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Modification and Analysis of Conventional Air Conditioning "Subcooling Effect by Mix of Glycerin and H_2O"

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ABSTRACT

Increasing the coefficient of performance of conventional air conditioning system by adopting the method of sub cooling. Due to sub cooling the saturated liquid at the outlet of condenser is sub cooled which will results in increase in the refrigerating effect. The sub cooling is done by extracting the heat from condenser by employing the tubing (Heat exchanger) between the fan and the condenser. The tubing is placed parallel to the condenser and the fan blows the cool air from the tubing. Tubing consists of combination of partial refrigerant taken from the evaporator outlet and the coolant which is circulated using a pump. This will result in extraction of extra amount of heat from the refrigerant owing through the condenser. Hence the sub cooling is achieved. This will also ensure the constant supply of refrigerant in saturated vapour phase in the compressor and hence the compressor life will increase providing higher overall efficiency of the system. The use of coolant for condenser cooling shows positive response. By implementing this kind to reforms in the conventional air conditioning system we can increase the coefficient of performance and also increase the power saving of the conventional air conditioning system. The average cop improved obtained to be 50 percent so that Power consumption is reduced by 20-25 percent.

INTRODUCTION

Air conditioning systems control the temperature, humidity, air movement and air cleanliness inside a building, in order to provide occupants a comfortable environment with good indoor air quality. An air conditioning system, or a stand-alone air conditioner, provides cooling and humidity control for all or part of a building. Air conditioned buildings often have sealed windows, because open windows would work against the system intended to maintain constant indoor air conditions. Outside, fresh air is generally drawn into the system by a vent into the indoor heat exchanger section, creating positive air pressure. The percentage of return air made up of fresh air can usually be manipulated by adjusting the opening of this vent. Typical fresh air intake is about 10%. Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection, or conduction. Refrigeration conduction media such as water, air, ice, and chemicals are referred to as refrigerants. A refrigerant is employed either in a heat pump system in which a compressor is used to drive thermodynamic refrigeration cycle, or in a free cooling system which uses pumps to circulate a cool refrigerant (typically water or a glycol mix).

ELEMENTS OF AIR CONDITIONING SYSTEM

The main components of any air conditioning system are as follows **(Figure 1)**:-

- Compressor
- Condenser
- Condenser
- Expansion Valve

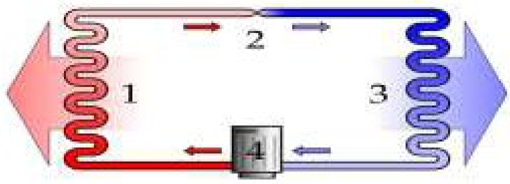

Figure 1. Parts of air-conditioning system.

COMPRESSOR

The purpose of the compressor is to circulate the refrigerant in the system under pressure; this concentrates the heat it contains. The compressor has reed valves to control the entrance and exit of refrigerant gas during the pumping operation. These must be _rmly seated. There are three types of compressor which are commonly used:

- Reciprocating compressor
- Rotary compressor
- Centrifugal compressor

CONDENSER

A condenser is a device or unit used to condense a substance from its gaseous to its liquid state, typically by cooling it. In so doing, the latent heat is given up by the substance, and will transfer to the condenser coolant. Condensers are typically heat exchangers which have various designs and come in many sizes ranging from rather small (hand-held) to very large industrial-scale units used in plant processes. For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers the condenser removes the heat from refrigerant carried from evaporator and heat added by compressor and converts the vapor refrigerant into liquid refrigerant. The condenser is classified on the basis of:-

- Air cooled condenser
- Earth cooled condenser (Geothermal Heat Pumps
- Water cooled condenser
- Combination of air and water cooled condenser (Evaporative condensers)

EVAPORATOR

He evaporator works the opposite of the condenser, here refrigerant liquid is converted to gas, absorbing heat from the air in the compartment .When the liquid refrigerant reaches the evaporator its pressure has been reduced, dissipating its heat content and making it much cooler than the fan air owing around it. This causes the refrigerant to absorb heat from the warm air and reach its low boiling point rapidly. The refrigerant then vaporizes, absorbing the maximum amount of heat. This heat is then carried by the refrigerant from the evaporator as a low-pressure gas through a hose or line to the low side of the compressor, where the whole refrigeration cycle is repeated. Evaporator removes heat from the area that is to be cooled. The desired temperature of cooling of the area will determine if refrigeration or air conditioning is desired. For example, food preservation generally requires low refrigeration temperatures, ranging from 40F (4°C) to below 0F (-18°C). A higher temperature is required for human comfort. A larger area is cooled, which requires that large volumes of air be passed through the evaporator coil for heat exchange. A blower becomes a necessary part of the evaporator in the air conditioning system. The blower fans must not only draw heat-laden air into the evaporator, but must also force this air over the evaporator _ns and coils where it surrenders its heat to the refrigerant and then forces the cooled air out of the evaporator into the space being cooled.

EXPANSION VALVE

The expansion valve also known as capillary tube is the expansion device which reduces the pressure and temperature of the refrigerant before entering the evaporator.

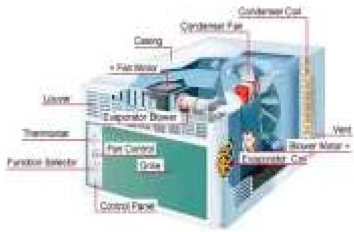

Figure 2. Air conditioning system.

LITERATURE REVIEW

In the most general sense, air conditioning can refer to any form of technology that modifies the condition of air (heating, cooling, (de-)humidification, cleaning, ventilation, or air movement). However, in construction, such a complete system of heating, ventilation, and air conditioning is referred to as HVAC (as opposed to AC) [1]. The basic concept behind air conditioning is said to have been applied in ancient Egypt, where reeds were hung in windows and were moistened with trickling water **(Figure 2)**. The evaporation of water cooled the air blowing through the window. This process also made the air more humid, which can be beneficial in a dry desert climate. In Ancient Rome, water from aqueducts was circulated through the walls of certain houses to cool them. Other techniques in medieval Persia involved the use of cisterns and wind towers to cool buildings during the hot season. In 1758, two chemistry professors of Cambridge University, Benjamin Franklin and John Hadley, conducted an experiment to explore the principle of evaporation as a means to rapidly cool an object [2]. They suggested that evaporation of highly volatile liquids such as alcohol and ether could be used to bring down the temperature of an object below the freezing point of water. In their experiment, in which they used the bulb of a mercury thermometer with bellows (used to quicken evaporation), they lowered the bulb temperature up to -14°C while the ambient temperature was 18°C. Franklin concluded, "From this experiment one may see the possibility of freezing a man to death on a warm summer's day"[3] Evaporative cooling was the first method to de used for real air-conditioning. And shortly after that the first private home to have an air conditioning (The Dubose House) was built in Chapel Hill, North Carolina in 1933. David St. Pierre DuBose realized that air conditioning would one day be a necessary feature of all private homes; he designed an ingenious network of ducts and vents. Meadow Mont was the first private house in the United States equipped with central air conditioning system [4]. Hence from the above data we could say that achieving sub-cooling has been the prime motto of all researchers and for this purpose the condenser cooling has to be increased. In Oct 2013 it is reported by ASCER and ITC [5] that air conditioning system using developed an innovative thermal conditioning panel made of ceramic material, which can control the climate of any room easily, sustainably and energetically efficient.

CONCLUDING REMARKS

1. The Book of Refrigeration and air-conditioning by Domkundwar, Provides us the system or technology which modifies the atmospheric air with respect to temp, cleaning moisture and flow controls [6].
2. The Book on "Refrigeration and air-conditioning" by "S.C Arora" provides the idea by adding earth tube heat exchanger in conventional ac increases the COP of the system [7].
3. William C Whitman, "on performance of air conditioner system" reveals that COP of the system is increased by around 5-6% [8].
4. Perry RH, et al. reveals that less input is required to run the air conditioner and also CFC emission is less [9].
5. "Earth Air Tubes on Sugar Mountain Farm". SugarMtnFarm.com. 2012, Increases the COP of the conventional air conditioner system [10].
6. Report by Spanish Association of Manufacturers of Ceramic Tiles and Pavements (2013) Gives information about how speed factors influence the COP of air conditioner systems like fans, pump [11].

THEORETICAL ANALYSIS

In our project we have taken the temperature of different points like condenser inlet-outlet, compressor inlet-outlet, wet bulb, dry bulb temperature, room temperature etc. We also calculated the humidity with the help of wet bulb and dry bulb temperature.

After introducing the coolant in heat exchanger the temperature of same points and also taken the coolant temperature rise during the heat absorption. We also measured the power consumption for conventional as modified air conditioner.

PSYCHROMETRY

Psychrometry is the study of atmospheric air and its associated Water vapour. Air comprises a mixture of gases of which nitrogen makes up 78%, oxygen 21% and carbon dioxide and the inert gases (such as argon, neon, krypton, helium etc.) the remainder. These are known as the dry gases of the atmosphere.

DRY AIR

The dry air is considered as a mixture of nitrogen and oxygen neglecting the small percentages of small gases. Volumetric composition of air is 79% nitrogen and 21% oxygen. The molecular weight of dry air is taken as 29 approximately.

MOIST AIR

It is mixture of dry air and moist air. The quantity of water vapor present depends on the temperature of air and its quantity may change from zero to maximum.

DRY BULB TEMPERATURE

The dry-bulb temperature (DBT) is the temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture. DBT is the temperature that is usually thought of as air temperature, and it is the true thermodynamic temperature. As a matter of fact, it indicates the amount of heat in the air and it is directly proportional to the mean kinetic energy of the air molecules **(Figure 3)**. Temperature is usually measured in degrees Celsius (C), Kelvin (K), or Fahrenheit (F).

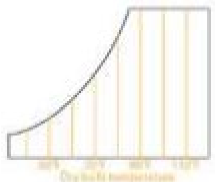

Figure 3. Dry bulb temperature.

WET BULB TEMPERATURE

The wet-bulb temperature is the temperature a parcel of air would have if it were cooled to saturation (100% relative humidity) by the evaporation of water into it, with the latent heat being supplied by the parcel. A wet-bulb thermometer will indicate a temperature close to the true (thermodynamic) wet-bulb temperature **(Figure 4)**. The wet-bulb temperature is the lowest temperature that can be reached under current ambient conditions by the evaporation of water only.

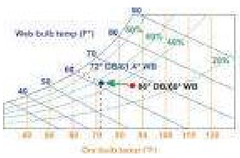

Figure 4. Wet bulb temperature.

DEW POINT TEMPERATURE

Newline The dew point is the temperature at which the water vapor in a sample of air at constant barometric pressure condenses into liquid water at the same rate at which it evaporates. At temperatures below the dew point, water will leave the air **(Figure 5)**. The condensed water is called dew when it forms on a solid surface. The condensed water is called either fog or a cloud, depending on its altitude, when it forms in the air.

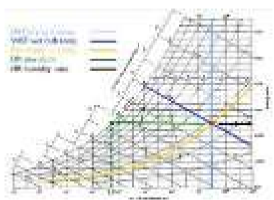

Figure 5. Dew point temperature.

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SPECIFIC HUMIDITY RATIO

Specific humidity ratio denoted by "is defined as the ratio of the mass of the water vapor to the mass of dry air in the given volume of mixture.

RELATIVE HUMIDITY

Relative humidity (abbreviated RH) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at the same temperature **(Figure 6)**. Relative humidity depends on temperature and the pressure of the system of interest.

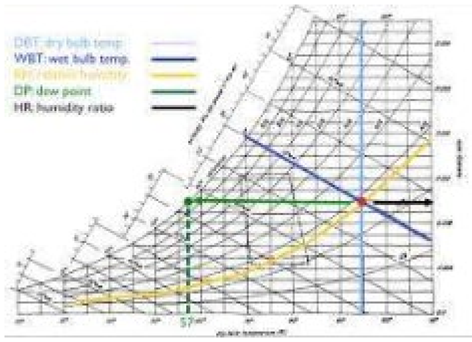

Figure 6. Relative humidity.

SENSIBLE HEAT

Sensible heat is heat exchanged by a body or thermodynamic system that changes the temperature, and some macroscopic variables of the body, but leaves unchanged certain other macroscopic variables, such as volume or pressure. The term is used in contrast to a latent heat, which is the amount of heat exchanged that is hidden, meaning it occurs without change of temperature **(Figure 7)**.

LATENT HEAT

Latent heat is energy released or absorbed, by a body or a thermodynamic system, during a constant-temperature process. An example is a s tate of matter change, meaning a phase transition, such as ice melting or water boiling. The latent heat of ice 335KJ/Kg and the latent heat of vaporization of water at 1000°C and at atm is 2257 KJ/Kg.

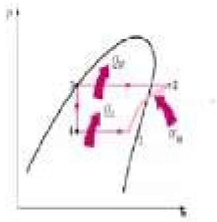

Figure7. pH diagram.

TOTAL HEAT

It is the sum of latent heat and sensible heat of water vapor associated with dry air Total heat=sensible heat+ latent heat TH=SH+LH.

THEORY OF IDEAL AND ACTUAL VAPOUR REFRIGERATION CYCLE

Air conditioning (often referred to as air on, AC or A/C) is the process of altering the properties of air to more favorable conditions. More generally, air conditioning can refer to any form of technological cooling, heating, ventilation, or disinfection that modifies the condition of air [9].

BASIC PROCESSES

A vapour compression cycle has four stages. It is explained with P-H and T-S diagram as shown in **Figures 8 and 9**. The working fluid usually used in commercial AC is R-22, R-12, R-11, R410 etc. as per availability.

- **Process 1-2:** The saturated vapor received after evaporator is compressed adiabatically in hermitically sealed compressor. In compressor the refrigerant compressed to higher desired pressure. Work is done by compressor, due to compression the temperature raises and the enthalpy of refrigerant is increased. so, Work done by compressor= (h2 - h1).

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- **Process 2-3:** The refrigerant which is compressed in the compressor at high temperature and pressure. Hence the refrigerant is cooled at constant pressure in the condenser by forced convection with ambient air. That results to decrease the enthalpy of the refrigerant. So, Heat loss by condenser = h2 -h3.

- **Process 3-4:** The refrigerant coming out from the condenser at ambient temperature and high pressure in saturated liquid phase is expanded in the expansion valve there by refrigerant converted into very low temperature and low pressure. So, in Expansion valve enthalpy is constant (h3 = h4).

- **Process 4-1:** The refrigerants are at low temperature and low pressure and in wet condition received from expansion valve, pass through the evaporator coil. The refrigerant absorbs heat of vaporization in evaporator at constant pressure and turns to saturated vapour. So, Heat gain by refrigerant in evaporator= (h1-h4).

Cop of conventional Ac= (h1-h4)/(h2-h1)

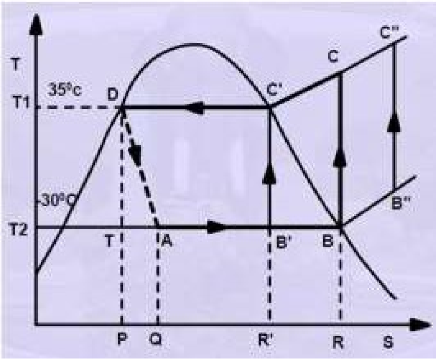

Figure 8.T-s diagram showing comparison with carnot cycle.

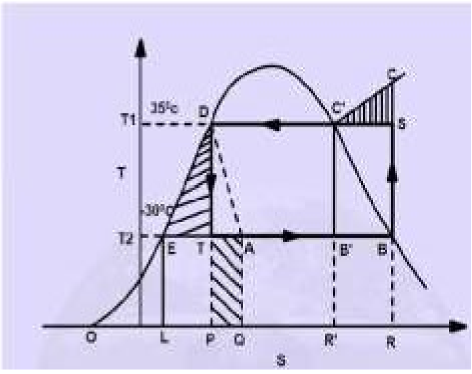

Figure 9. T-s diagram showing comparison with carnot cycle.

MODIFIED AC CYCLE

- **Process 1-2**: The saturated vapor received after evaporator is compressed adiabatically in hermitically sealed compressor. In compressor the refrigerant compressed to higher desired pressure. Work is done by compressor, due to compression the temperature raises and the enthalpy of refrigerant is increased. So, Work done by compressor= (h2' h1').

- **Process 2-3**: The refrigerant which is compressed in the compressor at high temperature and pressure. Hence the refrigerant is cooled at constant pressure in the condenser by forced convection with ambient air. That results to decrease the enthalpy of the refrigerant. So, Heat loss by condenser = (h2' - h3').

- **Process 3-4**: The refrigerant coming out from the condenser at ambient temperature and high pressure in saturated liquid phase is expanded in the expansion valve there by refrigerant converted into very low temperature and low pressure. So, in Expansion valve , enthalpy is constant (h3' = h4').

- **Process 4-1**: The refrigerant is at low temperature and low pressure and in wet condition received from expansion valve, passes through the evaporator coil. The refrigerant absorbs heat of vaporization in evaporator at constant pressure and turns to saturated vapour. So, Heat gain by refrigerant in evaporator= (h1'-h4').

Cop of modified Ac= (h1'-h4')/(h2'-h1')

COMPARISON BETWEEN CONVENTIONAL AND MODIFIED AIR CYCLE

In conventional air conditioner the vapour refrigerant entering the compressor is not totally saturated. Whereas in modified air conditioning system the vapour entering the compressor would be saturated. Due to this compressor life increases. Now by adopting the method of sub cooling the condenser will reject more heat so that refrigerating effect can be increased. Refrigerating effect of conventional ac = (h1-h4) which is less than refrigerating effect of modified ac i.e.,=(h1'-h4').

HEAT EXCHANGER

A heat exchanger is a device that is used to transfer thermal energy between two or more fluids. Heat exchangers are classified according to the heat transfer process, number of fluids, construction, surface compactness, flow arrangements, and heat transfer mechanisms. Two fluids are commonly used in heat exchangers, with one fluid being cooled and another fluid acting as a coolant. However, "as many as twelve fluid streams have been used in some chemical processes. A shell and tube heat exchanger is a class of heat exchanger designs **(Figure 10)**. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. The set of tubes is called a tube bundle, and may be composed of several types of tubes: plain, longitudinally finned, etc.

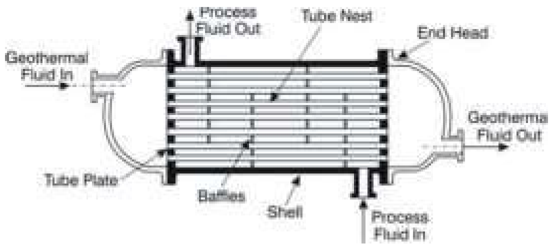

Figure 10. Shell and tube heat exchanger.

DESIGN OF HEAT EXCHANGER

In this project the heat exchanger used is of shell and tube type. Heat exchanger is made up of copper tube so as to enhance the heat transfer rate. The heat exchanger consists of a sump in which he condensed cool water is poured. It consists of a coolant reservoir in which the mixture of glycerin and water in the ratio of 9:3 is poured. Now this coolant water mixture is circulated with the help of a water pump of 8W rating. The specification of the copper tube used for the heat exchanger is as follows **(Tables 1-3):**

- Diameter of the pipe (in meter) D=0.00954
- Length of pipe in heat exchanger (in meter) L= 1.2
- Cross sectional area of pipe (in meter square)

$$A = \pi DL \times \text{no. of tube pass} = 3.14 \times (0.0095) \times (1.2) \times (4) = 0.143\ m^2$$

Specific Heat Cp(kj/kgc)=2.41

Specific Heat Cp(kj/kgc)=4.18

Specific heat of mixture of glycerin and water (75%and 25%) in kj/kg=3.3117

Mass of Glycerin=900 gm

Mass of water=300 gm

Mass of Condensed water Flow rate=2 lit/hr=2 kg/hr=gm/sec=1.38×10^{-3} kg/sec

Mass of coolant flow rate=8 gm/sec=8×10^{-3} kg/sec

Overall Heat Transfer coefficient of mixture of glycerin and water U (W/m^2c)=250

Table 1. Reading of condensed water in heat exchanger.

Tc1	Tc2	Tc3	Heat gain by coolant in condenser Qg1	Heat loss by coolant in H.E Q11
26.2	29.2	25.4	15.12	14.13
26.6	30.1	25.7	17.48	16.3
27	30.8	26.6	16.69	15.49
26.6	29.8	25.6	16.69	15.5

Table 2. Heat gain by water.

Tw1	Tw2	heat gain by water Qg2
22.5	26.2	30.9
22.6	26.3	30.8
23.5	27.5	30
22.8	26.6	31.7

Table 3. Properties of glycerin and water mixture.

		Specfic Heat, Cal/g/°C or Btu/lb/°F								
		Glycerine								
°F	°C	25%	30%	35%	40%	45%	50%	55%	60%	65%
35	1.7	0.88	0.87	0.86	0.84	0.82	0.8	0.77	0.74	0.79
30	-1.1	0.88	0.86	0.85	0.83	0.81	0.79	0.76	0.73	0.7
25	-3.9	0.87	0.86	0.84	0.82	0.8	0.78	0.75	0.72	0.69
20	-6.7	0.86	0.85	0.83	0.82	0.79	0.77	0.74	0.71	0.68
19	-7.2	6.8	-	-	-	-	-	-	-	-
15	-9.4	4.1	4.8	0.82	0.8	0.78	0.76	0.73	0.7	0.67
10.4	-12	-	-	3.7	-	-	-	-	-	-
10	-12.2	2.7	3.2	3.6	0.8	0.78	0.75	0.72	0.69	0.66
5	-15	2.1	2.4	2.7	0.79	0.77	0.74	0.71	0.67	0.65
4.6	-15.2	-	-	-	2.9	-	-	-	-	-
0	-17.8	1.7	1.9	2.1	2.4	0.76	0.73	0.7	0.66	0.63
-1.8	-18.8	-	-	-	-	2.4	-	-	-	-
-5	-20.6	1.4	1.6	1.8	2	2.2	0.72	0.69	0.65	0.62
-9.6	-23.1	-	-	-	-	-	2	-	-	-
-10	-23.3	1.2	1.4	1.6	1.7	1.9	2	0.68	0.64	0.61
-15	-26.1	1.1	1.2	1.3	1.5	1.6	1.7	0.67	0.63	0.6
-18.9	28.3	-	-	-	-	-	-	1.7	-	-
-20	-29.9	1	1.1	1.2	1.3	1.4	1.5	1.6	0.62	0.59
-25	-31.7	0.9	1	1.1	1.2	1.25	1.3	1.4	0.61	0.58

C_{max}=0.008*3.3117=0.026kw/c=26.5w/c C_{min}=0.00138×4.18=5.78w/c

Capacity ratio C=C_{min}/C_{max}=5.78/26.5=0.218

NTU (Number of Transfer Unit)=(U*A)/C_{min}=(250×0.143)/5.78 =6.12

From **Figure 11** Graph of One shell and 4 tube plot NTU&C We get effectiveness, _(%)=75

Enthalpy loosed by air in fan=heat gain by coolant in condenser so, Average enthalpy loosed by air in fan=16.495 KJ.

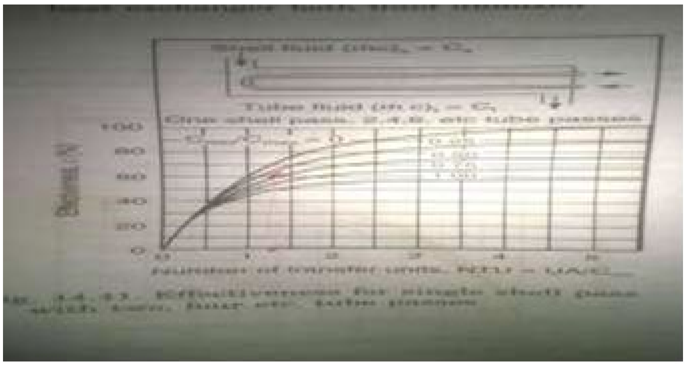

Figure 11. Effectiveness graph.

DESIGN OF AIR CONDITIONED SPACE

- Data taken for calculation for thermal load Plaster on inside wall: 1.25.
- Outside wall construction: 20 cm concrete block: 10 cm brick veneer.
- Partition wall construction: 33 cm brick: 20 cm RCC slab with 4cm asbestos cement board.
- Floor construction: 20 cm concrete.
- Densities, brick: 2000 kg/m^3.
- Concrete: 1900 kg/m^3.
- Plaster: 1885 kg/m^3.
- Asbestos board: 520 kg/m^3.
- Outdoor design condition: 45°C DBT, 27.3 WBT.
- Indoor design condition: 25 c DBT, 50% RH.
- Daily range: 25-45°C=20°C.
- Occupancy: 01.
- Lights: 60 W fluorescent.
- Thermal conductivities of different materials taken from the table attached
- k glass =0.78 W/mK
- k concrete =1.73 W/mK
- k brick = 1.32 W/mK
- k plaster =8.65 W/mK
- k plywood =0.1 W/mK
- Assumed film coefficient

LOAD CALCULATION

Table 4. Sensible heat solar gain glass.

Item	Area or quality	Sun gain and Temp Diff	Factor	W
East glass	-	-	-	-
West glass	2.2743	467	-	1062
North glass	-	-	-	-
South glass	-	-	-	-
Sky light	-	-	-	-

Table 5. Solar transmission gain walls and roof.

Item	Area or quality	Sun gain and Temp Diff	Factor	W
East Wall	-	-	-	-
North Wall	-	-	-	-
West Wall	9.54	18.53	3.5	618.71
South wall	-	-	-	-
Roof Shaded	12.38	13.56	2.13	-

Table 6. Transmission gain-others.

Item	Area or quality	Sun gain and Temp Diff	Factor	W
Door	17	20	3.78	128.52
All Glass	8.41	20	5.9	993.09
Partition	7.39	1705	1.08	138.61

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Celling	12.38	20	2.13	527.39
Floor	12.38	2.5	6.05	187.34

Table 7. Internal heat gain.

Item	Area or quality	Sun gain and Temp Diff	Factor	W
People	1	-	75	75
Power	-	-	-	-
Lights	40	-	1.25	50
Appliances	-	-	-	-
Additional	-	-	-	-

Note: SAFTY FACTOR=153.85'

Table 8. Outdoor air.

Item	Area or quality	Sun gain and Temp Diff	Factor	W
By Pass	0.21	20	20.4	12.85
	-	-	0.15	-

Table 9. Effective room sensible heat

Item Latent Heat	Area or quality	Sun gain	Factor	W
Infiltration		-		
People	1	-	55	55
Steam		-		
Appliances	-	-	-	-
Additional	-	-	-	-
Vapour trans	-	-	-	-
	-	-	Sub Total	3360

Note: Effective room sensible heat=3305.82

Table 10. Grand total Heat.

Safety factor	5%	2.75
Room latent heat		55
Supply Duct	Effective room latent heat	57.754
	Effective room latent heat	3,417
Grand total heat	-	3417(.975 TR)

After understanding the thermal load calculation processor form **Tables 4-10** the actual room thermal load calculation have been made to suggest a suitable window air conditioner of 1 TR

EXPERIMENTAL SETUP AND EXPERIMENTATION

We have used 1 ton window air conditioner as per the room specification **(Figure 12)**. The technical specification of ac as follows:

- Blue star model no.: wam241r
- Serial no: wam241r050474
- Equipment rating: single phase, 230 v, 50 hz, 13 a.
- Power rating: 2.5 kw
- Refrigerant: r-22 (chclf2)
- Normal capacity: 1.0 tr at

- Compressor: hermitically sealed rotary
- Condenser: forced convection air cooled
- Evaporator: forced convection air cooled
- Thermostat: on panel
- Energy meter: for compressor provided
- Pressure gauge: 1 no. for suction pressure and 1 no. for dis- charge pressure temperature indicator: digital thermometer indicator
- Air flow measurement: by inclined tube manometer

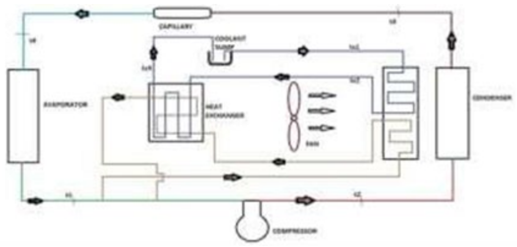

Figure 12. Modified AC setup.

EXPERIMENTATION

We have used coolant system in which mixture and water as a coolant used to flow in pipe. The setup is consist of heat exchanging pipe is connected from coolant sump and passes through in between fan and condenser and connected to heat ex- change. Now from the heat exchanger it passes to coolant sump. First we have taken reading for conventional ac and after than not down the reading of modified ac.

OBSERVATION AND CALCULATION

Conventional AC Reading

Mass of Refrigerant=0.850 kg **(Figure 13)**

Heat capacity cp (vapour)= 0.55 kj/kgk

Theoretical Conventional Cop= ((h1-h3))/((h2-h1))

Actual Conventional Cop = ((M ∗ C p ∗ (DBT i − DBT f))/((Energy utilization K W H))

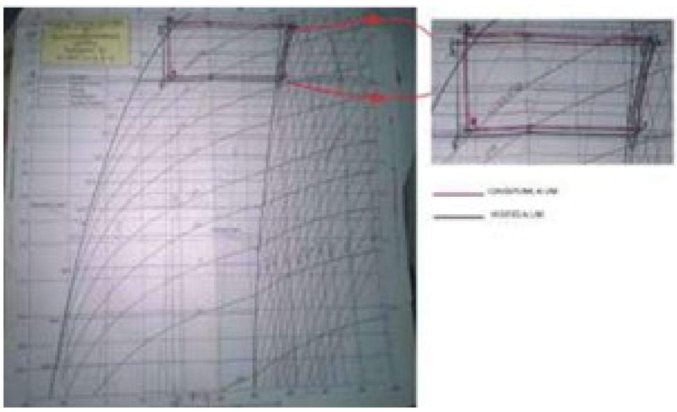

Figure 13. Actual pH diagram.

Modified AC Reading

Mass of Refrigerant=0.850 kg

Heat capacity cp (vapour)=0.55 kj/kgk Theoretical Modified Cop=((h1-h3))/((h2-h1))

Actual Modified Cop = M ∗ C p ∗ (DBT i − DBT f))/((Energy utilization K W H))

RESULTS AND DISCUSSION

In our experiment we found that COP of Modified Air conditioning system is more than normal air conditioning system. We also observe the power saving of new modified system which is about 50-60%. The below graph shows the variation of COP and the subsequent power consumption for conventional as well as modified air conditioning system. This show that:

- Modification carried out improves cop and reduce power consumption.
- Average cop improved obtained to be 50 percent.
- Power consumption is reduced by 30 percent.

CONCLUSION

From the analysis of the conventional as well as the modified air conditioning system we conclude that:

1. The use of coolant for condenser cooling shows positive response. By implementing this kind to reforms in the conventional air conditioning system we can increase the coefficient of performance and also increase the power saving of the conventional air conditioning system.
2. The use of bypass refrigerant cooling system is not capable of providing the desired result and hence this kind of modification can be eliminated.
3. Green scale inhibitor effectively use to avoid the formation of scale on condenser coils **(Figures 14 and 15)**.
4. Thermal load calculation of a room carried out and suitable 1 TR window air conditioner fabricated.

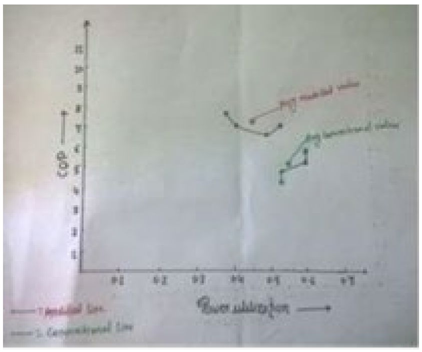

Figure 14. Cop vs. power consumption graph.

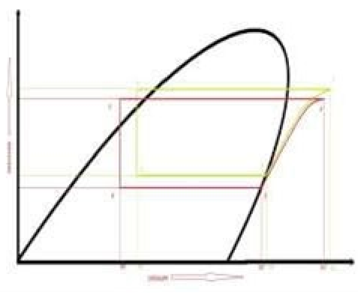

Figure 15. pH diagram.

NOMENCLATURE

- Symbol- description-units
- T1- inlet temperature of compressor
- T2- outlet temperature of compressor
- T3- outlet temperature of condenser
- T4- inlet temp of evaporator
- Tc1- inlet temperature of coolant in between condenser and fan
- Tc2-outlet temperature of coolant from between condenser and fan/ inlet temperature of coolant in the heat exchanger

- Tc3-outlet temperature of coolant from heat exchanger
- Tw1-initial temperature of water in heat exchanger
- Tw2-final temperature of water in heat exchanger
- P1-suction pressure in psig
- P2-discharge pressure in psig F1-Air flow
- W1-compressor power (watt)
- W2-heater power
- RH1-Initial humidity (%RH)
- RH2-final x humidity (%RH)
- COP - Coefficient of Performance
- i=inlet, o=outlet, s=surface, l=loss, g=gain

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