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An Experimental Investigation for Air Conditioning Condenser to Increase the Heat Transfer Rate by Varying the Tube Arrangement

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Abstract*: Refrigeration is the procedure of achieving and maintaining a temperature below that of the surroundings, the aim being to cool some product or space to the required temperature. One of the most important applications of refrigeration has been the preservation of unpreserved food products by storing them at low temperatures. Refrigeration systems are also used broadly for providing thermal console to human beings by means of air conditioning. Whereas Air Conditioning is referred to the treatment of air so as to all together control its temperature, moisture content, cleanliness, odor and circulation, as required by occupants, a process, or products in the space. The subject of refrigeration and air conditioning has evolved out of human need for food and comfort, and its history dates back to centuries. The history of refrigeration is very fascinating since every aspect of it, the availability of refrigerants, the prime movers and the developments in compressors and the methods of refrigeration all are a part of it. In the present work the experimental investigation for air conditioning condenser to increase the heat transfer rate by varying the tube arrangement. In this experiment the Air conditioning cycle test ring is used & the heat transfer rate & C.O.P of air conditioning is measure by varying the tube arrangement of condenser. Air Conditioning is referred to the treatment of air so as to all together control its temperature, moisture content, cleanliness, odor and circulation, as required by occupants, a process, or products in the space. The subject of refrigeration and air conditioning has evolved out of human need for food and comfort, and its history dates back to centuries. The history of refrigeration is very fascinating since every aspect of it, the availability of refrigerants, the prime movers and the developments in compressors and the methods of refrigeration all are a part of it.

***Keywords*: Air Conditioning, Condense, C.O.P. Compressor, Heat transfer, Prime mover.**

1. Introduction

An air conditioner (often referred to as AC) is a home appliance, system, or mechanism designed to dehumidify and extract heat from an area. The cooling is done using a simple refrigeration cycle. In construction, a complete system of heating, ventilation and air conditioning is referred to as "HVAC". Its purpose, in a building or an automobile, is to provide comfort during either hot or cold weather.

A diagram of the refrigeration cycle:

1. Condensing coil,
2. Expansion valve
3. Evaporator coil,
4. Compressor,

In the refrigeration cycle, a heat pump transfers heat from a lower-temperature heat source into a higher-temperature heat sink. Heat would naturally flow in the opposite direction. This is the most common type of air conditioning. A refrigerator works in much the same way, as it pumps the heat out of the interior and into the room in which it stands. This cycle takes advantage of the way phase changes work, where latent heat is released at a constant temperature during a liquid/gas phase change, and where varying the pressure of a pure substance also varies its condensation/boiling point. The most common refrigeration cycle uses an electric motor to drive a compressor. In an automobile, the compressor is driven by a belt over a pulley, the belt being driven by the engine's crankshaft (similar to the driving of the pulleys for the alternator, power steering, etc.). Whether in a car or building, both use electric fan motors for air circulation. Since evaporation occurs when heat is absorbed, and condensation occurs when heat is released, air conditioners use a compressor to cause pressure changes between two compartments, and actively condense and pump a refrigerant around. A refrigerant is pumped into the evaporator coil, located in the compartment to be cooled, where the low pressure causes the refrigerant to evaporate into a vapor, taking heat with it. At the opposite side of the cycle is the condenser, which is located outside of the cooled compartment, where the refrigerant vapor is compressed and forced through another heat exchange coil, condensing the refrigerant into a liquid, thus rejecting the heat previously absorbed from the cooled space.By placing the condenser (where the heat is rejected) inside a compartment, and the evaporator (which absorbs heat) in the ambient environment (such as outside), or merely running a normal air conditioners refrigerant in the opposite direction, the overall effect is the opposite, and the compartment is heated.,

This is usually called a heat pump, and is capable of heating a home to comfortable temperatures (25 °C; 70 °F), even when the outside air is below the freezing point of water (0 °C; 32 °F). Cylinder un loaders are a method of load control used mainly in commercial air conditioning systems. On a semi-hermetic (or open) compressor, the heads can be fitted with unloaders which remove a portion of the load from the compressor so that it can run better when full cooling is not needed. Unloaders can be electrical or mechanical. In this for air conditioning condenser to increase the heat transfer rate by varying the tube arrangement.

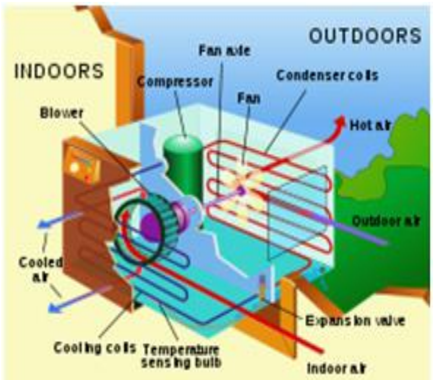

Fig. 1. Typical home air conditioning unit

2. Literature review

"Review Paper on Improving the Heat Transfer Rate of AC Condenser by Optimizing Material" (2017) Assistant Professor. P PRASAD. says that, the majority of the research work focused large chillers. But in this paper discusses the single split air conditioning system using instead of air cooling using liquid based cooling. The coolant used in the heat exchanger pure ethylene glycol. Compare the experimental results value of existing system with new modified system. The compressor running time for the pure ethylene glycol based cooling system is less than the existing system. The compressor's running time is reduced from 44 minutes 30 seconds to 33 minutes and 4 seconds. The required indoor temperature of 18°C is reached in 11minutes 26seconds earlier. It is evident that the time taken for cooling by the modified system is 25.69 % less than that of the existing split air condition system. Time taken for cooling reduces automatically improve the efficiency of the air conditioning system.

Design and Heat Transfer Analysis of AC Condenser for Different Materials" (2015) N. Venkateswarlu says that, the idea behind the proposed system is to design optimization technique that can be useful in assessing the best configuration of a finned-tube condenser. Heat transfer by convection in air cooled condensers. Modeling is done in Pro/Engineer. Heat transfer analysis is done on the condenser to evaluate the material and refrigerant. The materials considered for tubes are Copper and Aluminum alloy 1100 and for fins are 1050 and 1100. The refrigerants varied are R12, R 22 and R 134. 3D modeling is done in Pro/Engineer and analysis is done in Ansys. Air cooled condensers are used in small units like house hold refrigerators, deep freezers, water coolers, window air-conditioners, split air-conditioners, small packaged air-conditioners etc. These are used in plants where the cooling load is small and the total quantity of the refrigerant in the refrigeration cycle is small. Air cooled condensers are also called coil condensers as they are usually made of copper or aluminum coil. Air cooled condensers occupy a comparatively larger space than water cooled condensers. In the present work, the performance analysis of air cooled condensing unit has been carried out by varying the fin material and fin thickness.

At present aluminum alloy 204 is being used for fins. Two fin materials namely, Aluminium alloys 1100 and 6063were considered to study the effect of fin's thermal conductivity on the performance of the condenser. Pro Engineer is used to model the system. For thermal analysis purpose COSMOS Works software is used. Considering different factors for a condenser, such as heat transfer, density etc., Aluminium alloy 1100is found to be the best fin material [2].

" Investigation and Optimization of Air Cooled Condenser of Chillers by Replacing Cu to Al Tubes'' (2015)Prof A. M. Chavan, S. R. Deodas Says that, Compact heat exchanger i.e. round tube plate heat exchangers are commonly employed in vapour compression refrigeration system to exchange heat between refrigerant to environment. A well designed, highly effective air cooled condenser can help to save energy and material cost. Now days, material cost is one of the important issues that should be consider during condenser design. The analytical study was carried out on air cooled condenser of a chiller by using R134a. This paper presents the improvement and development of heat transfer that occurs in the condenser by changing the coil material and also predicts the thermal performance of the condenser. Aluminium is chosen as our material due to cheap, corrosion resistant and good machinability. Use of low cost Aluminium material coil will increase the efficiency of the condenser due to factors such as the specific heat at constant pressure (Cp), overall heat transfer coefficient (U). The present study shows effect on condenser air outlet temperature, condensing temperature, heat rejection rate and on overall heat transfer coefficient and ultimately overall condenser cost.[3]

Optimization of Fin Density of Air Cooled Condenser'' (2018) Devang Thakar says that, the fins industry has been seeking ways to reduce the size and cost of fins. This demand is often justified by the high cost of the high-thermal conductivity metals that are employed in the manufacture of finned surfaces and by the cost associated with the weight of the fin. The reduction in the size and cost of fins is achieved by the enhancement of the heat transfer carried out by the fins. The enhancement of heat transfer from fins has become an important factor that has captured the interest of many researchers. So, if material is considered, large number of works has been conducted to find the best materials for fin.

For example, Srividhya and Venkateswara [1] had compared theheat flux generation for three types of Aluminum and concluded that Al 6063 must be preferred over other Aluminum alloys. Extending their work Khadimali [5] and Arunakumari altered the material of both Tubes and Fins.They recorded that Copper tubes proven best with Al 6063instead of Aluminum tubes, which are lighter and cheaper when compared with copper.Some of the researchers not only worked on material but also varied the refrigerants in the system likewise a paper by Mallikarjun and Anandkumar [9] includes the comparisons of HCFC and R 404 with the former materials i.e. Al 1100, Al 6063 and Magnesium and leaded to the conclusion that Thermal flux is more when Aluminum alloy 6063 is used for fin and refrigerant used is R 404 than other combinations. The comparison of R12, R22 and R134a has also been done by Mr. Bhimesh and Vankateshwarlu [2] who in their analysis found that R 22 gives maximum heat flux and hence have better heat transfer. Although R 22 because of its toxic properties may get phased out by 2020 as it was banned in many countries in 2015 and we must rely on some of the new blends of refrigerant. R 404A is a blend of HFC refrigerants commonly used for medium and low temperature refrigeration applications. Its composition comprises: HFC- 125 (44%), HFC-143a (52%), HFC-134a (4%). It is nontoxic and non-flammable and gives better heat transfer at condenser side which is negotiated by Raghu Babu and Srikanth [4]. Even some researchers tried to enhance the heat transfer by using colloidal solutions which are called nanofluids. Henderson and Jacobi [10] evaluated that if R134a is used with 0.04% CuO volume fraction the average heat transfer is improved by 52% which is great achievement in the field of heat transfer and Refrigeration. Recently M.A. Al Nimr and Kiwan [11] suggested that thermal performance of fin can be enhanced by using porous fins alternative to conventional solid fins. It increases the initial designing cost but proven to save about 70% of fin material. One of the experimental investigation shows that the creation of turbulence of air on fin by providing vortex generators is also one of the techniques for improving heat transfer suggested by Kumar and Choube [8]. Stewart [3] and his team also found that heat transfer rate also gets affected by some of the geometric parameters like width of condenser, vertical and horizontal tube spacing, number of rows and diameter of tube. Their result shows that the condenser with single row and smaller size gives best performance and aspect ratio must be kept higher in order to reduce number of tube bends which in turn reduces the pressure drop. Mostafa and Elbooz [7] presented the case where a new type of tube called Extruded Micro channel Flat Tube made of Aluminum with flat tube profile was used for improving the Heat Transfer Coefficient. The optimization of circuits of flow of refrigerant, using staggered fin structure for reducing the bypass factored utilization of HTC Porous Carbon foam as a fin material are some other identified methods of improving effectiveness of condenser which are suggested by various researcher's engine [4].

3. Problem definition and solution

1) Problem definition

In the light of the review of literature studied on Air cooled air conditioning condenser it is seen that the problem of heat transfer from condenser surfaces has been studied Theoretical calculations are done to determine heat transfer rate & C.O.P of air conditioning condenser and experimentally by a number of investigators. It is observed in the literature that no one investigators work on the orientation of the air cooled condenser by varying the tube arrangement of the condenser. Therefore, present work is decided to Experimental investigate of the air cooled condenser by varying the condenser arrangement. The performance of the air cooled condenser in horizontal, vertical and inclined arrangement. This Experiment is performed on the Air conditioning Cycle test.

2) Solution

Thus, in the present day investigation on thermal issues on Air Conditioning Condenser are carried out. The main of aim of this work is to study various researches done in past to improve heat transfer rate of Air Conditioning Condenser by changing different materials & Parametric Design optimization.

We will change or Varying the tube arrangement and investigation on thermal analysis on air conditioning condenser to increase the heat transfer rate

3) Objective

The objectives of the present work are:

- Experimental investigation of the performance of Air Conditioning Condenser.
- To increase the heat transfer rate from the Air conditioning condenser surface to the surrounding.
- To compare the heat transfer rate & C.O.P of Air conditioning condenser with the Varying the tube arrangement of condenser.
- To predict the arrangement of Air conditioning condenser for maximum heat transfer rate.

4) Need of project

Most of the researcher carried out investigation and optimization of air cooled condenser by varying the various effecting parameters such as fin spacing, fin thickness, diameter of tubes number of tube circuit etc. the current study proposed to predict the thermal performance of air cooled condenser by varying the tube arrangement air conditioning condenser.

5) Facilities required for work

1. Compressor
2. Evaporator coil
3. Condenser coil
4. Expansion valve
5. Blower
6. Fan
7. Refrigerant R134-a

6) Parametric measurements and instrumentation

1. Pressure gauge
2. Meter gauge
3. Temperature measurement

4. Psychrometer
5. Air velocity(Anemometer)

7) Technical Specifications of Air Conditioning

Table 1
Technical Specifications of Air Conditioning

Compressor	Hermetically sealed
Condenser	Force convection air cooled
Drier / Filter	Provided
Refrigerant flow measurement	Glass tube Rotameter
Expansion device	Capillary tube
Energy meter	Provided
Condenser fan	Axial flow type
Evaporator fan	Axial flow type
Heater	1000Watt finned type
Temperature indicator	6channel facility with digital display
HP/LP	Provided
Pressure gauges	2nos

Table 2
Standard Values and Formulae

Standard Barometric pressure	1.013 bar= 1.103×10^5 N/M^2
Density of manometric Liquid (Water)	1000 Kg/m^3
Gas Constant for air	0.287KJ/ kg K
Specific gravity of R134a at 40 C	1.2
1 Ton of Refrigeration effect	3500 watts= 3.5KJ/s
Density of air at 25 C	1.1kg/m^3

8) Procedure of experimentation

In the present work enthalpy difference method is used.

Connect the supply cable to regulated /stabilized power supply.

1. Switch ON the main switch.
2. Put ON the AHU fan
3. Record the DBT &WBT at the inlet and outlet of the duct. (Ensure that the well of WBT is filled with water.)
4. Switch ON the compressor
5. Allow the system to reach steady state. (Run for 20 min)
6. Record the air temperatures at inlet and outlet (DBT& WBT) use digital indicator.
7. Record the Energy meter reading.
8. Record suction and discharge pressures.
9. Record rotameter reading, refrigerant temperature at various location viz., before &after compression and before &after expansion.
10. Measure velocity head with the help of manometer at inlet of ducting.
11. Take the reading 15-20 minutes after starting cooling.
12. Repeat the above procedure by varying the condenser tube arrangement. that is vertical condenser arrangement and inclined condenser tube arrangement.

9) Experimental Setup

The Experimental set up is as shown in the fig. 1.

Fig. 1. Air conditioning cycle test

10) Observations table

When the Air conditioning condenser at horizontal arrangement

After performing the test following observations were recorded.

Calculation from Experimental Data

Here only first reading calculation are given

11) Tonnage Capacity of the Air Conditioning Cycle test

i. Inlet condition = 28 ℃ ,WBT =23 ℃

ii. Outlet condition = 21℃, WBT = 19℃

iii. Inlet Enthalpy H1= 87.5KJ/ kg

iv. Outlet Enthalpy H2 =69 KJ/ kg

v. Enthalpy difference

= H1 - H2

=87-6

= 18.5 KJ/Kg.

vi. Head of Liquid

= 1 mm of liquid column

= 1×10^{-3} meters of liquid column

vii. Head of air h_a

$= \rho_w \times h_w / \rho a$

ρ_w=Specific Density of manometer liquid = 0.81×10^3 Kg/m^3

h_w= Head of liquid

ρa= density of air

$$h_a = \frac{810\times h_w}{1.1} = \frac{0.81\times h_w}{1.1} = \frac{0.81\times1}{1.1}$$

=736 mm=0.736m

viii. Velocity of air V_a

$=\sqrt{2gha}$

$= \sqrt{(2\times9.81\times0.736)}$

V_a =3.8 m/s

ix. Air outlet section area A=0.051 m^2

x. Volume flow rate of air

$Q=V_a \times A$

Table 3
Air conditioning condenser at horizontal position

S. No.	Inlet air Temperature		Outlet air Temperature		P1 (Psi)	P2 (Psi)	R-134a refrigerant Temperature				Time for 10pluse of energy meter (Sec)	Mano meter Reading (mm of liquid)
	DBT 1	WBT 1	DBT 2	WBT 2			T1	T2	T3	T4		
1	28	23	21	19	18	145	-7	42	36	-10	16	7
2	28.5	23.5	21	19	23	153	-4	45	38	-10	15	7
3	29	24	21.5	20	23	153	-4	45	38	-10	17	7

= 38 ×0.051

=0.1938 m^3/s

xi. Mass flow rate of air

M_a = volume flow rate × density of air

= Q × ρ_a = 0.1938×1.1,Ma= 0.2132 kg/s

xii. Refrigeration effect (actual)

N = mass flow rate ×Enthalpy difference

= M_a × (H1-H2)

= 0.2132×18.5

N= 3.9442 KJ/s

xiii. Tonnage capacity

$$TR= \frac{N}{3.5}=\frac{3.9}{3.5}$$

= 1.11 TR.

12) Actual C.O.P of the system

Compressor Work

W= ((10×3600))/((t×3200))

= ((10×3600))/((16×3200))

=0.70 Kw

Actual COP = (Actual Refrigeration effect (N))/(Actual compressor Work (W))

= 3.94/0.70

Actual COP = 5.62

13) Actual Heat rejected in the Condenser (Qh)

Tc =45 0 + 273 = 318 K

T ∞= 380 C + 273= 311 K

= M Cp(Tc - T ∞)

= 0.2132×1.005×(318-311)

(Qh) = 1.4998 KW

14) Theoretical C.O.P. of the System

To Evaluate of theoretical C.O.P. of the system, carry out following procedure

- For any set of reading at a particular time, note suction pressure and discharge pressure in psi g.
- Divide these pressure by 14.5 to convert them into bar.
- Add barometric pressure of the present location obtain absolute pressure in bar.
- Locate this pressure on Y axis of P-H chart. Draw two horizontal lines, one for low pressure and one for high pressure.
- Locate particular temperature on these lines and mark 1,2,3,4.
- Find out at salient points by referring to X axis of P-H chart.
- Calculations for R134-a were made with the help of P-h chart and Psychrometric chart. Sample calculations for first reading are as follow:

Enthalpies of refrigerant at salient points from p-h chart of Refrigerant R134-a are

Enthalpy of refrigerant at inlet of compressor

=h1 =412.10 KJ/kg

Enthalpy of refrigerant at outlet of compressor

= h2 =429.48 KJ/kg

Enthalpy of refrigerant after condensation

= h3 = 263.38KJ/kg

Enthalpy of refrigerant after expansion

= h4 = 263.38KJ/kg

Theoretical refrigerant effect

(N)=h1-h4

=(412.10-263.38)

= 48.72 KJ/kg

Theoretical compressor work

W= h2- h1

= (429.48-412.10)

= 17.38KJ/kg

Coefficient of performance

C.O.P=N/W

= 8.5569

Capacity of the system

= 1.5 TR

= 1.5x 3.5 kW

= 5.25kW

Mass Flow Rate

= Capacity in kW/(h1-h4)

= 5.25/ (412.10-263.38)

ma= 0.03530 kg/sec

Heat rejected in the Condenser (Qh):

Qh=m x (h2- h3)

=0.040(429.48-263.38)

Qh=5.8135 KW

Refrigerant effect (RE)

= ma (h1-h4)

= 0.03530 (412.10-263.38)= 5.20KJ

15) When air conditioning condenser at vertical arrangement

After performing the test following observations were recorded.

Sample calculation of table 3 of first reading are given above.

Similarly you can calculate all the reading of the table 4 .

16) Observations Table of when condenser inclined arrangement

After performing the test following observations were recorded.

Table 4
Air conditioning condenser at vertical position

S. No.	Inlet air Temperature		Outlet air Temperature		P1 (Psi)	P2 (Psi)	R-134a refrigerant Temperature				Time for 10pluse of energy meter (Sec)	Mano meter Reading (mm of liquid)
	DBT 1	WBT 1	DBT 2	WBT 2			T1	T2	T3	T4		
1	30	25	23	21	40	182	6.5	50	39	-10	20	7
2	30	25	22.5	21	40	182	6.5	50	39	-10	19	7
3	29	24.5	22	20.5	34	174	3.27	49	38	-10	17	7

Table 5
Air conditioning Condenser is in Inclined Position at an Angle of 45^0

S. No.	Inlet air Temperature		Outlet air Temperature		P1 (Psi)	P2 (Psi)	R-134a refrigerant Temperature				Time for 10pluse of energy meter (Sec)	Mano meter Reading (mm of liquid)
	DBT 1	WBT 1	DBT 2	WBT 2			T1	T2	T3	T4		
1	31	26	23.5	22	52	214	12.33	58	41	-10	20	7
2	30.5	26	23.5	22	52	214	12.7	58	41	-10	19	7
3	30.5	26	23.5	22	44	204	8.87	55	40.5	-10	19	7

Sample calculation of table 3 of first reading are given above. Similarly you can calculate all the reading of the table 5.

17) Experimental results

The experimental results are shown in the following table.

Table 6
Result Table

Position of condenser	Horizontal	Vertical	Inclined
$COP_{theoretical}$	8.55	8.26	9.86
COP_{actual}	5.62	7.75	7.91
Heat Rejected $(Qh)_{theoretical}$ in kw	5.81	5.76	5.8
Heat Rejected $(Qh)_{actual}$ in kw	1.49	2.35	3.64
R.E. theoretical KJ/sec	5.2	5.1616	5.362
R.E. actual	3.9442	4.3492	4.4772

From the Experimental result, we conclude that by varying the air conditioning condenser tube, increase the C.O.P and heat transfer rate and the Comparison as shown in the following graph.

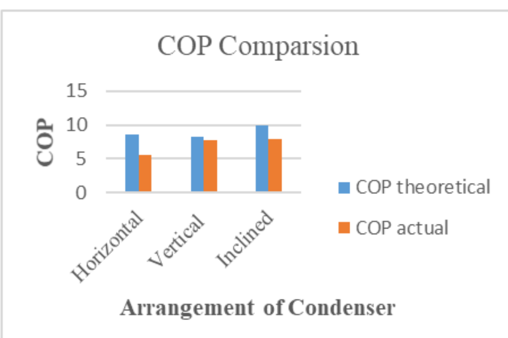

Fig. 2. Chart No. 1 COP Comparison

The minimum cop is 5.62 in horizontal condenser arrangement of the system and the maximum cop is 7.91 in inclined condenser arrangement of the system.

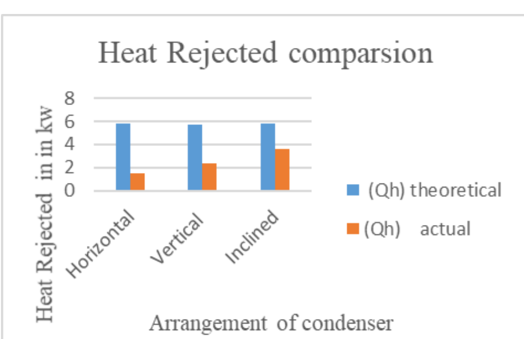

Fig. 3. Heat rejected comparison

It observed that, the actual heat rejected in horizontal condenser arrangement is 1.49 KW and in vertical condenser arrangement is 2.35 KW. The actual heat rejected in inclined condenser arrangement is 3.6 4KW. Theoretical heat rejected in horizontal, vertical, inclined, condenser arrangement is, 5.81KW, 5.76KW, 5.8KW respectively .

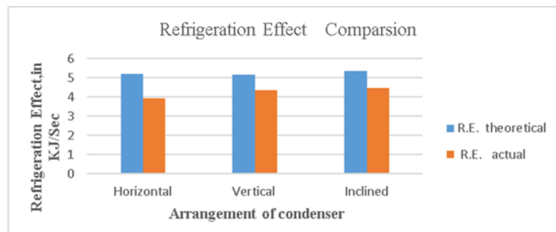

Fig. 4. Refrigeration effect comparison

The Actual refrigeration effect in horizontal condenser arrangement is 3.9442 KJ/sec and in vertical condenser arrangement is 4.3492 KJ/sec The Actual refrigeration effect in inclined condenser arrangement is 4.4772 KJ/sec. Theoretical refrigeration effect in horizontal, vertical, inclined, condenser arrangement is, 5.2 KJ/sec, 5.1616 KJ/sec, 5.362 KJ/sec respectively.

4. Conclusion

During experimental investigation, it is found that, the performance all parameter of the varying condenser tube arrangement of air conditioning is better than the Horizontal and vertical tube arrangement of the condenser. In the present work the varying condenser tube of air conditioning at an angle of 45^0 that is inclined tube arrangement of the condenser .it is observed that The co-efficient of performance that is COP of the system is higher than the horizontal and vertical tube arrangement of the condenser.

It observed that, COP (actual) of the system in horizontal condenser arrangement is 5.62 & in vertical condenser arrangement is 7.75. The cop of the system in inclined condenser arrangement is 7.79. The cop of the system is increased in vertical condenser arrangement of the system that is 2.13 as compared to the horizontal condenser arrangement of the system. The maximum cop of the system is obtained in the inclined condenser arrangement of the system is 7.79. The cop increased in inclined condenser arrangement is 0.16 as compared to the vertical condenser arrangement. The minimum cop is 5.62 in horizontal condenser arrangement of the system and The maximum cop is 7.91 in inclined condenser arrangement of the system.

The actual Refrigeration Effect is in inclined condenser arrangement of the system is higher than horizontal and vertical condenser arrangement of the air conditioning. .it observed that, The Actual refrigeration effect in horizontal condenser arrangement is 3.9442 KJ/sec and in vertical condenser arrangement is 4.3492 KJ/sec The Actual refrigeration effect in inclined condenser arrangement is 4.4772 KJ/sec.

The Actual refrigeration effect is increased in vertical condenser arrangement of the system that is 0.405 KJ/sec as compared to the horizontal condenser arrangement of the system. The maximum Actual refrigeration effect is obtained in the inclined condenser arrangement of the system that is 4.4772 KJ/sec. The Actual refrigeration effect increased in inclined condenser arrangement is 0.128 KJ/sec as compared to the vertical condenser arrangement. The Actual refrigeration effect increased in inclined condenser arrangement is 0.533 KJ/sec as compared to the Horizontal condenser arrangement. The Minimum Actual refrigeration effect is 3.9442 in horizontal condenser arrangement of the system and R Maximum Actual refrigeration effect is 4.4772 in inclined condenser arrangement of the system.

During Experimental, it is observed that, the heat transfer rate of varying i.e. inclined condenser tube arrangement of air conditioning is higher than the horizontal and vertical tube arrangement of the condenser air conditioning. the varying tube condenser reject the more heat than the horizontal and vertical tube arrangement of the condenser air conditioning. it observed that, heat rejected in horizontal condenser arrangement is 1.49 KW & in vertical condenser arrangement is 2.35 KW. The actual heat rejected in inclined condenser arrangement is 3.6 4KW.

The actual heat rejection rate is increased in vertical condenser arrangement of the system that is 0.86 KW as compared to the horizontal condenser arrangement of the system. The maximum actual heat rejection rate is obtained in the inclined condenser arrangement of the system that is 3.64 KW. The actual heat rejection rate increased in inclined condenser arrangement is 1.29 KW as compared to the vertical condenser arrangement. The actual heat rejection rate increased in inclined condenser arrangement is 2.15 KW as compared to the Horizontal condenser arrangement. The minimum actual heat rejection rate is 1.49 KW in horizontal condenser arrangement of the system and The maximum actual heat rejection rate is 3.64 KW in inclined condenser arrangement of the system

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