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EXPERIMENTAL ANALYSIS OF VCRS BY INTRODUCING THERMOELECTRIC MODULE

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ABSTRACT:

In the present situation, energy emergency is the main issue for the development of the country. For the development of the country, as it relies upon the power generation and demand, there is a two different ways either age of greater power or sparing of power. By the present venture we are going to presenting thermoelectric module, working on a Peltier Effect. By presenting thermoelectric module in domestic refrigerator which gives extra sub-cooling and superheating impact in the framework and it will reduce energy utilization. Refrigerators and air conditioners are the most energy consuming appliances. 40-70% of aggregate vitality utilization of a nation is used for air conditioning and cooling indoor air. Consequently numerous analysts had performed work to upgrade execution of the refrigeration frameworks. In household fridges, the most utilized cooling framework is vapor compression, as it has good value of Coefficient of performance (COP). A Peltier impact is a temperature distinction made by applying a voltage between two terminals associated with semiconductor material. By applying a low voltage DC capacity to a thermoelectric module from one side to other. One module face will be cool while the other face is at the same time warmed. By changing in polarity(plus and short) of the connected DC voltage will make warm be moved the other way. Consequently, a thermoelectric module may utilized for both warming and cooling subsequently making it exceptionally appropriate for exact temperature control application. A Thermoelectric module can also be utilized for power generation. It tends to be utilized either to heat or for cooling, despite the fact that practically the fundamental application is cooling. It can also be utilized as a temperature controller that either warms or cools. By presenting Thermoelectric module in the Domestic refrigerator we can achieve the refrigeration effect ,Coefficient of performance and decrease the power utilization when compared to the without Thermoelectric Module in the household refrigerators.

Keywords: Thermoelectric module, Coefficient of performance, Domestic refrigerator

1. INTRODUCTION

Refrigeration is the way toward lessening and keeping up the temperature of a body underneath the temperature of its surroundings. In different words, refrigeration implies proceeds with extraction of warmth from a body whose temperature beneath the temperature of environment. Presently a days Domestic refrigerator is a typical family gear that comprises of a thermally protected part and a warmth pump that exchange warm from within fridge to its outer condition so that within the fridge is cooled to a temperature beneath the surrounding temperature of the room. It consists of the following four basic components :

- Compressor
- Condenser
- Expansion device
- Evaporator

Domestic refrigerator works on Vapour compression refrigeration cycle.

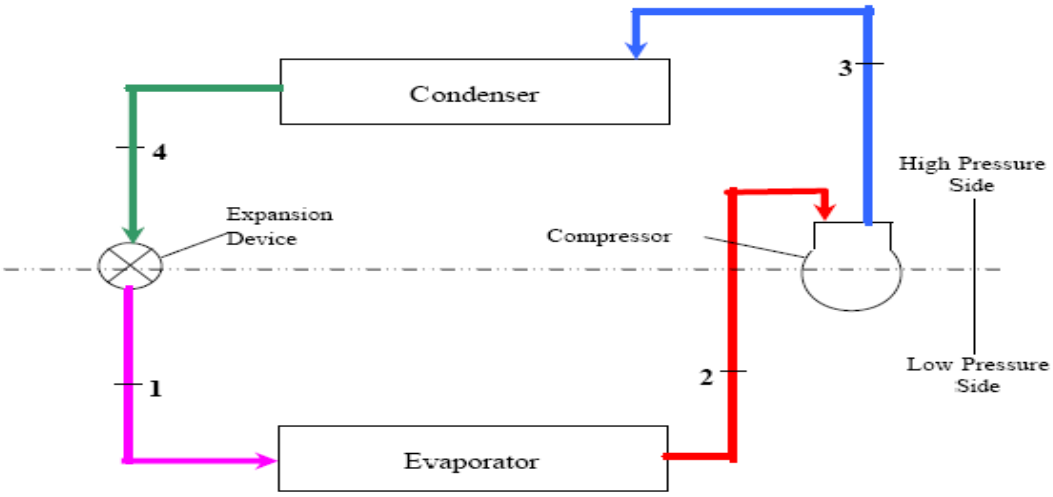


Fig1: VCRS Cycle

The superheating of vapor before entering into the compressor and sub cooling of liquid before entering into in expansion valve is shown in fig2. where 5-2 represent the superheating and 4-6 represent undercooling.

Superheating is done in order to as certain that there is no droplet of liquid refrigerant being carried over into the compressor. A small degree of sub cooling of liquid refrigerant after the condenser is also used to reduce the mass the vapour format during expansion, so that too many vapour bubbles do not impede the flow of liquid refrigerant through the expansion valve.

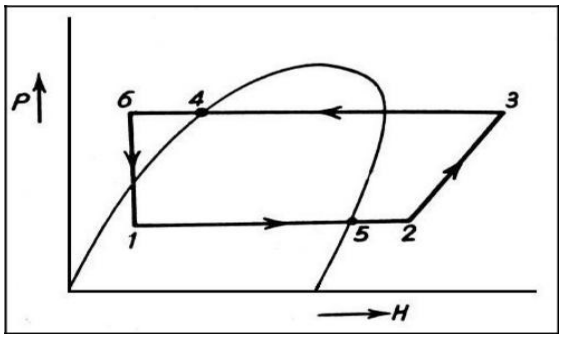


Fig2: P-H diagram with subcooling and superheating

Both the superheating of vapour at the evaporator outlet and the sub cooling of the liquid at the condenser outlet contribute to an increase in refrigerating effect .The compressor discharge temperature increases due to superheat, and the load on the load on condenser also increases.

Sometimes, a liquid line heat exchanger is used in the plantain which the liquid is sub cooled in the heat exchange, reducing the load on the condenser and improving C.O.P.

Heat extracted from the space =h3-h1

Refrigeration effect =h2-h1

Work done =h3-h2

C.O.P= h2-h1/h3-h2

Tending to todays imperativeness troubles. Along these lines, thermoelectric refrigeration is essentially required, particularly to create countries where long life and low support are required. The goals of this examination is plan and develop a working thermoelectric refrigerator inside cooling volume of 5L that uses the Peltier effect to refrigerate and keep up a picked temperature from 5 °C to 25 °C. The outline necessities are to cool this volume to temperature inside a period of 6 hrs and give upkeep of at any rate next thirty minutes. The arrangement need, choices open and the last outline of thermoelectric fridge for application are introduced.

II. LITERATURE REVIEW

The worldwide expanding interest for refrigeration in field of refrigeration ventilating, sustenance and food protection, vaccine storages, therapeutic administrations, and cooling of electronic gadgets, prompted creation of greater power and thusly more arrival of CO2 everywhere throughout the world which it is contributing the global warming it effect on environmental change. Thermoelectric refrigeration is new option since it can change over waste power into helpful cooling, is relied upon to assume a critical part in addressing todays energy difficulties.

Hence, thermoelectric refrigeration is enormously required, especially to develop nations where long life and low management are required. The destinations of this investigation is plan and build up a working thermoelectric refrigerator inside cooling volume of 5L that uses the Peltier impact to refrigerant and keep up a chose temperature from 5 °C to 25 °C. The plan necessities are to cool this volume to temperature within a period of 6 hrs and give maintenance of in any event next thirty minutes. The outline prerequisite, choices accessible and the last plan of Thermoelectric refrigerator for application are displayed.

A Thermoelectric Refrigerator Cooling framework is has been planned and created to give dynamic cooling help of single stage 12 V Thermoelectric module is utilized to give satisfactory cooling. First the cooling load figurings for this Thermoelectric Refrigerator compartment considered under examination were displayed. Simulation tests in research facility have approved the hypothetical plan parameters and built up the achievability of giving cooling single stage thermoelectric cooler was tried in the natural chamber. As Thermo electric refrigerator not accessible in open market which we can hold cooling at instance of power blackout because of high current conveying limit. The maintenance time accomplished was 52 mins with the outlined module in this undertaking. With a specific end goal to accomplish the higher maintenance time, another alternative was incorporate. This comprises the extra radiator on heat sink. The most elevated maintenance time accomplished was 57 minutes.

III. OBJECTIVES

The objectives of the performance improvement Vapour compression refrigerator by using Thermoelectric Module.

1.To create test setup by altering vapour comprssion refrigerator with peltiers on the fins of the condenser tubes.

2. To watch the distinction on the Coefficient Of Performance of the refrigeration cycle with peltiers.

3. To observe the differences of power consumption of refrigerator with or without having thermo electric modules.

4. To observe the consumption of refrigerant of refrigerator having with peltiers.

IV. THERMOELECTRIC MODULE

A Thermoelectric module additionally called thermoelectric cooler or Peltier cooler, is a semiconductor based electronic part that functions as heat pump.The Peltier effect is named after a French scientist Jean Peltier who discovered it in 1834.

The Peltier impact is a temperature contrast made by applying a DC voltage between two terminals associated with an example of two semiconductor material. This wonder can be valuable when it is important to exchange warm starting with one medium then onto the next medium. By applying a low voltage DC capacity to a thermoelectric module from one side to other. One module confront, subsequently, will be cool while the other face is at the same time warmed. Note that this phenomenon might be turned around whereby an adjustment in extremity of the connected DC voltage will make warm be moved the other way. Thusly, a thermoelectric module might be utilized for both warming and cooling along these lines making it exceptionally reasonable for exact temperature control application. A Thermoelectric Module can likewise be utilized for power generation.

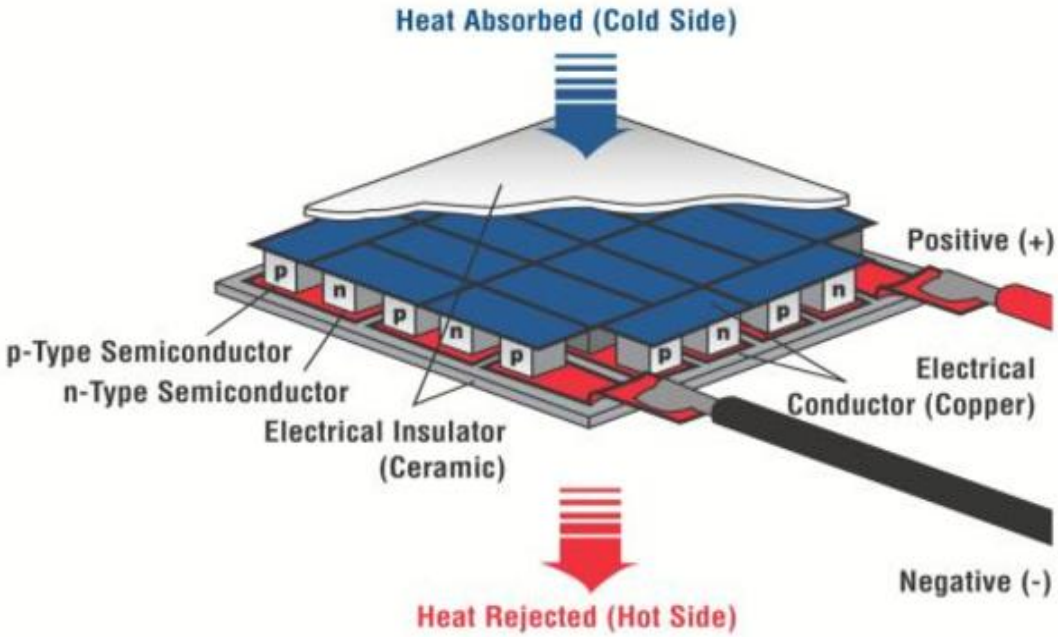


Fig3: Thermoelectric Module

V.EXPERIMENTAL SETUP

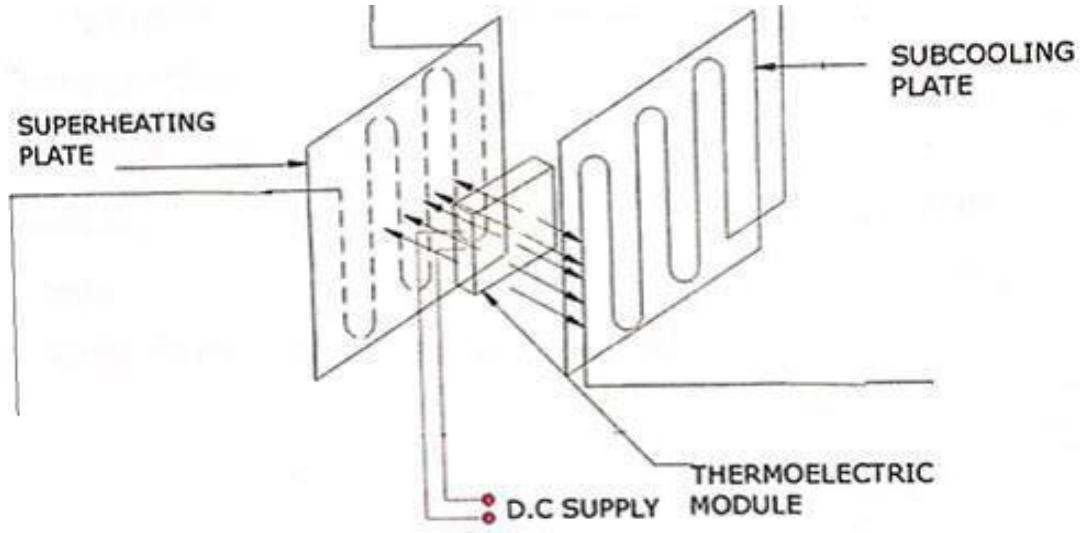


Fig4: Block diagram setup of Thermoelectric Module

Fig 5: Experimental Setup

Vapour compression refrigerator used in the two 12V Thermoelectric Modules. A two Thermoelectric Modules with 12V Capacity are fixed on the fins of the condenser tubes. These two Thermoelectric Modules are connected to the battery power source. The Direct current passed to the Thermoelectric Module which is negligible.Thermo couples are taken to notedown the readings of temperatures corresponding values of compressor,condenser and evaporator. Note down the pressure in the pressure gauges.

The experimental setup comprised with a refrigerator, pressure gauges, Thermo couples, Thermoelectric Modules.

VI. COMPONENT SPECIFICATIONS

1. Refrigerator Capacity: 200 liters

2. Compressor:

Reciprocating type

--- Hermitically sealed

--- 1/8 HP, 230 VOLT, 50 Hz,

--- A.C. Only 1.1 Amp. Max.

3. Refrigerant: R600a

4. Thermoelectric Module:

--- Imax: 9 amp

--- Vmax: 12 volts

--- Number of thermocouples: 3

VII. DATA COLLECTION

All calculations has been done by considering the conditions of refrigerant. We take temperatures and pressures of different point on cycle at interval of five minute. Here observation table of third reading is given.

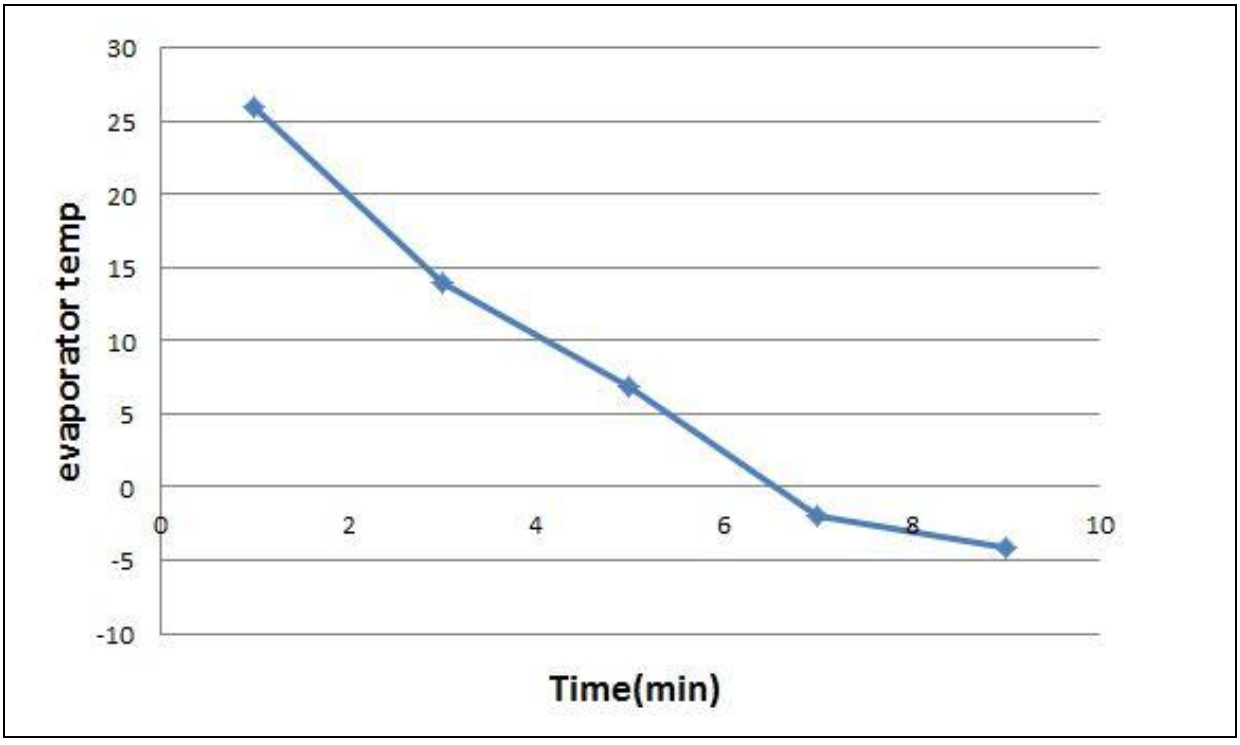
Table 1: Without Thermoelectric Module

	Comp(inlet)	Comp(outlet)	Evap(Temp)	Compressor Pressure(bar)	
Time (min)	T1(^{O}C)	T2(^{O}C)	T3(^{O}C)	Inlet(P1)	Outlet(P2)
1	27	42.9	26	1.2	14.6
□	26.7	43.9	14	1.2	14.6
□	26.2	44.4	10	1.2	14.6
□	25.8	44.8	6.9	1.2	14.6
□	25.4	45	–2	1.2	14.6
□	25	46	–4.2	1.2	14.6

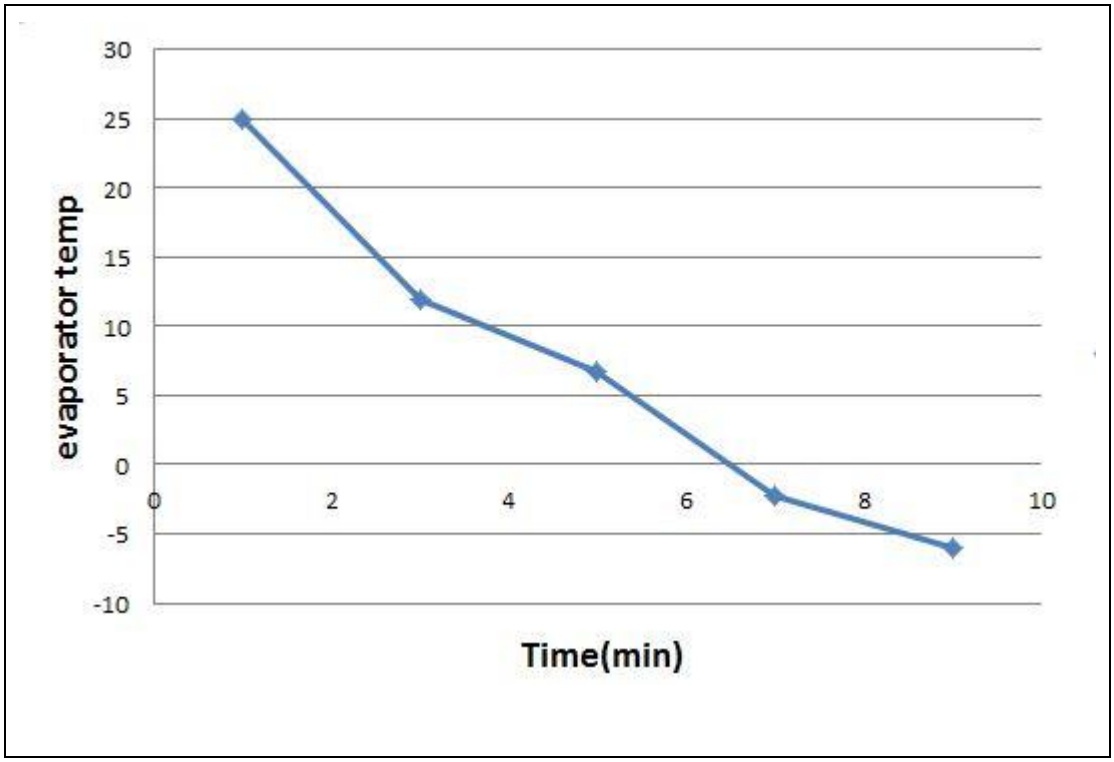
Table 2: With Thermoelectric Module

	Comp (inlet)	Comp (outlet)	Evap (Temp)	Compressor Pressure(bar)	
Time (min)	T1(^{O}C)	T2(^{O}C)	T3(^{O}C)	Inlet(P1)	Outlet(P2)
1	32	33	25	1.25	14.8
□	27.5	37	12	1.25	14.8
□	25.4	40	6.8	1.25	14.8
□	24.6	41.2	–2.2	1.25	14.8
□	24.2	44	–6	1.25	14.8

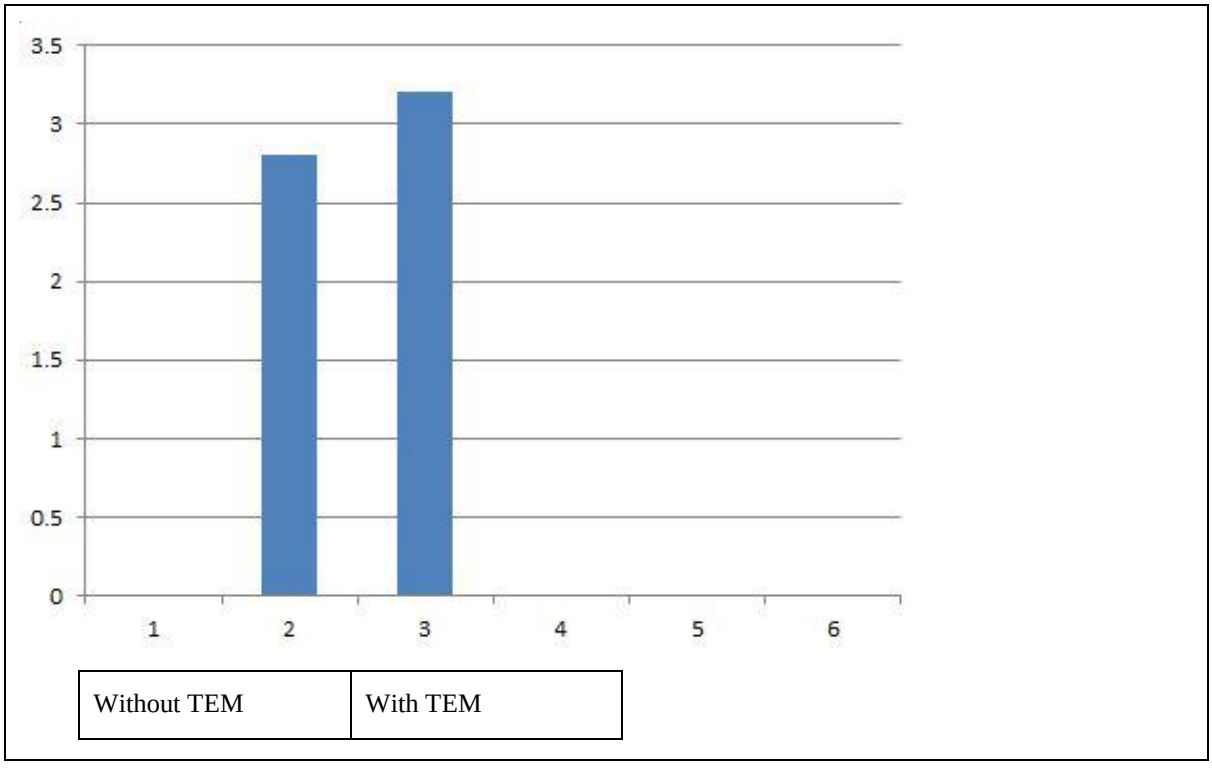
Graph 1 : Between evaporator temp Vs Time without Thermoelectric Module



Graph 2 : Between evaporator temp Vs Time with Thermoelectric Module



Graph 3: Comparison of COP



1) Calculation (Without TEM)

Taking fifth reading of the observation. Using p-h chart of R600a.

h1 = 600 kJ/kg

h2 = 700 kJ/kg

h3 = h4=320 kJ/kg

Refrigerating effect R.E. = h1 – h3

=600-320 =280 kJ/kg

Mass of refrigerant M.R. =14000/(R.E.)

= 14000/280

= 50kg/hr.-tonne Work done

W.D. = h2 – h1

= 700-600

= 100 KJ/kg.

C.O.P. = (R.E.)/(W.D.)

=280/100=2.8

Power Consumption

= (M.R.* W.D.)/3600

= (50*100)/3600

= 1.3888 kW/tonne

1) Calculation (With TEM)

Taking third reading of the observation. Using p-h chart of R600a.

h1 = 600 kJ/kg

h2 = 695 kJ/kg

h3 = h4=295 kJ/kg

Refrigerating effect R.E. = h1 – h3

=600-295 =305 kJ/kg

Mass of refrigerant M.R. =14000/(R.E.)

= 14000/305

= 45.90kg/hr.-tonne Work done

W.D. = h2 – h1

= 695-600

= 95 KJ/kg.

C.O.P. = (R.E.)/(W.D.)

= 305/95=3.210

Power Consumption

= (M.R.* W.D.)/3600

= (45.90*95)/3600

= 1.2112 kW/tonne

VIII. RESULT

Table 3: Results

S.NO	Parameters	Without TEM	With TEM
1	Refrigerating Effect(kJ/kg)	280	305
2	Work done (kJ/kg)	100	95
3	C.O.P	2.8	3.210
4	Mass of refrigerant (kg/hr.tonne)	50	45.90
5	Power consumption (kw/tonne)	1.3888	1.2112

IX. CONCLUSION

1) From the real figuring we can get wanted outcome. The refrigerating impact is expanded, work done by compressor is diminishes, mass flow rate is diminishes, power utilization is diminished and C.O.P is increments by presenting of TEM.

2) By presenting Thermoelectric module in household refrigerator which gives extra sub-cooling and super warming impact in the framework and increment the refrigerant impact and Coefficient of execution and it will lessen the power utilization.

3) TEM work in DC voltage (1-12v) so Power devoured by TEM is less. This power is dismissed contrasted with expanding Refrigeration impact and diminishing force utilization with its assistance.

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