

# Study, Analysis and Fabrication of Thermoelectric Refrigeration System using TEC1-12706

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**Abstract** – The direct conversion of the thermoelectric effect is temperature differences to electric voltage and vice versa. The thermoelectric effect is three separately identified effects are the see beck effect, Thomson effect, and the Peltier effect. The present objective work present experimental and mathematical investigation to pick up the efficiency and lower the manufacturing cost of thermoelectric refrigeration system. The discussed of the performance of thermal characteristics and the various parameter like thermal performance. A Peltier effect refrigeration system is the designed, fabricated and the tested at the various parameters. The various parameters in to improve the efficiency and lower the manufacturing cost of thermoelectric refrigeration system, the system thermoelectric refrigerator is fabricated of 28.5cm X 26cm X 18 cm and supplied power of 18W to 90W. The temperature of thermoelectric refrigerator system was measured at four points i.e.  $T_c$  Temperature at refrigerator,  $T_h$  Temperature at outer wall,  $T_{box}$  Temperature of box &  $T_{door}$  temperature at door. The differential temperature, time, and coefficient of performance were analyzed. Results the  $T_c$  was decreased from 28 °C to -3.2 °C for 45 min and also continuously decreasing with respect to time. The maximum coefficient of performance of Peltier effect refrigeration system was 6.85 -0.59 at various parameters.

**Keywords** – COP, Peltier Effect, Thermoelectric, Thermal Performance and COP.

## I. INTRODUCTION

The process of the refrigeration is of heat-removal from a gap in arranged to pass to a lower temperature than surrounding the temperature. “Peltier cooling module” which works of the thermoelectric refrigeration and the effects are cooling by means of thermoelectric effect rather than the added prevalent conventional methods like ‘vapors compression cycle’ or the vapors absorption cycle [21].

### 1. Thermoelectric Effect

The direct conversion of thermoelectric effect is the temperature difference in to electric voltage and other way around. The different temperature on each side of thermoelectric device are the creates voltage. Equally, when the creates a temperature difference voltage is applied to it. A connected temperature gradient causes charge transporter in the material to diffuse from the hot side to the chilly side.

#### 1.1. The Seebeck Effect

The conversion of the heat directly into the electricity and Seebeck effect is the junction of dissimilar electrical conductors. It is the Baltic German physicist Thomas Joha-

-nn Seebeck and named.

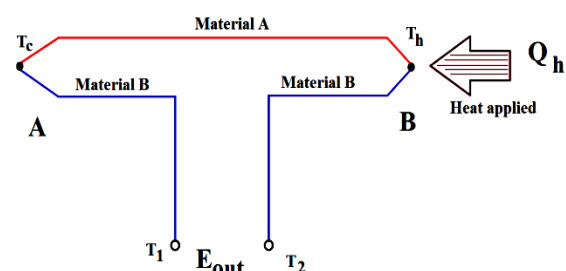


Fig. 1.1. The Seebeck effect

As shown in Figure 1.1 the two dissimilar are conductors metals denoted as material A and material B. The connection of the temperature at A is use since a situation and is maintained at a rather temperature ( $T_c$ ). The junction temperature at B is used as temperature higher than temperature  $T_c$ . The heat provides the junction B, a voltage ( $E_{out}$ ) resolve appear across terminals  $T_c$  and  $T_h$  and hence an electric current would flow continuously in this closed circuit. [21] This voltage, the Seebeck EMF, can be expressed as [21].

$$E_{out} = \alpha(T_h - T_c)$$

Where:

$$\alpha = dE / dT = \alpha_A - \alpha_B$$

$\alpha$  is the differential Seebeck coefficient or (thermo electric power coefficient) connecting the two materials, A and B, positive when the direction of electric modern is same as the way of thermal current, unit is V/K.

$E_{out}$  is the output voltage in volts.

$T_H$  and  $T_C$  are the junction temperatures are hot and cold, are respectively, in Kelvin.

### 1.2. The Peltier Effect

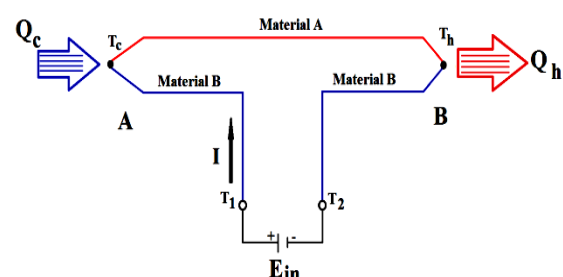


Fig. 1.2. The Peltier effect.

The Peltier found was an opposed phenomenon the Seebeck Effect, whereby thermal energy possibly will be the absorbed on diverse metal junction and discharge at the extra when an electric current flow within the block of circuit. [21] In Figure 1.2, the seebeck effect opposed that of the phenomenon and the circuit is modified to get hold of a different configuration that illustrates the Peltier Effect. If the voltage ( $E_m$ ) in applied of terminals  $T_c$  and  $T_h$ , an electrical current ( $I$ ) and will the circuit flow in current. With the result the flow current, a slight cooling affects us.

( $Q_c$ ) will occur at thermocouple junction A (where heat is absorbed), with heating effect ( $Q_h$ ) will occur at junction B (where heat is expelled). Note the effect is the reversed by a change the direction of the electric current flow will reverse of the direction of the heat flow. [21]

The Joule heating, and the magnitude of  $I^2 \times R$  (where  $R$  is the electrical resistance), also occur in conductors as a result of flow in the current. The Peltier effects are opposition of the joule heating effect and the available cooling are causing a net reduction. The Peltier effects are mathematically as

$$Q_c \text{ or } Q_h = \beta \times I = (\alpha T) \times I$$

Where:

$\beta$  is the differential Peltier coefficient between the two materials A and B in volts.

$I$  is the electric current flow in amperes.

$Q_c$  and  $Q_h$  are the charge practical of cooling and heating, respectively, in watts.

### 1.3 The Thomson Effect

The conductor of expelled or the Thomson effect, when electric current is pass during the conductor having a temperature gradient over. It is the length of heat will be either absorbed. The expel lend depend on the direction of the electric current and the temperature gradient. It is the known as the Thomson Effect.

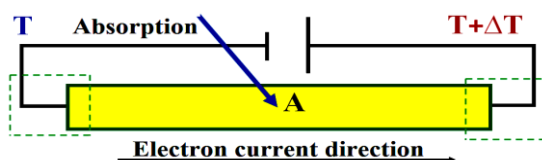


Fig. 1.3. The Thomson effect.

### 1.4. Working of Peltier Cooler

The Peltier effect occur when electrical current flows through two diverse conductors; depends on the direction of flow of the current, the connection two conductors will each take up or let go heat. The thermoelectric technology in the world of technology, the semiconductors of the (usually Bismuth Telluride) material of option for produce the Peltier shape since they can be added easily optimized for pumping the heat us. Using this category of material, a Peltier device (i.e., thermoelectric module) it can be constructed and its simplest a lone semiconductor “pellet” which is soldered to electrically-conductive objects (usually plated copper). The power provides this configuration, the second different material requisite for the Peltier effect is in really the copper correlation paths to.

It is significant to heat resolve be motivated the direction of charge mover movement all through the circuit (actually, it is the charge carriers that transfer the heat).

### 1.5. Peltier Cooling with N-type Semiconductor

In Figure 1.5, “N-type” semiconductor material is used to the fabricated the pellet so that the electrons by means of a negative charge. Those are the charge carrier in employment to create the size of the Peltier effect.

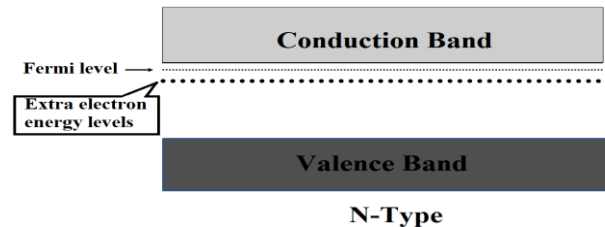


Fig. 1.4. Peltier cooling with N-type semiconductor energy band diagram.

With a DC voltage source connected as shown, the electrons will be repelling by the negative pole and the supply attracted by the positive pole of; the attraction of the electrons at Fermi level be in movement towards positive terminal are heat and create the hole in the Fermi phase of the system. It is the junction constant provider of current, electrons from valance band (lower energy band) to Fermi level. The electrons flow during the N-type material from stand to top and the heat is absorbed of the junction and actively transferred to the junction of the system. [21]

The Peltier cooler using N-type of semiconductor, heat is absorbed at the junction close to negative terminal and the heat is discard of the junction close up to positive terminal of the system us.

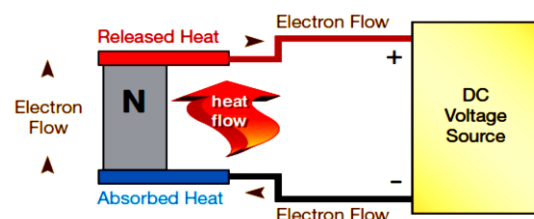


Fig. 1.5. Peltier cooling with N-type semiconductor.

### 1.6. Peltier Cooling with P-type Semiconductor

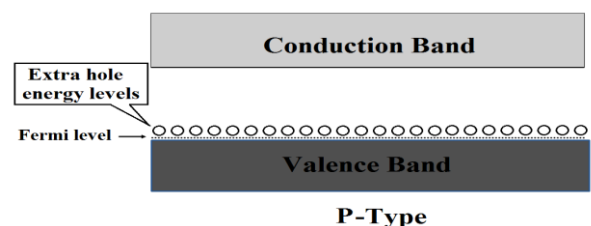


Fig. 1.6. Peltier cooling with P-type semiconductor energy band diagram.

In the thermoelectric industry, “P-type” semiconductor pellets are also in employment. Figure 06 shows the energy band diagram of P-type semiconductor. In this, the holes at the Fermi stage (higher energy level). Now, when DC

current is functional through the circuit as shown in Figure 1.7; whole get attracted towards negative terminal of source. By this attraction, the move to holes of negative terminal by release heats us. The continuous provider of current, holes from transmission band goes to Fermi level by absorb heat from the junction of the system.

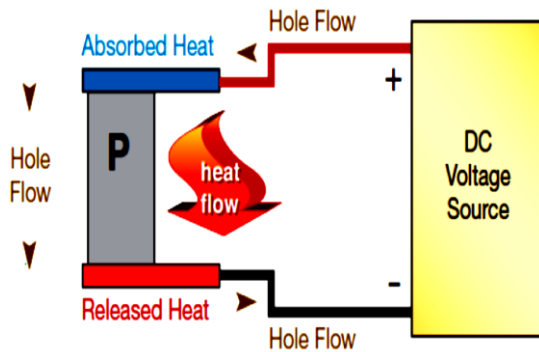


Fig. 1.7. Peltier cooling with P-type semiconductor.

The Peltier are using P-type of semiconductor, heat is absorbing at the junction close up to terminal of the positive and heat is rejected at the junction close to negative terminal.

#### 1.7. Peltier Cooling with P & N type of Semiconductors:

By arranging N and P-type pellets in a “couple” as shown in Figure 1.8 and forming a junction between the plated copper tabs. It is the possible of configure a sequence circuit which can remain all of the heat moving the equal direction. As shown in the illustration, with the free (bottom) end of the P-type pellet connected to the positive voltage potential and the free (bottom) end of the N-type pellet similarly associated to the negative area of the voltage in the system.

The previous sections, for N-type of semiconductor, the junction negative terminal is heat is absorbed and heat is releases at the junction by to the positive terminal. For P-type of semiconductor, the junctions in front of two positive terminal are heat is absorbed and released at the junction by to negative terminal.

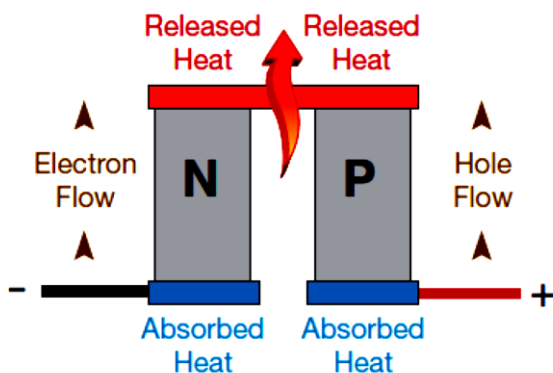


Fig. 1.8. Peltier cooling by couple of N&P semiconductor.

By arranging the circuit as like in Figure 1.8, it is possible to leave go of heat to the one side and absorb from another side. Using these particular properties of the TE “couple”, the possible the team a lot of pellets together rectangular

arrays to produce practical thermoelectric modules. As in Figure 1.9.

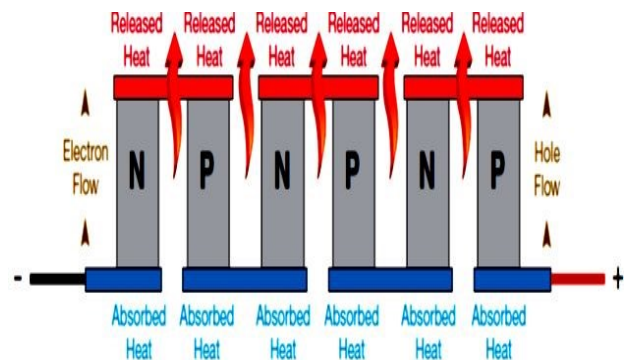


Fig. 1.9. Peltier cooling by multiple pellets.

## II. LITERATURE REVIEW

**Carlos Alberto Badillo-Ruiz et al [1]** in this paper is influences of the Thomson result and the geometry of the p-type segmented leg on the presentation of a segmented thermoelectric micro cooler were examined. That the inverse system (where the material with a higher Seebeck coefficient is used for the first segment) delivered an advanced performance than the direct system is the result show, with improvements in the COP and Qc of 6.67% and 29.25%, respectively.

**S. Choi, U. Han, H. Cho & H. Lee [2]** the studies of the paper comprehensively review household refrigerator technologies include current cycle option and prospect not-in-kind options. The refrigerators are based on a vapor density cycle, so that its option is reviewed and the compare. Technologies that are not base on the VCC, such as a combination, thermoelectric, magnetic, thermo-acoustic, and thermo-elastic are the presented for the request of domestic refrigerators us. Even though they have not been widely used for household refrigerators owed to insufficient reliability.

**K.O. Daffallah [3]** the study of this paper are experiments be carried out on different thermostat set of the refrigerator. The monthly and yearly consumption of the refrigerator were too carried out. The lowly and highly increase the compressor of the run instance for each daytime for each degree increased (in average from 25 to 35 °C) in ambient temperature investigate and found to be 0.216 h/°C and 0.912 h/°C for 12 V system. The association showed results of those 12 V operations of DC refrigerator be able to be much more efficient than 24 V operations particularly at higher ambient temperature with a standard of energy saving of 81.28 kWh/year.

**Hamed Sadighi Dizaji et al. [4]** the studies of this paper the effect of a range experimentally focusses on of parameter on energy destruction. And the moment of the second law presentation from side to side a thermoelectric air cooler. The thermodynamic parameters include of the air flow rate and the flow of effects his and the incoming air hotness of the water flow rate, received water temperature, DC voltage/ ampere etc. the addition air flow rate better the exegetic performance of Peltier-air cooler. Besides, high air inlet temperature reduced the energy of the destruction of

thermoelectric module (TEM) in which means that are Peltier air cooler is apposite for regions us.

**Diana Enescu et al. [5]** in this paper of the addresses and the thermoelectric refrigerator of an electrical characteristic associated. The powers in micro grid-like installation in the sustainable solutions are the thermoelectric refrigerator is connected to a micro grid powered by a photovoltaic plant and the equipped with an electric, is designed and simulated.

**G. Anbazhgan & R. Hariharan [6]** this work is the focused on the performance analysis of the thermoelectric Refrigerator. The refrigerator was experimentally under varying conditions of source and sinks temperature differences and input current. It is consisting of the refrigeration chamber of the thermoelectric module, heat basis and heat sink and thermocouples. Results prove that the COP in which of the criterion of such a machine in the system. It is the function of temperature difference between the resource and sink. For maximum efficiency, the temperature dissimilarity should be maintained at the barest minimum temperature.

**Murat Gokcek & Fatih Sahin [7]** in this paper are performance of mini channel water cooled-thermoelectric refrigerator in the presented the cooling of refrigerator the system. It consists of two thermoelectric modules integrated with the mini channel heat sinks in its hot side and the heat dissipaters in its cold side. The mini channel is the experiments carried absent for different system voltages and dissimilar flow rates of cooling water. The results show that the inner temperature of water-cooled thermoelectric refrigerator is about 2 °C for 0.8 L/min flow rate while it is about -0.1 °C for 1.5 L/min flow rate at the end of 2-h experiment.

**Prashant Kumar Pathak, Mr. Abhishek Singh & Dr. Lokesh Boriwal [8]** the study of the work presents an analysis of difference of temperature with respect to time for water cooled thermoelectric congregation. Here TEC-12715 thermoelectric module was used for cooling the refrigeration cabinet. The current was diverse from 5A to 11A and time was noted for temperature to fall from ambient temperature to 10-15°C. Outcome showed that maximum decrease in temperature of polystyrene cabinet was experiential when  $I = 0.5I_{max}$ .

**Prof. Rajendra. P. Patil et al. [9]** the paper of the Thermo electric refrigeration is the alternative because it can change waste electrical energy into useful cooling is the expected to play a significant role in gathering nowadays fossil energy challenges. The thermo electric refrigeration is the greatly need, particularly for developing country where extended life and low preservation are need to this. The strategy are solid state devices us. They are pleasing to the environment as CFC gas or at all other refrigerant gas is not used. The basic knowledge of the thermoelectric plans and an impression of this application are given us.

**Junyi Wang, Yuan Wang, Shanhe Su, Jincan Chen [10]** the paper of the thermoelectric refrigerator with size of semiconductors, it is the expound the quantum property such as confinement and the tunneling are capable of significantly dropping the irreversible power losses due to the electron transfer, which has a great potential to improve

the cooling efficiency. The results obtained can provide all theoretical the optimal design of practical thermoelectric refrigerators.

**Xiaoqin Sun et al. [11]** the study of the thermoelectric cooling (TEC) system is proposed to do away with the heat that is generated by electronic device in this work. To improve of this system, a gravity assistant heat pipe (GAHP) is attached on the hot side of the thermoelectric cool component, serving as a heat sink. A mathematical model of heat transfer, the energy conservation, is established for the integrated system. It is the various conditions of the, comparing with a TEC system with air cooling heat sink. It is found that the cooling capacity is improved by approximately 73.54% and the electricity consumption was reduced by 42.20% to produce the same amount of cold energy.

**Yu Wang, Yushu Shi & Di Liu [12]** the study of paper mathematical model of the refrigeration system based on one-dimensional heat transfer. The operating characteristics of thermoelectric refrigerator under the condition of maximum cooling capacity and maximum cooling efficiency. The text results the performance of the thermoelectric cooling system coupled with heat pipe affected by the above control parameters. The ventilation speed of the cold surface increase with the increasing of operating voltage and the cooling effect will be more observably. The application of spoiler duct is possible significantly to enhance cooling system performance.

**D. Astrain, P. Aranguren, A. Martinez, A. Rodriguez, M.G. Perez [13]** A study has been carried in on a thermoelectric refrigerator of 15 m<sup>3</sup> of interior volume, in order to obtain the influence of the heat exchanger studied, on the total consumption of the refrigerator and its efficiency. The relevant improvement is able to be made in TEC efficiency by the correct optimizes of that results have demonstrated the heat exchangers.

**Darshan Suryawanshi et al. [14]** these papers are the environmental concerns and alternate cooling technology led us to use thermoelectric refrigeration. The thermoelectric refrigeration is considered to be popular cooling technology and potential to overcome problems regarding use of refrigerant base technologies. It is providing a review of thermoelectric refrigeration system, performance the probable applications of thermoelectric refrigeration. Use of thermoelectric technology in machining operations is innovative idea and outlined by suggesting experimentation work.

**N. Karwa, C. Stanley, H. Intwala, G. Rosengarten [15]** the study of this paper demonstrates a low thermal resistance water cooled heat sink devise for the hot surface the profitable low-cost thermoelectric refrigerator. An inline confined-jet array heat sink has been designed in which the coolant in a straight line impinge. The thermoelectric module, thus eliminating the interfacial thermal resistance and the work out was tested using CFD simulations and experimentally using a 3D printed prototype. A low thermal resistance 0.025 K/W was achieved with a small pressure drop of 25 kPa. The thermal confrontation predicted using CFD matched well by means of the experiments.



**Sujith G et al. [16]** the study of the paper needs of the thermoelectric refrigeration in developing country is very tall where lengthy life and low-down maintenance are needed. Is to develop the work of the thermoelectric refrigerator to cold a quantity of 40 L that utilize the Peltier cool of the effect and maintain a selected temperature range of 5 °C to 25 °C. The plan requirements are the quantity to the temperature within a short time and the provide retention of at least next half an hour and the design and fabrication of thermoelectric refrigerator meant for required applications are presented.

**Z.M. Ding, L.G. Chen & F.R. Sun [17]** the study of the performance of the irreversible mutual refrigerator, in which the heat transmit between the machine and the heat reservoir obeys Newton's heat transmit law, is analyzed and optimized by using the combination of finite time thermodynamics and the non-equilibrium thermodynamics. The total heat transfer plane area on the most favorable presentation of the irreversible refrigerator is explored by numerical examples. Application of practical combined thermionic thermoelectric refrigeration plans results attain herein may provide guidelines for the design.

**Opeoluwa Owoyele, Scott Ferguson & Brendan T. O Connor [18]** the study of the thermoelectric (TE) cooler design is presented that employ thin film thermoelectric element on a plastic substrate in a corrugated structure sandwiched between the planar thermal interface plates. The design represents a hybrid of a conventional bulk TE device and an in-plane thin movie TE design. A comparison is then made between the heat sink demands of the hybrid TE design and a conventional bulk TE device where it is found that the lower cooling power density of the hybrid TE results in a reduction of heat sink demands as compared to bulk TE modules.

**Pradhum Tiwari & Prakash Pandey [19]** in this paper a brief introduction of thermoelectric refrigeration, its principle and applications has been presented. The research and the development work of carried out by the different research. It is the improvement of thermoelectric R&AC system has been thoroughly reviewed in this paper.

**Mayank Awasthi & K V Mali [20]** the objectives of are design and develop a working thermoelectric refrigerator interior cooling volume of 5L that utilizes the Peltier effect to refrigerate and maintain a selected temperature from 5 °C to 25 °C. The requirements designs are the cool of the volume of the temperature within a time phase of 6 hrs and provide release of at least next half an hour. The design requirement, options available and the final design of thermoelectric refrigerator for application are presented.

### III. OBJECTIVE

There are following objective of the present.

1. To fabricate experimental setup of the thermoelectric refrigeration system.
2. To perform experimental analysis at different watts on the thermoelectric refrigeration system to optimize the thermal performance.
3. To compare the various results such as COP, Cooling effect with respect of time and efficiency of the thermo-

-electric refrigeration system.

### IV. METHODOLOGY

#### 4.1. Experimental Set up and Arrangements:

The Thermo electric refrigeration system in this work is fabricated by using Peltier module TEC1-12706, and with six cooling fans in this system. Thermo electric refrigeration system having dimension of 28.5cm X 26cm X 18 cm and supplied power of 18W to 90W is designed. Peltier module is mounted between cold side heat sink and on the hot side of the thermo electric refrigeration system. Rectangular heat sink used on the hot side of thermo electric refrigeration system was made of aluminum. For the heat removal from the hot side of the refrigeration system cooling fans are used. There are four thermo couples are used to measure the various temperatures on the thermo electric refrigeration system these are  $T_c$  Temperature at refrigerator wall,  $T_h$  Temperature at outer wall,  $T_{box}$  Temperature of box &  $T_{door}$  temperature at door.

#### 4.2. Step of Working:

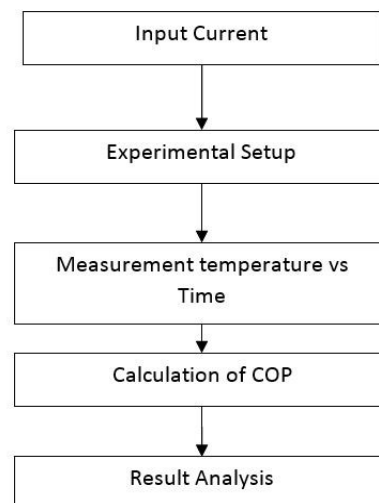


Fig. 4.2(a). Step of working.



Fig. 4.2 (b) Peltier module with cooling fan.



Fig. 4.2(c): inside view of refrigerator.



Fig. 4.2(d). Outside view of refrigerator.



Fig. 4.2(e). Front door of refrigerator.

All the above experimental picture is taken during the experimental setup arrangement. Checking all the connection before experimentation and also pre-arrangement is taking into considered such as heat sink, fan, thermo couple, insulated body & even all the proper connection before starting the reading during experiment.

## V. RESULT AND DISCUSSION

The relationship of time and temperatures of thermo electric refrigeration system used the electrical power of 18 watts, 36 watts, 54 watts, 72 watts 90 watts and 108 watts. There is four thermo couple placed at  $T_c$  Temperature at refrigerator wall,  $T_h$  outside of Peltier refrigeration system,  $T_{box}$  at center of box and  $T_{door}$  at refrigerator door.

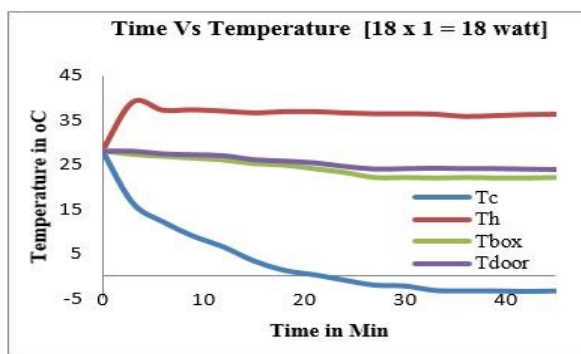


Fig. 5.1. Time Vs Temperature for 18 watts.

After performing experimentation, a Peltier effect refrigeration system for 18 watts (12volt X 1.5A) with considering single cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.2$ ,  $T_h = 36.2$ ,  $T_{box} = 22.2$  &  $T_{door} = 23.9$ .

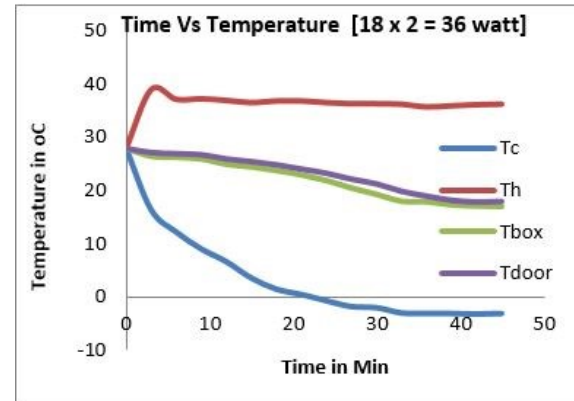


Fig. 5.2. Time Vs Temperature for 36 watts.

After performing experimentation, a Peltier effect refrigeration system for 36 watts with considering double cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.2^\circ\text{C}$ ,  $T_h = 36.2^\circ\text{C}$ ,  $T_{box} = 17^\circ\text{C}$  &  $T_{door} = 18^\circ\text{C}$ .

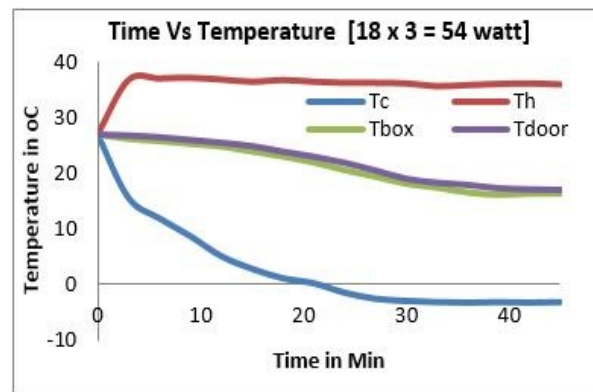


Fig. 5.3. Time Vs Temperature for 54 watts [13].

After performing experimentation, a Peltier effect refrigeration system for 54 watts with considering three cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.2^\circ\text{C}$ ,  $T_h = 36^\circ\text{C}$ ,  $T_{box} = 16.2^\circ\text{C}$  &  $T_{door} = 17^\circ\text{C}$ .

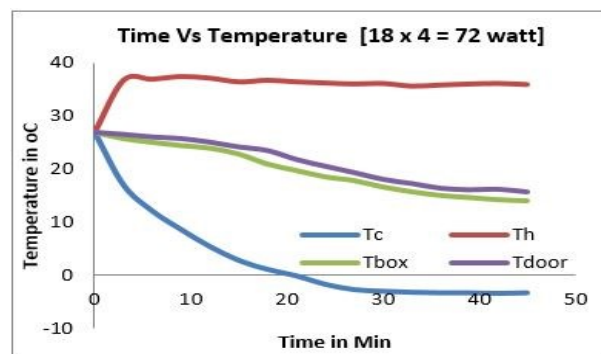


Fig. 5.4. Time Vs Temperature for 72 watts.

After performing experimentation, a Peltier effect refrigeration system for 72 watts with considering four cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.2^\circ\text{C}$ ,  $T_h = 36^\circ\text{C}$ ,  $T_{box} = 14.1^\circ\text{C}$  &  $T_{door} = 15.6^\circ\text{C}$ .

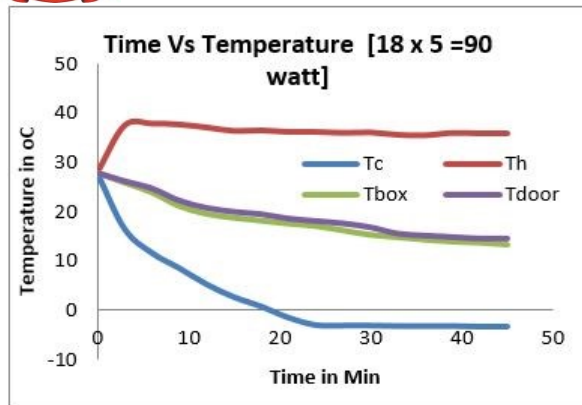


Fig. 5.5. Time Vs Temperature for 90 watts.

After performing experimentation, a Peltier effect refrigeration system for 90 watts with considering five cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.3^\circ\text{C}$ ,  $T_h = 36^\circ\text{C}$ ,  $T_{\text{box}} = 13.3^\circ\text{C}$  &  $T_{\text{door}} = 14.5^\circ\text{C}$ .

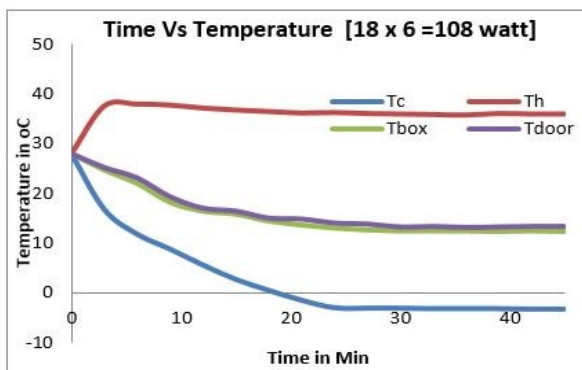


Fig. 5.6. Time Vs Temperature for 108 watts.

After performing experimentation, a Peltier effect refrigeration system for 108 watts with considering six cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken which are  $T_c = -3.3^\circ\text{C}$ ,  $T_h = 36^\circ\text{C}$ ,  $T_{\text{box}} = 12.3^\circ\text{C}$  &  $T_{\text{door}} = 13.3^\circ\text{C}$ .

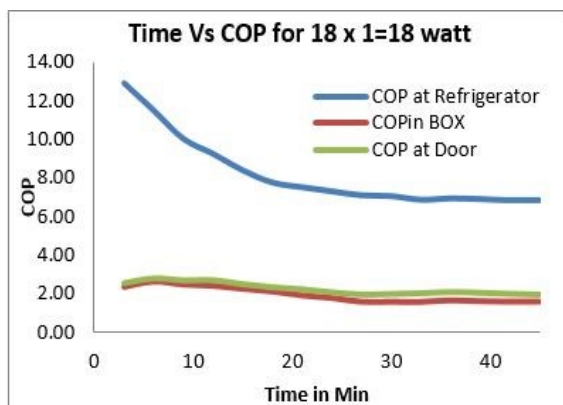


Fig. 5.7. Time Vs COP for 18 watts.

Coefficient of performance of Peltier effect refrigerator system also have been calculated, according to result obtained from experimentation the value of COP at refrigerator, COP in box and COP at door have been

calculated for all temperatures. The time v/s COP for 18 watts with single fan graph have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.85, COP in box is 1.59 and COP at door is 1.95.

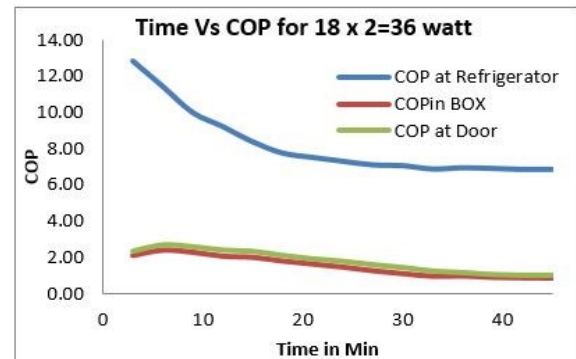


Fig. 5.8. Time Vs COP for 36 watts.

The time v/s COP for 36 watts with double cooling fan graph have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.85, COP in box is 0.89 and COP at door is 0.99.

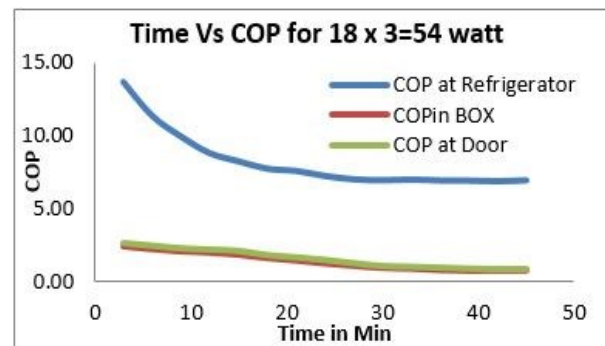


Fig. 5.9. Time Vs COP for 54 watts.

The time v/s COP for 54 watts with three cooling fan graphs have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.89, COP in box is 0.82 and COP at door is 0.89.

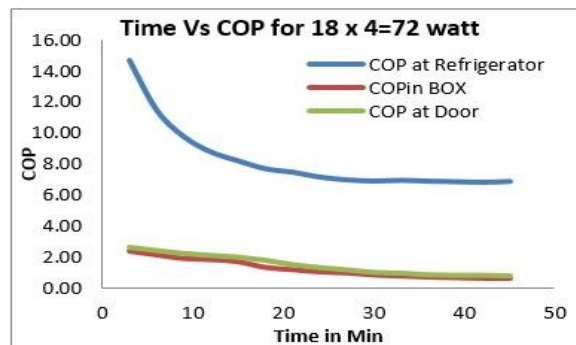


Fig. 5.10. Time Vs COP for 72 watts.

The time v/s COP for 72 watt with four cooling fan graph have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.89, COP in box is 0.64 and COP at door is 0.76.



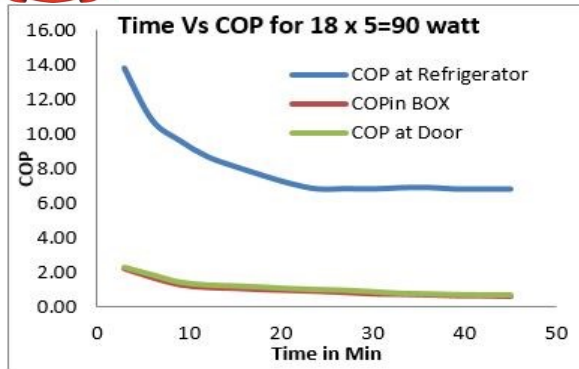


Fig. 5.11. Time Vs COP for 90 watts.

The time v/s COP for 72 watts with five cooling fan graphs have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.87, COP in box is 0.59 and COP at door is 0.67.

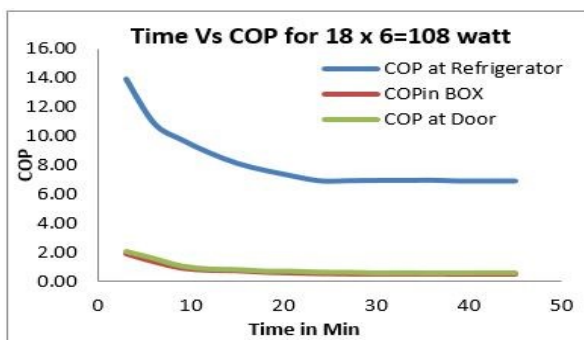


Fig. 5.12. Time Vs COP for 108 watts.

The time v/s COP for 72 watts with six cooling fan graphs have been plotted with the help using these results as shown in figure after 45 minutes the COP at refrigerator wall is 6.87, COP in box is 0.52 and COP at door is 0.59.

Comparative Result of temperature at different location				
Power supply	$T_c$	$T_h$	$T_{box}$	$T_{door}$
at 18 watts	-3.2	36.2	22.2	23.9
at 36 watts	-3.2	36.2	17	18
at 54 watts	-3.2	36	16.2	17
at 72 watts	-3.2	36	14.1	15.6
at 90 watts	-3.3	36	13.3	14.5
at 108 watts	-3.3	36	12.3	13.3

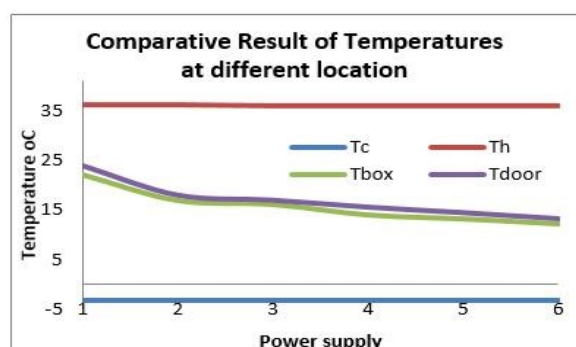


Fig. 5.13. Comparative result of temperature.

Comparative Result of COP at different location			
Power supply	COP at Refrigerator	COP in BOX	COP at Door
at 18 watts	6.85	1.59	1.94
at 36 watts	6.85	0.89	0.99
at 54 watts	6.89	0.82	0.89
at 72 watts	6.89	0.64	0.76
at 90 watts	6.87	0.59	0.67
at 108 watts	6.87	0.52	0.59

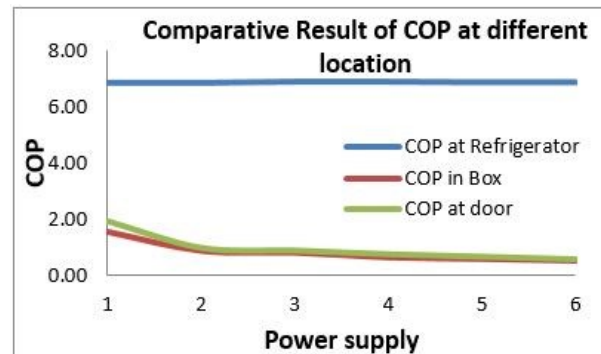


Fig. 5.14. Comparative result of COP.

## VI. CONCLUSION

After performing experimentation, a Peltier effect refrigeration system for different watts with considering single to six cooling fan the total experimentation time is 45 min. and after each 3 min reading has been taken. There are following conclusion points have been observed.

- Temperature range at refrigerator wall  $T_c$  for 18 to 108 watts with various cooling fans are  $28^\circ\text{C}$  to  $-3.3^\circ\text{C}$  for 45 minutes and continuous decreasing with time.
- The temperature of the thermo electric refrigeration system is initially increasing till  $38.9^\circ\text{C}$  and decreasing with time.
- The temperature of the refrigerator box  $T_{box}$  ranging from  $22.2^\circ\text{C}$  to  $12.3^\circ\text{C}$  and continuous decreasing with time.
- The temperature of the refrigerator door  $T_{door}$  ranging from  $23.9^\circ\text{C}$  to  $13.3^\circ\text{C}$  and continuous decreasing with time.
- The COP of the thermo electric refrigeration system at refrigerator is 6.85, in box ranging from 1.59-0.52 and at door the COP was ranging from 1.94-0.59.

It is observed heat transfer rate increase with no. of cooling fans. There for it can be done that the concert of thermoelectric refrigeration system can be improved with use of increasing cooling fans with Peltier modules and efficient heat dissipation technology.

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