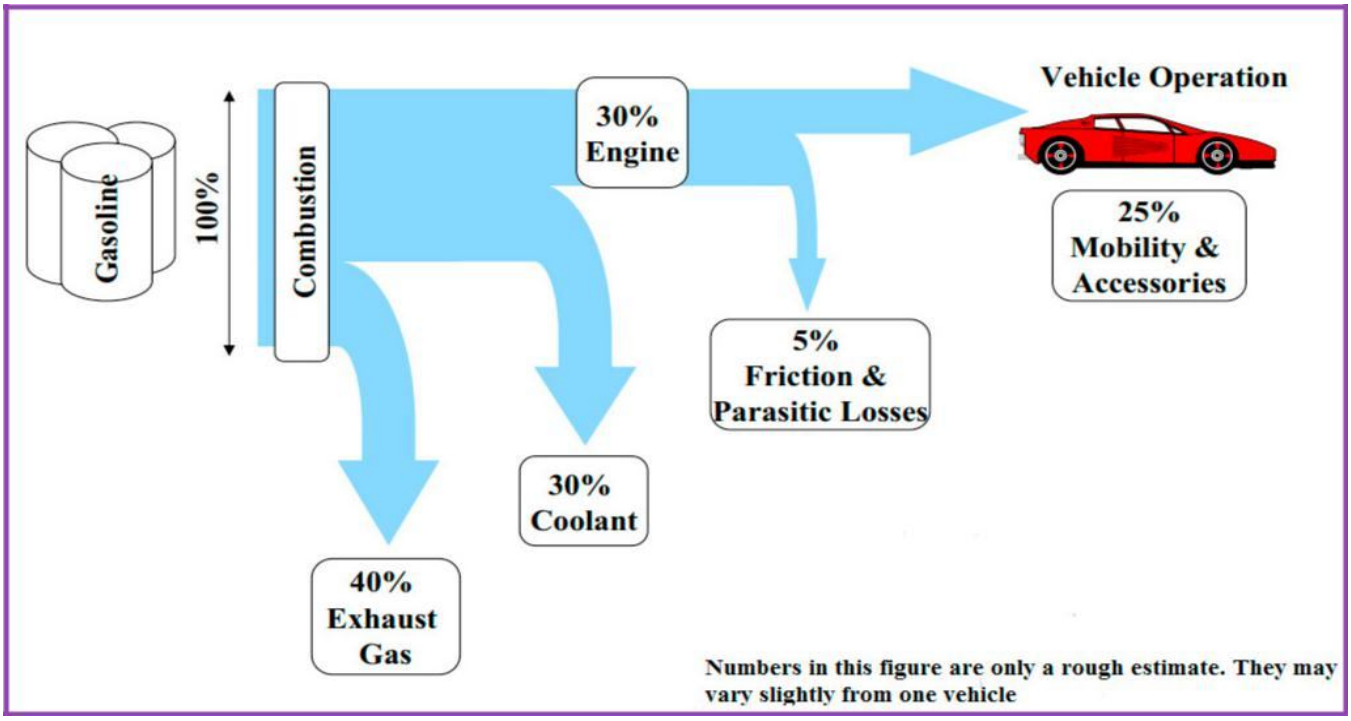


FIG.3 Typical Energy Path in Gasoline Fuelled Internal Combustion Engine Vehicles (Courtesy of xrisgraphics).

D. Christian J.L. Hermes , Jader R. Barbosa Jr The present study compares the thermodynamic performance of four small-capacity portable coolers that employ different cooling technologies: thermoelectric, Stirling, and vapor compression using two different compressors reciprocating and linear. The refrigeration systems were experimentally assess in a climatized chamber with controlled temperature and humidity. Tests were carried out at two different ambient temperatures 21 and 32 LC in order to obtain main performance parameters of the systems e.g., power consumption cooling capacity inside air temperature and the hot and cold temperatures. These performance parameters were compared using a thermodynamic method that splits the overall 2nd law efficiency into two terms namely the internal and external efficiencies. This type of the internal irreversibility e.g., friction in the working fluid in the Stirling and vapor compression machines Joule heating and heat conduction in the thermoelectric devices of the Peltier cooler were segregate from the heat exchanger losses external irreversibility allowing the comparison between different refrigeration technologies with respect to the same thermodynamic baseline

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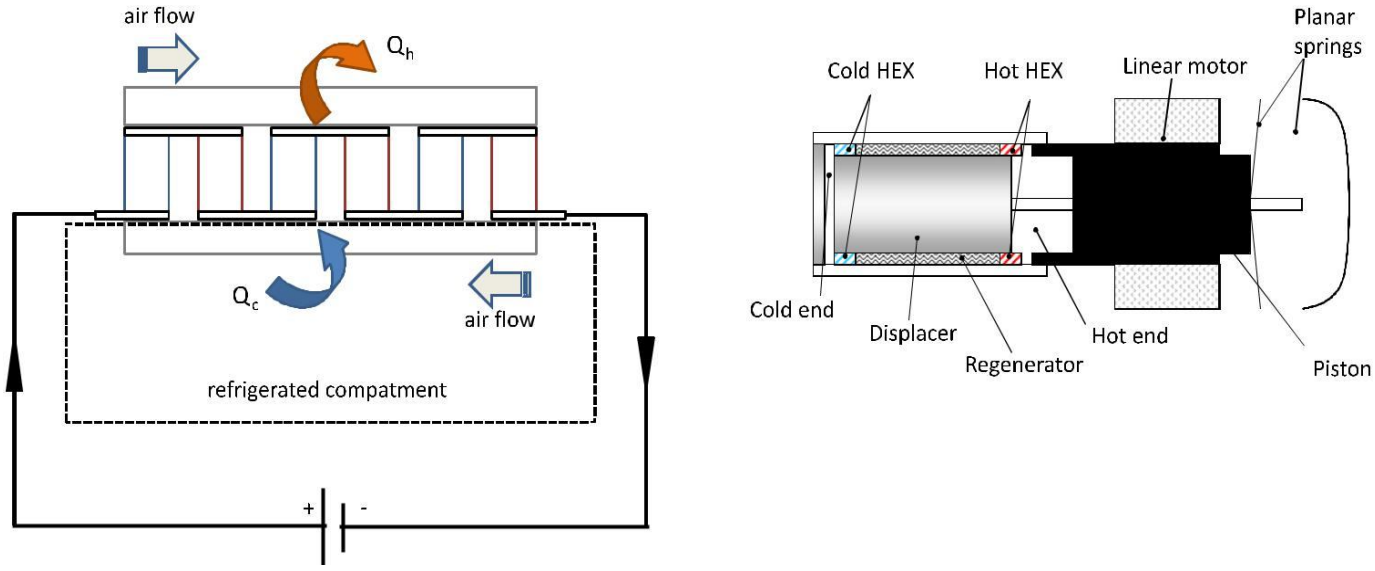


Fig. 4 Schematic representation of the internal components of the free-piston Stirling cooler

E. H. C. Kuttarmare has published the paper on "Fabrication of Peltier Cooling System: Alternative for Refrigeration" In this paper aims to developing a system which will devlope cooling effect without the use of mechanical devices and also refrigerant. Thermoelectric cooling system does not need working fluids or any moving elements. Thermoelectric refrigeration devices have a so many place in medical applications, scientific equipment, electronic applications and other applications. The difference between the recent methods and this model is that a thermoelectric cooling system refrigerates without use of mechanical devices that is Conventional Condenser fins and Compressor also without refrigerant.

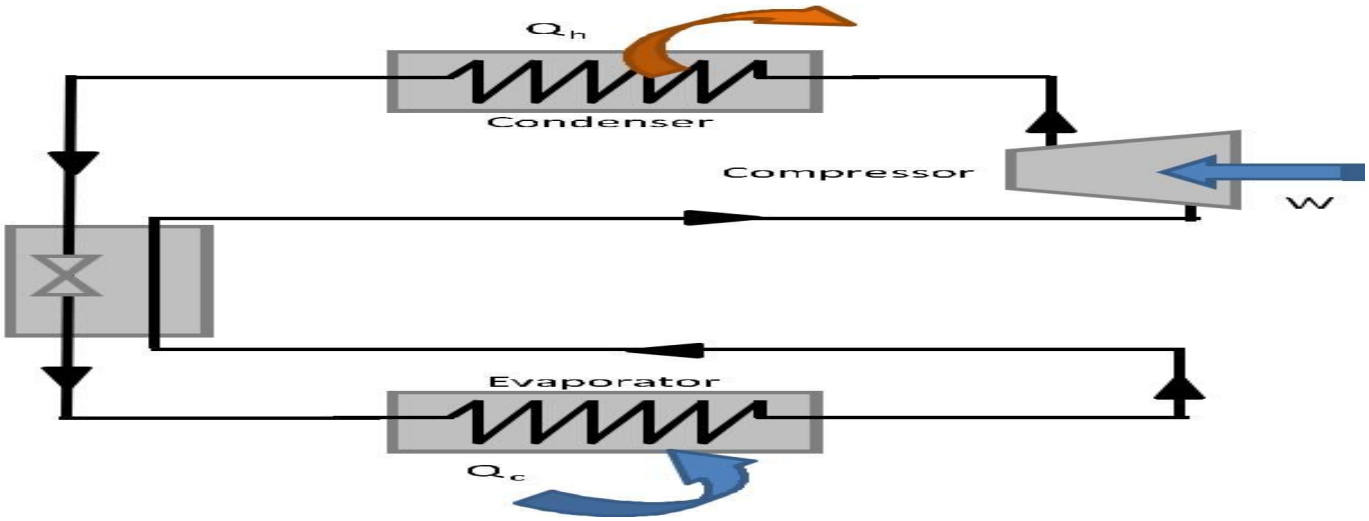


Fig. 5 Schematic representation of the Peltier cooling system

F. Prof. Vivek R. Gandharan et al "Fabrication of Solar Operated Heating and Cooling System Using Thermo-Electric Module" In the recent years, we all are facing electricity crisis. It's time to harness the renewable energy resources of the nature. Our project use the solar energy to developed a heating and cooling system. In this project we have fabricated a thermoelectric system using solar energy. It is an environment friendly project made by using thermoelectric module. The project supports both heating and cooling. The project has various applications like medical and pharmaceutical, military and aerospace equipment etc. So, it proves to be very helpful.

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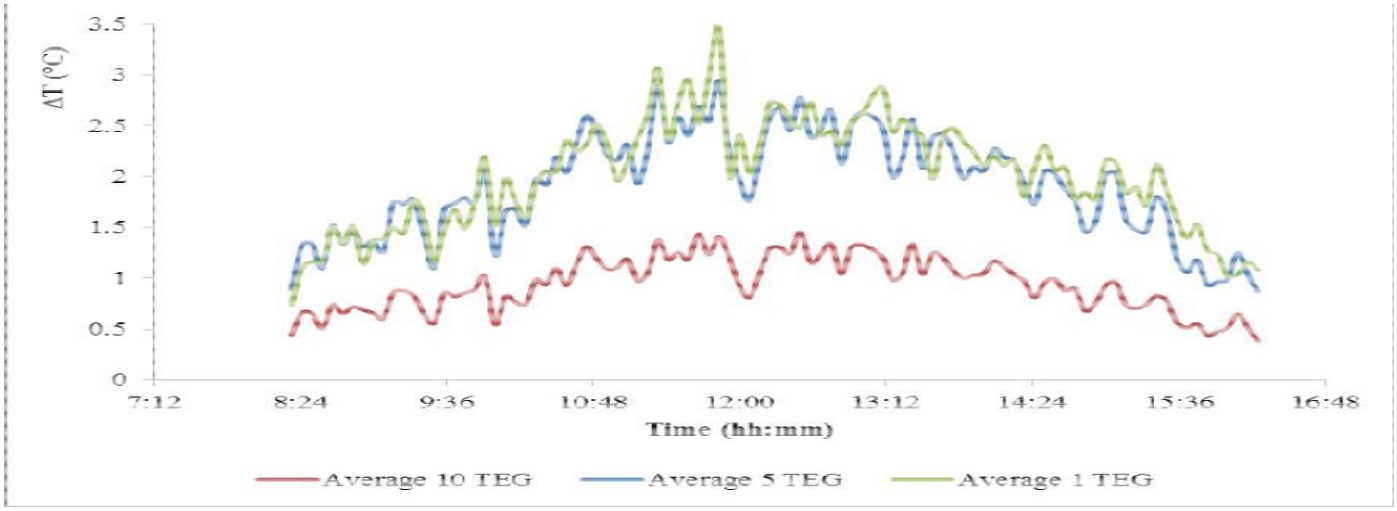


Figure 6 The average temperature difference of TEG_1, TEG_5 and TEG _10

G. In the paper of Experimental Analysis of Solar Operated Thermo-Electric Heating and Cooling System Mr. Swapnil B. Patond, Prof. V. G. Gore The main objective of this project is to design and make analysis of Heating and Cooling system which use non-conventional energy source like Solar Energy with the help of Thermoelectric Module which done on the principle of the Peltier effect. This will be a suitable & affordable system for the people living in remote part of India where load-shading is a major problem. The major difference between the existing system & our system is that, our project works without use of mechanical device & without refrigerant too. As the module is compact in size one can design like shape and capacity according to his requirement.



Figure 7. Designed Thermoelectric Heating & Cooling system.

III. EXPERIMENTAL METHODOLOGY AND MODELLING

A. Thermo Electrical Module

A basic thermoelectric module is combination of two different ceramic substrates which work as a base and electrical insulation for P-type and N-type Bismuth Telluride dice that are connected electrically in series and in parallel between the ceramics. The ceramics also work as insulation between the module's internal electrical elements and a heat sink which must be in contact with the hot side as well as an object against the cold side surface. Electrically conductive materials majorly copper pads attached to the ceramics maintain the electrical connections inside the module. Solder is most commonly used at the connection joints to enhance the electrical connections and hold the module together. Most modules have and even number of P-type and N-type dice and one of each sharing an electrical interconnection is known as a couple while both P-type and N-type materials like alloys of Bismuth and Tellurium both have different free electron densities at the same temperature.

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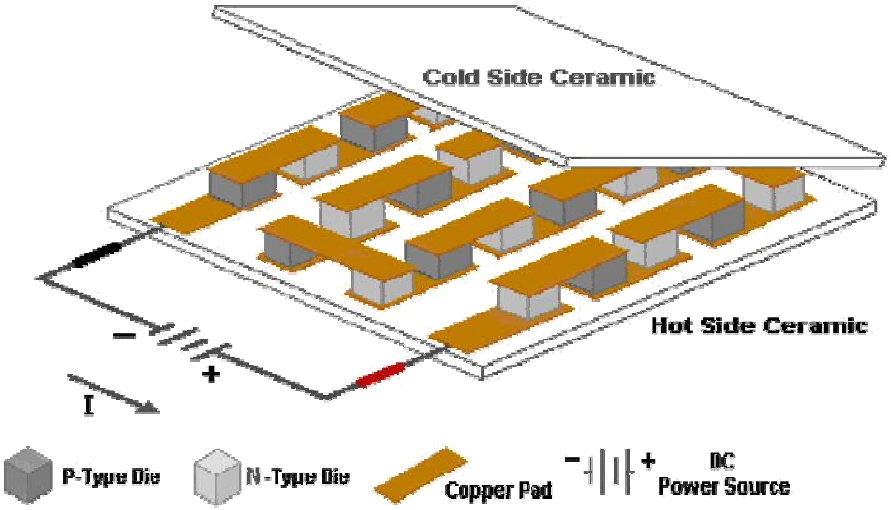


Figure 7. Schematic Diagram of P-Type And N-Type Semiconductor

B. Construction Of Solar Cell

Although this is basically a junction diode, but constructional it is little bit different from conventional p-n junction diode. A very thin layer of p-type semiconductor is grown on a relievable thicker n-type semiconductor. It provide so less finer electrodes on the top of the p-type semiconductor layer. These electrodes do not obstruct light to reach the thin p-type layer. Just below the p-type layer there is a p-n junction. It also provide a current collecting electrode at the bottom of the n-type layer. We encapsulate the entire assembly by thin glass protect the solar cell from any mechanical shock.

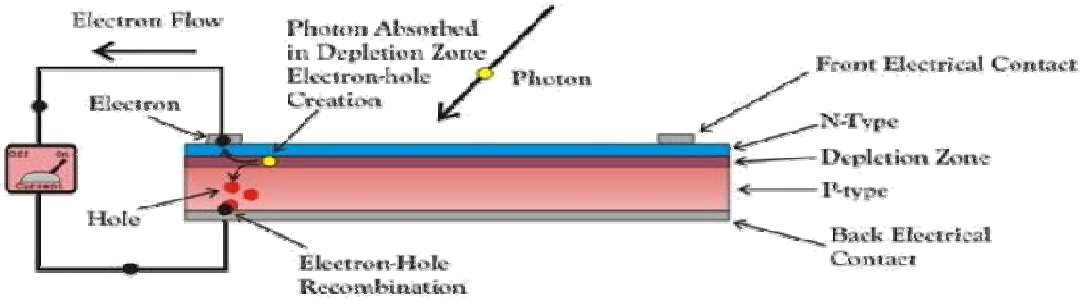


Figure 8. Basic construction of solar cell

C. Model for Experimental Study



Figure 9. model for experiment

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Figure 10. front view and back view of refrigerator

IV. COCLUSION

A. Temperature at behind of solar collector was decreased with increasing the produced power of TEG module which corresponded with solar irradiance. Solar collector can be operated and produced hot air temperature about 70-80 OC supported to chamber for drying

B. The TER temperature was decreased from 30 ºC to 20 ºC in 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65, respectively

C. The TER temperature was decreased from 30 ºC to 20 ºC in 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65, respectively

D. These performance parameters were measure using a thermodynamic approach that devide the overall 2nd law efficiency into two terms namely the internal and external efficiencies.

E. Thermoelectric cooling system does not require working fluids or any mechanical parts

F. The project supports both heating and cooling. The project has various applications like medical and pharmaceutical equipment and also military and aerospace, etc.

G. Thermoelectric Module that is works on the principle of the Peltier effect.

REFERENCES

[1] Simon Chinguwa[a], Christopher Musora[b] and Tawanda Mushiri[c] [a,b]University of Zimbabwe, Department of Mechanical Engineering, P.O Box MP167, Mt Pleasant, Harare, Zimbabwe [*]D.Eng Candidate, University of Johannesburg, Faculty of Engineering and the Built Environment, Auckland Park Campus, Auckland Park 2006, P.O Box 524, Johannesburg, South Africa.

[2] Christian J.L. Hermes [a,ﬧ], Jader R. Barbosa Jr. [b a] Center for Applied Thermodynamics, Department of Mechanical Engineering, Federal University of Paraná, PO Box 19011, 81531990 Curitiba-PR, Brazil [b] POLO Research Laboratories for Emerging Technologies in Cooling and Thermophysics, Department of Mechanical Engineering, Federal University of Santa Catarina, 88040900 Florianópolis-SC, Brazil

[3] Suwit Jugsujinda*, Athorn Vora-ud, and Tosawat Seetawa Thermoelectrics Research Center and Program of Physics, Faculty of Science and Technology, Sakon Nakhon Rajabhat University, 680 Nittayo Rd., Muang District, Sakon Nakhon, 47000, Thailand Elsevier use only: Received 15 November 2010; revised 15 December 2010; accepted 20 December 2010

[4] S. Thongsan[a], B. Prasit[a,] *,T. Suriwrong[a], Y. Mensin[a] and W. Wansungnern[a] 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies 2017 AEDCEE, 25-26 May 2017, Bangkok, Thailand

[5] Asmma Ahmed M. El-bahloul,Ahmed Hamza H.Ali,Shinichi Oockawara "Performance and sizing of solar driven dc motor vapor compression refrigerator with thermal storage in hot arid remote areas" Department of Chemical Engineering, Graduate School of Science & Engineering, Tokyo Institute of Technology, Tokyo 152-8552, Japa

[6] Guadalupe Moreno-Quintanar,Victor Gomez,Roberto Best "Exergetic analysis of a GAX refrigeration system design to operate with LP gas and solar energy" Instituto de Energías Renovables-UNAM, Privada Xochicalco s/n, Temixco, Morelos, México, 62580. Energy Procedia 70 (2015) 644 – 651

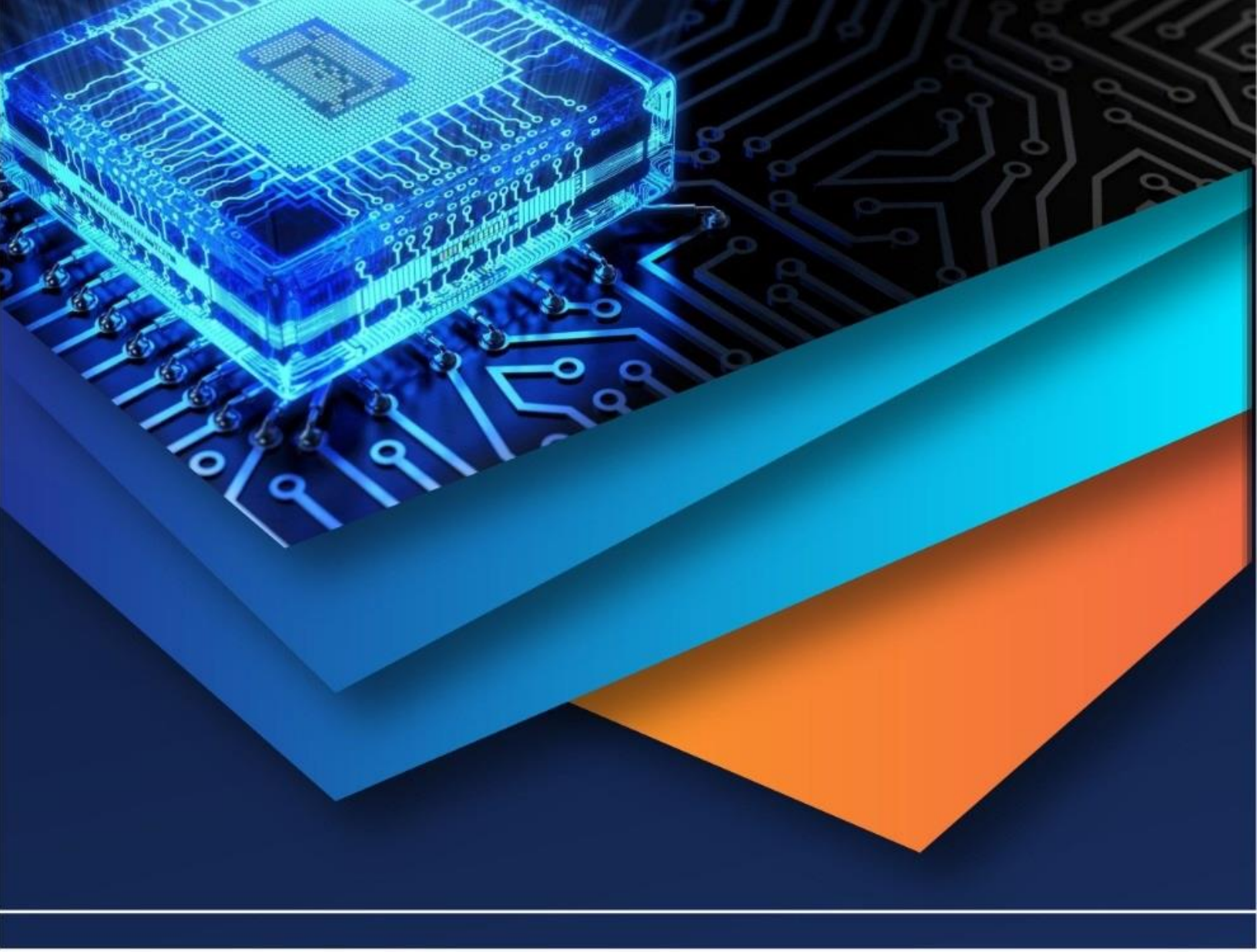
[7] Bingqing Luo,Zhongting Hu,Xiaoqiang Hong,Wei He "Experimental study of the water heating performance of a novel tileshaped dual-function solar collector" Department of Thermal Science and Energy Engineering, University of Science and Technology of China, Hefei 230026, China Energy Procedia 70 (2015) 87 – 94

[8] S. Thongsan[a], B. Prasit[a,] *,T. Suriwrong[a], Y. Mensin[a] and W. Wansungnern[a] 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies 2017 AEDCEE, 25-26 May 2017, Bangkok, Thailand

[9] Lincheng Wang,Yaohua Zhao,Zhenhua Quan,Hongyu GAn,Heran Jing "Simulation study on household forced circulation photovoltaic thermal system based on micro heat pipe array" Beijing University of Technology,NO.100, Pingleyuan, Chaoyang District, Beijing100124, China Energy Procedia 70 (2015) 130 – 137

[10] Peteris Shipkovs, Andrejs Snegirjovs, Janis Shipkovs, Galina Kashkarova, Kristina Lebedeva, Lana Migla "Solar thermal cooling on the northernmost latitudes" Energy Procedia 70 (2015) 510 – 517 Institute of Physical Energetics, Aizkraukles 21, Riga LV-1006, Latvia

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