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Absorbs Heat from Outside Air And Release it inside the Building by Heat Pump

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Abstract:

A heat pump in the most basic sense, is little more than a conventional air – conditioning system that is equipped with the necessary components to cause it to reverse its running cycle, while the heat pump is operating in reverse, it absorbs heat from the air outside and releases it inside the building.

In this system Freon gas (R_{134}) was used because it is more efficiency from the other kinds of gases that used for conditioning, and the data that produced from this system at its running time was compared with that produced from another system also used the same kind of gas.

In this work the first step is to measure the temperatures at various points in the cycle (t_1-----t_8) these points are:

- ***The temperature of (R_{134}) at outlet from the compressor.***
- ***The temperature of (R_{134}) at outlet from the condenser.***
- ***The temperature of (R_{134}) at outlet from the expansion valve.***
- ***The temperature of (R_{134}) at outlet from the evaporator.***
- ***The temperature of water at inlet to the condenser.***
- ***The temperature of water at outlet from the condenser.***
- ***The temperature of water at inlet to the evaporator.***
- ***The temperature of water at outlet from the evaporator.***

Also to measure the intake and compression pressures, denoted with P_v and P_c, which do not coincide with the evaporation and compression pressures, due to the pressure drops taking place in the refrigerant going through the heat exchangers.

And determine the heat in condenser and in compressor, and in evaporator.

Then determine the efficiency of Carnot's ideal cycle to be able of compare the results with those relating to an ideal machine.

الخلاصة:

المضخة الحرارية بأبسط اوضاعها هي اصغر من منظومة مكيف الهواء التقليدية والتي تكون مزودة بالمحتويات الضرورية لتسبب انعكاس دورتها التشغيلية حيث ان المضخة الحرارية تعمل عكس هذه الطريقة تماما حيث تقوم بأمتصاص الحرارة من الهواء الخارجي وتطلقه داخل البناية حيث استخدم في هذه المنظومة غاز فريون من نوع (R_{134}) وقد تم اختيار هذا النوع من الغاز لكونه اكثر كفاءة من غيره من الغازات بالاضافة الى ان القيم الناتجة من عمل هذه المنظومة قد تمت مقارنتها مع قيم ناتجة من منظومة اخرى مستخدم فيها غاز(R_{134})

في هذا البحث اول خطوة نقوم بها هي قياس درجات الحرارة في نقاط مختلفة من المنظومة (t_1--------t_8) وهذه النقاط هي :

- ***درجة حرارة غاز الفريون (R_{134}) الخارج من الضاغط.***
- ***درجة حرارة غاز الفريون (R_{134}) الخارج من المكثف .***
- ***درجة حرارة غاز الفريون (R_{134}) الخارج من الصمام الموسع.***
- ***درجة حرارة غاز الفريون (R_{134}) الخارج من المبخر.***
- ***درجة حرارة الماء الداخل الى المكثف.***
- ***درجة حرارة الماء الخارج من المكثف.***
- ***درجة حرارة الماء الداخل الى المبخر.***
- ***درجة حرارة الماء الخارج من المبخر.***

بالاضافة الى قياس الضغط عند المأخذ و الضاغط والتي تعرف ب (P_v and P_c,) والتي ليس لها ارتباط بضغط المبخر والضاغط نسبة الى الخسارة الحاصلة بالضغط نتيجة للبرودة التي تمر خلال المبادلات الحرارية وحساب الحرارة في المكثف والضاغط والمبخر ومن ثم حساب كفاءة دائرة كارنوت المثالية للتمكن من مقارنة النتائج مع تلك الناتجة من منظومة مثالية اخرى .

Keywords: Heat Pump, temperature, cooling, cycle.

Introduction

The determination of the temperature at various points in the cycle of the Heat Pump is covered in detail by Richard.R.Stubblefied but the values are determined in cooling cycle.

Searcher such us Ken-Ichi Kimura (2005) is proposed determines the efficiency of the Heat pump.

E.L.Cuplinskas (1997) give the reading of temperature for some compounds for Heat pump, where compared the results of our work with the results of E.L.Cuplinskas.

The cooling by heat pump discussed by W.R.Muncey, and enhancement the performance of it.

During the early days of heat pump design, manufactures believed that a heat pump was a simple system – essentially a conventional air conditioning unit with a few valves installed to reverse the flow of refrigerant, ref. [10],[12],[13].

Consequently they manufactured units that were constant sources of trouble failing to produce the required amount of heat while operating at very high cost.

Because of these faults; heat pump systems acquired a bad name, ref. [8], [11].

However, through these mistakes many manufacturers learned that heat pump systems have specific operating conditions that must be included in the design of the equipment. Among are the following:

1. The indoor coil must have an extra amount of surface area to prevent the condensing temperatures from becoming too high during the heating cycle.
2. The air-handling capacity of the indoor unit and duct system must allow sufficient air flow to assure adequate condensing of the refrigerant.
3. The compressor must have especial design for heat pump application because it operates all year long at completely different operating pressures and condition from those of a standard air conditioning compressor.
4. Heat pump systems must be equipped with a suction line accumulator to prevent liquid refrigerant from entering the compressor.
5. A crank case heater is required to prevent refrigerant migration to the compressor lubricating oil during the off-cycle and low starting temperatures.
6. A defrost cycle is required to keep the unit operating at peak efficiency.
7. Auxiliary heating elements must be incorporated to aid the unit during periods of extreme cold or when the system might be mal functioning.

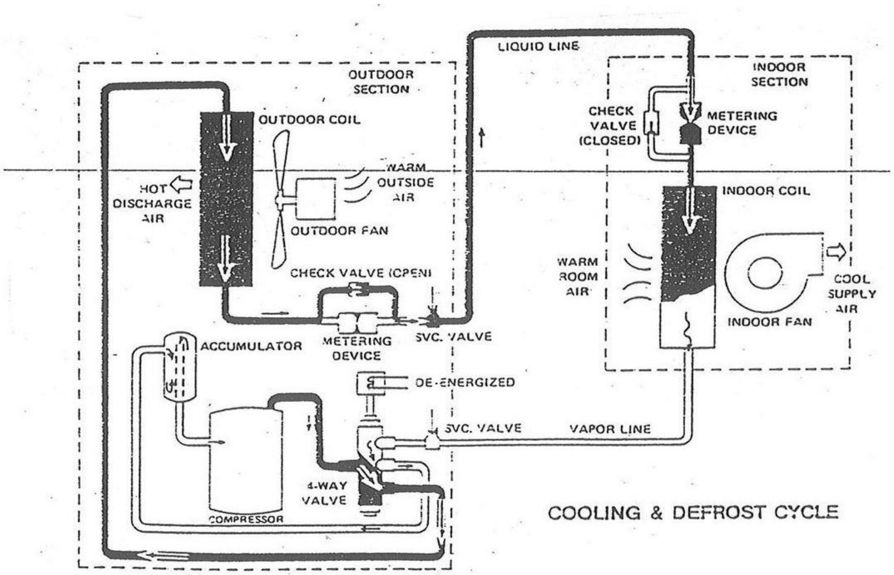

Fig.(1) presents schematic diagram of the heat pump, ref.[2]

Heat Pump Components are:

1. Compressor.
2. Reversing valve.
3. Refrigerant flow-control (Metering) Devices.
4. Check valves.
5. Accumulators.
6. Coils.
7. Auxiliary Heating Elements.
8. Crankcase Heaters.
9. Refrigerant piping and pipe insulation.
10. Heat exchanger.
11. Strainers.
12. Driers.
13. Discharge Mufflers.
14. Air filters.
15. Capacitors.

Heat pump in cooling mode

A heat pump, in the most basic sense, is little more than a conventional air – conditioning system that is equipped with the necessary components to cause to reverse its running cycle.
While the heat pump is operating in reverse, it absorbs heat from the air outside and releases it inside the building.

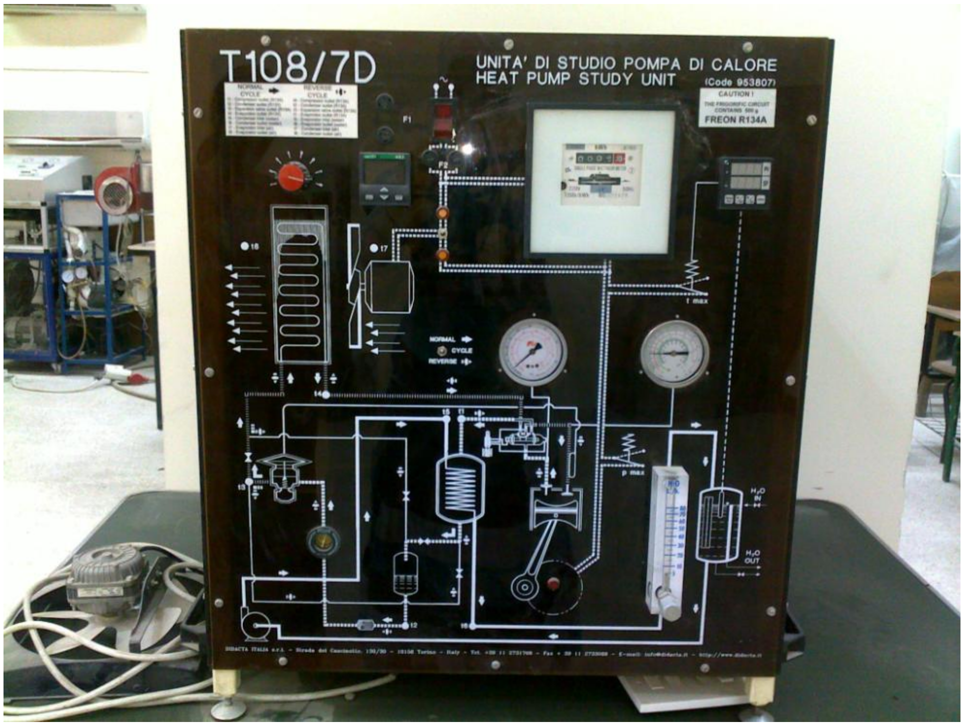

Fig.(2) Front panel of the Heat Pump

A heat pump uses the process described above to obtain heat from a given source (air, water) and raise its temperature, through the input of valuable energy, to a higher level, according to the intended use.

The working cycle of a heat pump is that of a compression cycle as represented in fig (3), ref. [15].

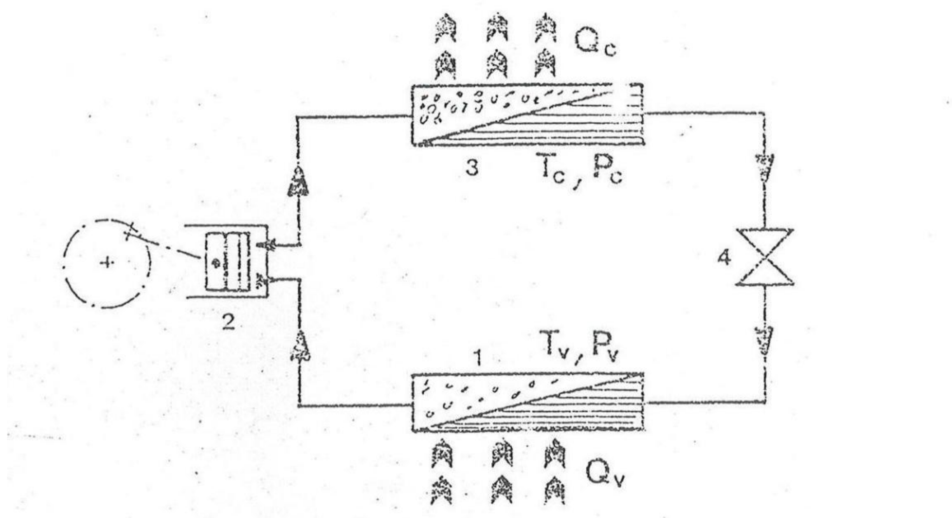

Fig. (3) Schematic view of a refrigeration cycle, ref. [5]

State diagrams for the study of the heat pump cycle:

The diagrams reflecting the compression stage of the cycle are:

The temperature, entropy (T, S) diagram and the pressure enthalpy (log p,h) diagram. In this cycle, produced between the hot source at a temperature T_{calda} and the cold source T_{fredda} the compressed refrigerant fluid whose state is represented by point 1 expands in reversible manner and along adiabatic line 1-2. The temperature of the refrigerant decreases from T_1 to T_2. Ref. [14],[16],[17].

After that, the refrigerant undergoes an isotherm expansion 2-3; along isotherm (constant temperature) T_2 during which the heat from the cold source is supplied as follows:

$q_2 = T_2 (S_3 - S_2)$

Keeping in mind that $\Delta S=\Delta Q/T$

Starting from point 3, the refrigerant undergoes an adiabatic compression from T_2 to T_1, then, at T_1 an isotherm transformation begins, during which the refrigerant yields a quantity of heat to the hot source:

$q_1 = T_1 (S_4 - S_1)$

The work used in this cycle is:

$l_{ciclo} = q_1 - q_2 = (T_1 - T_2)(S_3 - S_2)$

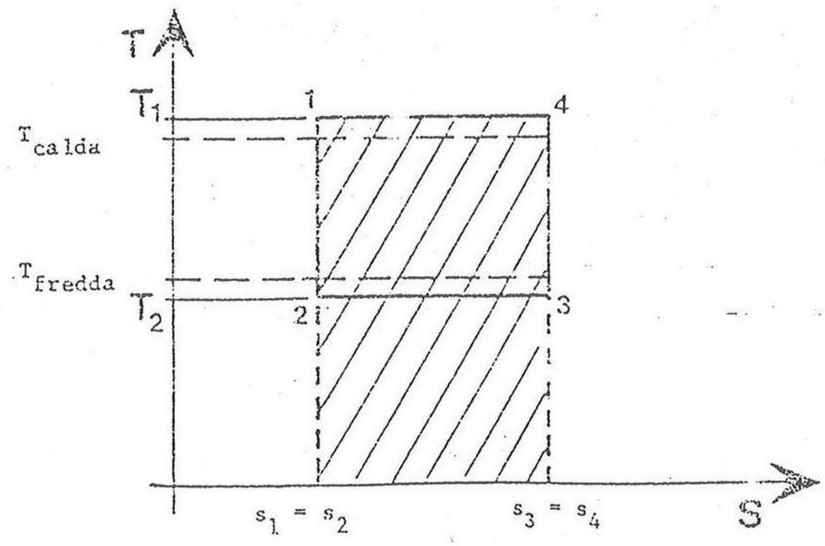

Fig.(4) ideal, or Carnot, refrigeration cycle, ref.[3]

While the heat yielded to the source is represented by the dashed area in the figure 3.

Fig 4 shows a generic log p,h diagram in schematic form. Let us examine this diagram to gain a better understanding of it:

The limit curve for x=0 and x=1 delimit the field of existence of the liquid – vapor mixtures in which only a portion of the refrigerant has evaporated; for x=1 and for all the values to the right of this curve up to critical point K, the refrigerant is in vapor form, ref. [3],[18],[19].

For all points to the left of the x=0 curve the refrigerant is wholly in liquid form.

For example, equal tetra curve x=0.8 means that 80% of the refrigerant is in vapor form.

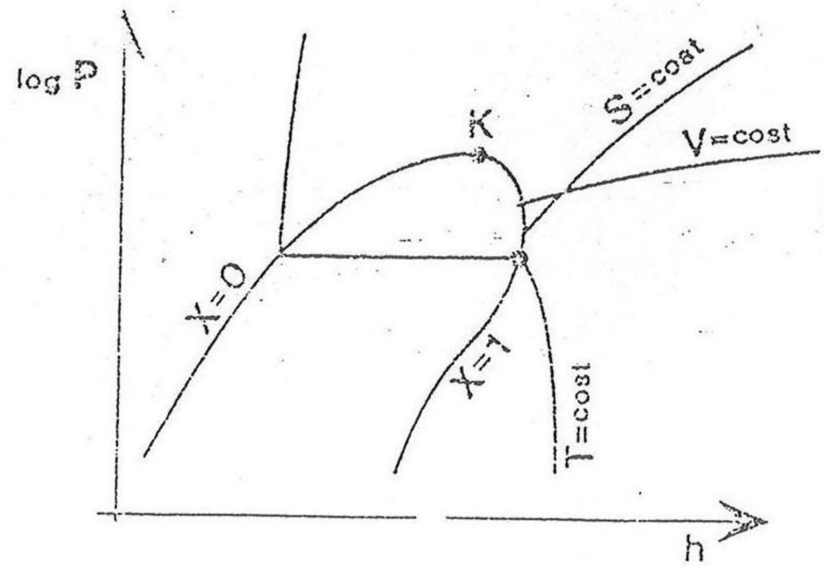

Fig. (5) Log P, h diagram, ref. [3]

Experimental Work:

In this search the temperatures was measured at various points in the cycle of heat pump instrument already exist at the conditioning laboratory of the college of engineering, at the beginning of system running (time 0) and compared it with the results from E.L.Cuplinskas at the same time as shown in fig. (14).

The results taken at various times (time = 0, 0.5, 0.75 hr) as shown in figures, (6, 7, 8, 9, 10, 11, 12, 13), where the temperature of the R_{134} that comes from compressor increase when the times go on and it is the same for the temperature of R_{134} that comes from the condenser and from the expansion valves and the temperature of the water that comes from the condenser.

But the temperature of the R_{134} that comes from the evaporator decrease and then increase when the times go on and it is the same for the temperature of the water that goes through to the condenser and comes from the evaporator, but the temperature of the water that goes through to the evaporator increase and then decrease.

Results and discussion:

The first step is to measure the temperatures at various points in the cycle (t_1--------t_8) and to measure the intake and compression pressures, denoted with P_v and P_c, which do not coincide with the evaporation and compression pressures, due to the pressure drops taking place in the refrigerant going through the heat exchangers.

And determine the heat in condenser and in compressor, and in evaporator.

Then determine the efficiency of Carnot's ideal cycle to able to compare the results to those relating to an ideal machine.

The equipment selected must match the building heat loss and heat gain.

To accomplish this, consideration must be given to the following points:

1. Load calculations must be completed and analyzed.
2. The building must be applied to an equipment performance graph.
3. All the controls must be set at the proper design points.

Q_w 50L/hr is given when Q_w = water flow rate

Time (hr)	$P_{cond.}$ (bar)	$P_{evap.}$ (bar)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
0	5.2	5.8	45	40	6	23	37	42	27	23
0.5	11.8	2.1	84.6	47.6	6.5	21.4	36	46.5	29	18
0.75	12	2.2	87.8	50.9	7	21.7	36.5	51.7	28.3	18.5

When

T_1=temperature of R_{134} at outlet from the compressor.

T_2=temperature of R_{134} at outlet from the condenser.

T_3=temperature of R_{134} at outlet from the expansion valve.

T_4=temperature of R_{134} at outlet from the evaporator.

T_5=temperature of water at inlet to the condenser.

T_6=temperature of water at outlet from the condenser.

T_7=temperature of water at inlet to the evaporator.

T_8=temperature of water at outlet from the evaporator.

The heat transfer from condenser to water:

$Q_c = m^o{}_w \, Cp_w \, (T_{wo} - T_{wi})$

$Q_c = m^o{}_R \, (h_1 - h_2)$

The heat across the evaporator:

$Q_c = m^o{}_R\ (h_4 - h_3)$

The heat across the compressor:

$Q_{comp.} = m^o{}_R\ (h_1 - h_4)$

The Coefficient of performance:

$$COP = \frac{Qr}{Qc - Qr}$$

When Q_R : The heat of evaporator.

Q_c : The heat of condenser.

From $p_c = 12$ bar , $T_c = 45^oC = 45+273=318k$

$p_e = 2.2$ bar , $T_e = -9^oC = -9+273=264k$

The ideal coefficient of performance:

$$COP_c = \frac{Tc}{Tc - Te}$$

The efficiency will be:

$$\Phi = \frac{COP}{COPc}$$ ref. [4], [7], [9].

From p-h diagram, and p_c, p_e at (0.75 hr), see Fig (5) as we see before that.

The heat transfer from condenser to water	3192 kJ/hr
The heat across the evaporator	2462.5 kJ/hr
The heat across the compressor	728.9 kJ/hr
The coefficient of performance	3.3
The ideal coefficient of performance	5.8
The efficiency	56%

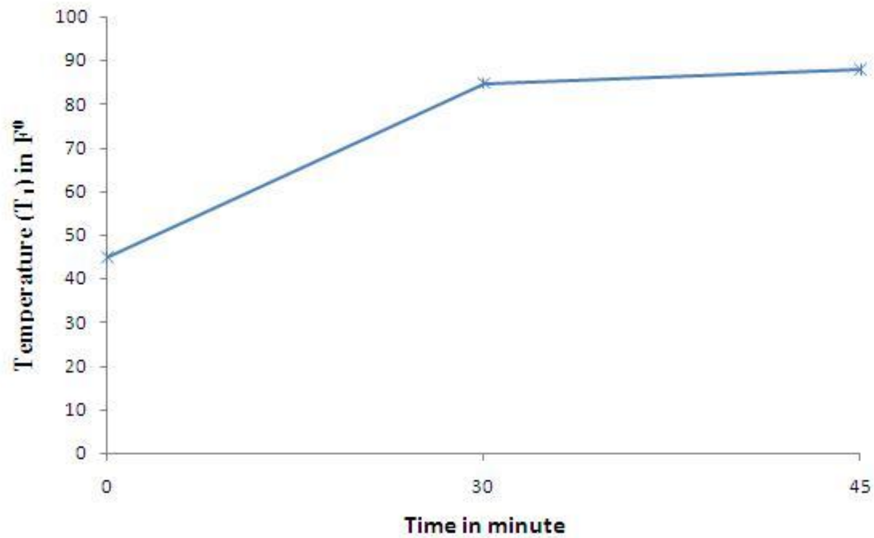

Fig. (6) Shows vary of temp. of R_{134} outlet from compressor due to the varies of time

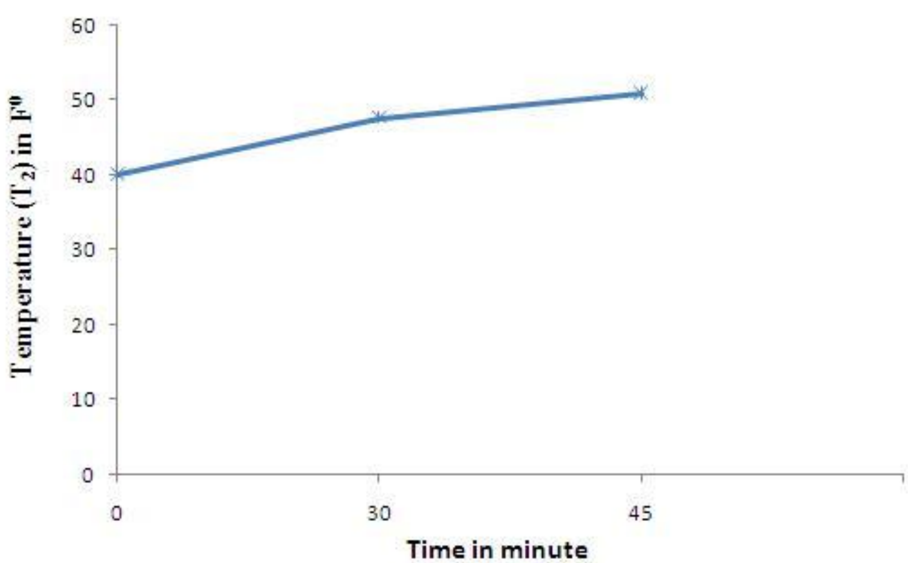

Fig. (7) Shows vary of temp. of R_{134} outlet from condenser due to the varies of time

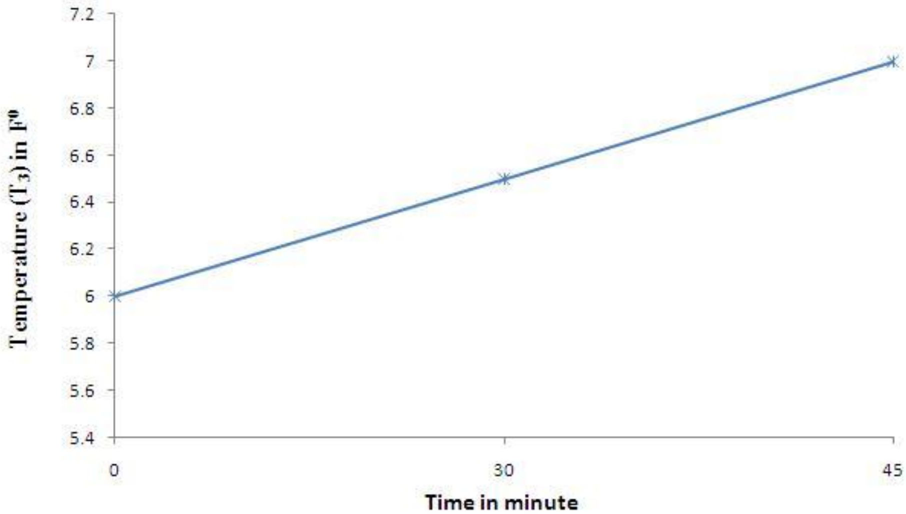

Fig. (8) Shows vary of temp. of R_{134} outlet from expansion valve due to the varies of time

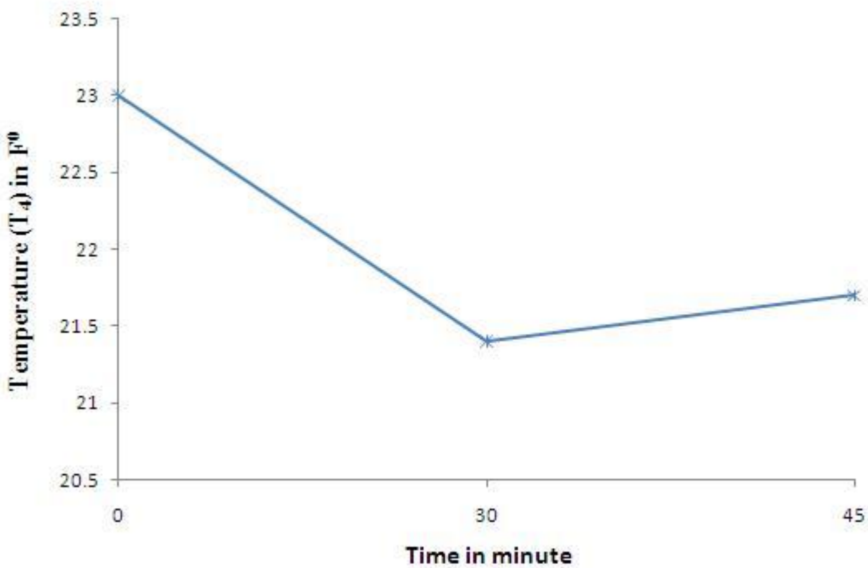

Fig. (9) Shows vary of temp. of R_{134} outlet from evaporator due to the varies of time

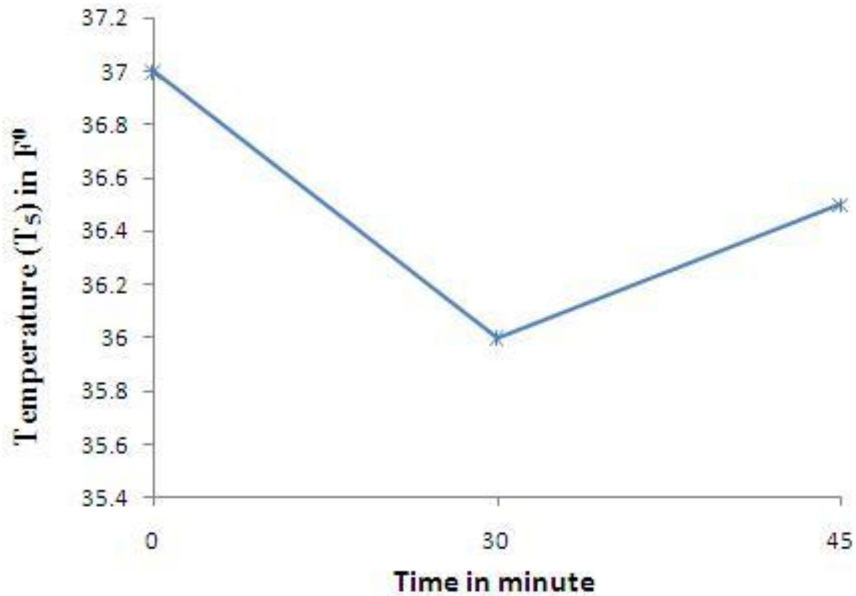

Fig. (10) Shows vary of temp. of water at inlet to the condenser due to the varies of time

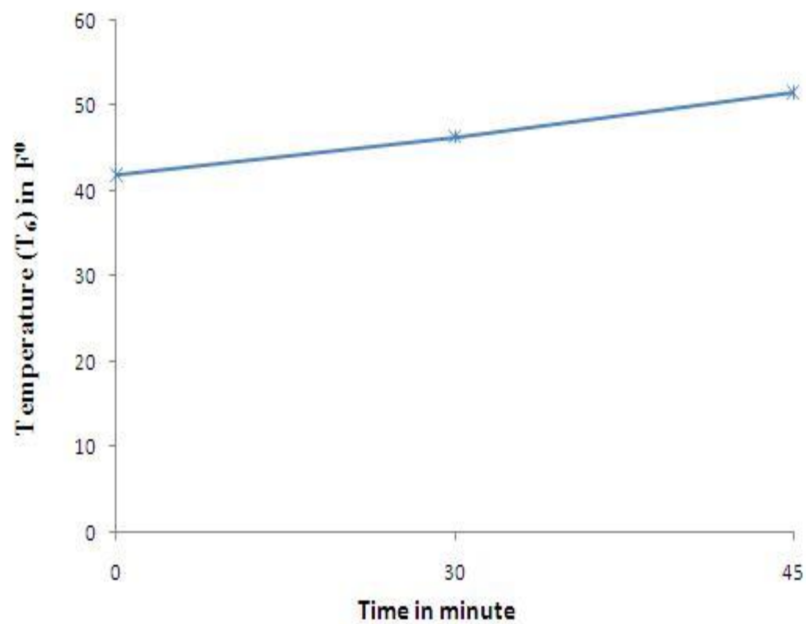

Fig. (11) Shows vary of temp. of water at outlet from the condenser due to the varies of time

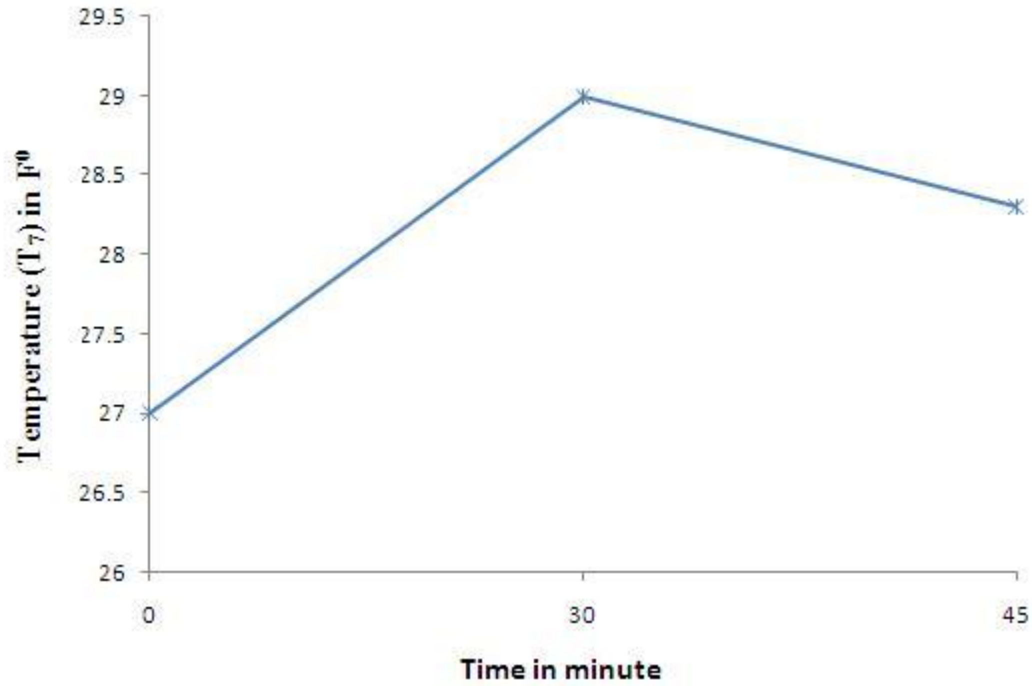

Fig. (12) Shows vary of temp. of water at inlet to the evaporator due to the varies of time

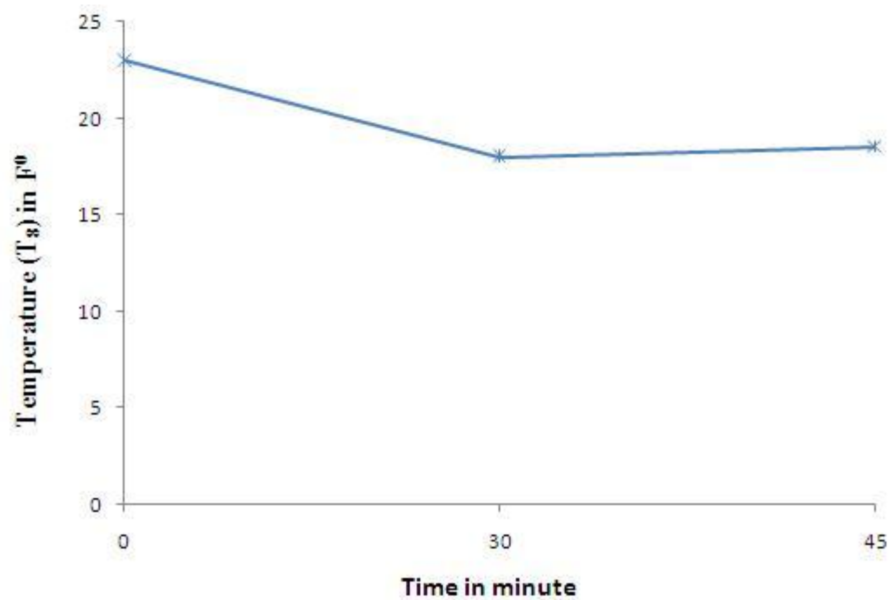

Fig. *(13) Shows vary of temp. Of water at outlet from the evaporator due to the varies of time*

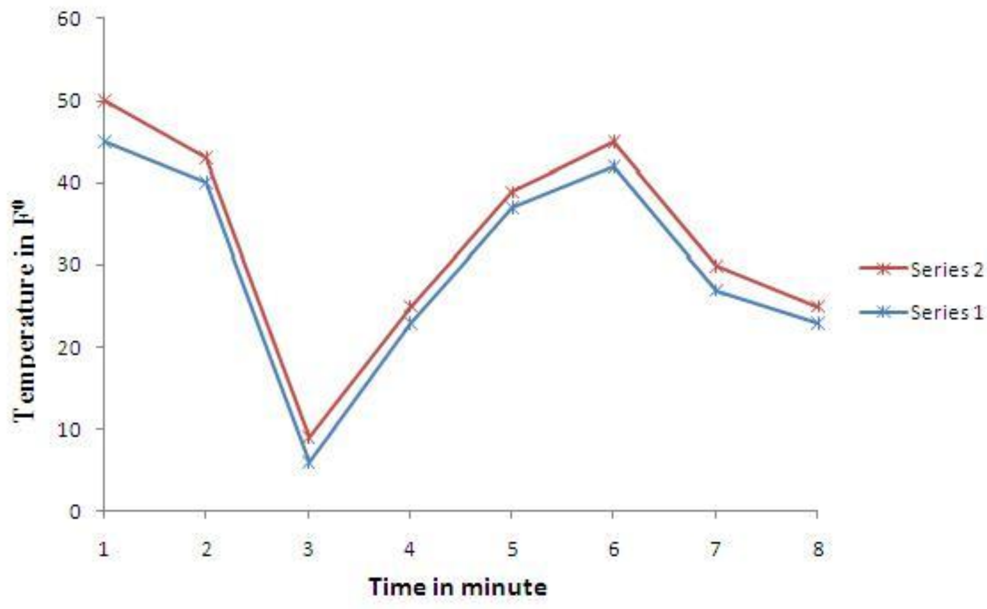

Fig. (14) Shows the comparison between experimental work with E.L.Cuplinskas @ time (0).

Conclusion:

It is convince from the above figures that when the heat pump start running the temperature of Freon gas that is outlet from the compressor was 45^{o}F then it was increased when the heat pump is still running and the time goes on as shown in figure (6) also it was the same case for the Freon gas that is the outlet from the condenser as shown in figure (7) and the Freon gas that it is the outlet from the expansion valve as shown in figure (8).

The temperature of water that outlet from the condenser was increased with the time increasing as shown in figure (11).

For the Freon gas that outlet from the evaporator its temperature was 23^{o}F when the heat pump start running, but when the time goes for 30min. the temperature was decreased to 21.4^{o}F and then for a little while the temperature is increased another time as shown in figure (9) and so for the temperature of the water that it is inlet for the condenser and outlet from the evaporator as shown in figures (10) and (13) respectively.

The temperature of the water that is inlet for the evaporator was 27^{o}F when the heat pump is start running and then when the time is goes on the temperature is increased to 29^{o}F as shown in figure (12).

It is convince when the heat pump still running that the temperature was decreased to 28.3^{o}f after the time goes for 45min.

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