EXPERIMENTAL PERFORMANCE ANALYSIS OF WINDOW AIR CONDITIONING TRIANER

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Abstract – Window air conditioner is available on various capacities & various manufactures in global market. During actual use it is not possible to evaluate the performance analysis of window air conditioner. The effect of condenser temperature on evaporator temperature on performance. At present manufactures specifies the data such as cooling capacity, EER power consumption on the basis of star rating. Energy star rating of window air conditioner one star less efficient and five star more efficient as it is regulated by BEE. In this research, for investigation of performance parameters for Window AC trainer is developed. In this psychometric test chamber is prepared and investigated the parameters with different operating procedures.

KeyWords: cooling capacity, EER, BEE, psychometric, window AC.

1. INTRODUCTION

1.1 HISTORY

Now-a-days the Ambient Temperature limit in summer is increasing year by year and the demand of Air Conditioners is going up. As the middle or lower class people hardly or cannot afford for the basic model AC respectively and the power consumption or running cost is high so we have come up with a new idea for energy efficient and economical cooling system.

This topic is particularly chosen as the Economical as well as energy efficient cooling system because our aim is to provide this type of cooling system for each and every class of people in the society. A revolutionary machine that cools like an AC while consuming 10% of its electricity. The electricity bill was coming way too high because of the air conditioner in the office, house and other room that was used all day long. With a view towards saving electricity, we tried to replace the air conditioner with a cooler. However, it wasn't much use in the tough summers.

Based on the humidity, air coolers usually bring down the temperature of a room by five degree, which was not enough. We started trying to put ice in the cooler everyday but it was practically not possible to keep doing so at regular intervals. That was when we decided to utilize all the equipment's used in an AC and make ice in the cooler itself. Once it was ready, the cooler was able to bring down the temperature of the room. The cooling system here basically works with the help of a refrigeration cycle operating via the compressor and condenser connected to it.

In 1902, the first modern electrical air conditioning unit was invented by Willis Carrier in Buffalo, New York. After graduating from Cornell University, Carrier found a job at the Buffalo Forge Company. While there, he began experimenting with air conditioning as a way to solve an application problem for the Sackett-Wilhelms Lithographing and Publishing Company in Brooklyn, New York. The first air conditioner, designed and built in Buffalo by Carrier, began working on 17 July 1902.

Designed to improve manufacturing process control in a printing plant, Carrier's invention controlled not only temperature but also humidity. Carrier used his knowledge of the heating of objects with steam and reversed the process. Instead of sending air through hot coils, he sent it through cold coils (filled with cold water). The air was cooled, and thereby the amount of moisture in the air could be controlled, which in turn made the humidity in the room controllable. The controlled temperature and humidity helped maintain consistent paper dimensions and ink alignment. Later, Carrier's technology was applied to increase productivity in the workplace, and The Carrier Air Conditioning Company of America was formed to meet rising demand. Over time, air conditioning came to be used to improve comfort in homes and automobiles as well. Residential sales expanded dramatically in the 1950s.

In 1906, Stuart W. Cramer of Charlotte was exploring ways to add moisture to the air in his textile mill. Cramer coined the term "air conditioning", using it in a patent claim he filed that year as an analogue to "water conditioning", then a well-known process for making textiles easier to process. He combined moisture with ventilation to "condition" and change the air in the factories, controlling the humidity so necessary in textile plants. Willis Carrier adopted the term and incorporated it into the name of his company.

Shortly thereafter, the first private home to have air conditioning was built in Minneapolis in 1914, owned by Charles Gates. Realizing that air conditioning would one day be a standard feature of private homes, particularly in regions with warmer climate, David St. Pierre DuBose (1898-1994) designed a network of ductwork and vents for his home Meadowmont, all disguised behind intricate and attractive Georgian-style open moldings. This building is believed to be one of the first private homes in the United States equipped for central air conditioning. In 1945, Robert Sherman of Lynn, Massachusetts invented a portable, in-window air conditioner that cooled, heated, humidified, dehumidified, and filtered the air.

1.2 The Six Basic Types of Liquid Cooling Systems

There are six basic types of cooling systems that you can choose from to meet the cooling needs of your load. Each one has its strengths and weaknesses. This article was written to identify the different types of cooling systems and identify their strengths and weaknesses so that you can make an informed choice based on your needs.

There are six basic types of liquid cooling systems:

1. Liquid-to-liquid
2. Closed-loop dry system
3. Closed-loop dry system with trim cooling
4. Open-loop evaporative system
5. Closed-loop evaporative system
6. Chilled water system

1. Liquid-to-Liquid Cooling Systems

The simplest of these systems is a liquid-to-liquid cooling system. In this type of system your plant has an abundance of some type of cooling liquid already available but you do not want to provide this coolant to the compressor. For example: you have well water available but you do not want to put the well water through your new compressor because the water quality is very poor (lots of dissolved solids like iron and calcium etc.), and you have had trouble with the well water fouling your heat exchangers in the past. A liquid-to-liquid cooling system is an ideal fit for this situation. It uses the well water on one side of an intermediate heat exchanger and a coolant such as glycol and water on the other side of the intermediate heat exchanger in a closed loop to cool the compressor. The heat is exchanged through the intermediate heat exchanger without fouling the heat exchangers. Fouling of the intermediate heat exchanger will likely happen on the well-water side, however, if the intermediate heat exchanger is selected properly it can be taken apart easily and cleaned. The most common intermediate heat exchangers are either plate and frame or shell and tube type. Coolant temperatures of 5 degrees above the plant cooling "water" are possible with a liquid-to-liquid type system. In the well water example above if the well water is available at 55^0F the liquid to liquid cooling system is capable of supplying 60^0 F coolant to the load.

Fig 1.1 Liquid-to-Liquid Cooling Systems

Weaknesses of the liquid-to-liquid cooling system include periodic downtime of the cooling system for cleaning. This can be offset by installing a standby intermediate heat exchanger that is put into service while the primary intermediate heat exchanger is cleaned. A standby heat exchanger adds additional cost but allows for continuous operation of the cooled load while cleaning is accomplished. This system requires a regulated supply of plant coolant like the well water example above for proper cooling of the load. There can be times that the cooled load does not operate at maximum capacity and the plant primary cooling "water" must be regulated to insure the load is not over or under cooled.

Closed-Loop Dry Cooling Systems

A closed-loop dry cooling system is very much like the radiator in your car. The system uses an air-cooled fluid cooler to transfer the heat from the closed-loop coolant fluid pumped through rows of finned tubes that have ambient air blown/drawn across them. The basic components to a closed-loop dry cooling system are the fluid cooler, which contains the air to liquid heat exchanger with the fan/s, the pump and control skid, the coolant, and the field installed system piping. The closed-loop dry cooling system fluid cooler will be located outside and use the ambient air to reject the heat. Coolant temperatures of 5^0 to 10^0 F above the ambient dry bulb temperature are possible with a closed-loop dry cooling system. The system is relatively inexpensive to operate with only the coolant pump and the fluid cooler fan/s using energy. The fans are thermostatically controlled to regulate the temperature of the cooling fluid so that the load is not over or under-cooled. Periodic cleaning of the fluid cooler may be necessary due to dirty atmospheric conditions at the site location.

Fig 1.2 Closed-loop Dry Cooling Systems

The strength of a closed-loop dry cooling system is that the unit is very simple and relatively easy to install. The energy requirements are relatively low and it is easily controlled. Maintenance is normally low requiring only periodic inspection, lubrication, and testing of the fluid. The weakness of a closed-loop dry cooling system is that it is dependent on the atmospheric dry bulb. For example, if your location's design dry bulb is 100^0 F in the summer and your equipment requires 90^0 F coolant; at best the system can only supply around 105^0 to 110^0 F coolant to the load. In this case you would need supplemental cooling to get the coolant temperatures down to 90^0 F.

The closed-loop dry cooling system also requires free clear air to work efficiently. This means that the fluid cooler must be placed in a location that is not affected by the prevailing winds, not too close to a building that will allow the warm exhaust air from the fluid cooler to be recirculated back to the fluid cooler, and finally not in a location that has heavy concentrations of dust, dirt, leaves, seeds, etc. Many times the best location for the fluid cooler is on the roof. Since the fluid cooler is located outside the coolant must also have a concentration of some type of glycol to prevent freezing if your location has a design dry bulb in the winter that dips below freezing. If the location is very cold, the concentration of glycol may need to be significant to prevent freezing. Glycol concentrations as they increase begin to reduce the rate of heat transfer. For example, if you need 50% ethylene glycol concentration with water the heat exchanger equipment and the flow/pressure of the coolant will need to increase to adjust for the glycol concentration. Larger fluid coolers and pumps will increase the cost of the system over those with lesser concentrations of Glycol/water. This cannot be prevented in colder climates.

3. Closed-loop Dry System with Trim Cooling

A closed-loop dry system with a trim cooler is the same as the closed-loop dry system but adds a supplemental fluid cooler. This system is typically used in a location that has too high of a dry bulb in the summer to provide the proper coolant temperature to the load. With an added liquid-to-liquid trim cooler the customer can use a water source to trim the temperature to the desired set point. Many times closed-loop dry system with a trim cooler are used to reduce the reliance on city water as a coolant. City water is becoming expensive to buy and to dispose of. These systems may be employed to completely eliminate the city water usage most months in a year, thus reducing the plant operating costs. The system must have a supply of free clear air and a regulated supply of plant coolant or city water as with a liquid-to-liquid cooling system.

The strength of the closed-loop dry system with a trim cooler is that it can provide coolant temperatures below that of a closed-loop dry system alone. The system will reduce the amount of plant/city water usage during the colder months. The weaknesses of the closed-loop dry system with a trim cooler include all of those listed for the closed-loop dry system. Also, it now requires some secondary coolant during warmer times of the year. Additional piping will be required for the trim coolant to/from the skid. Both the trim cooler and the air cooled fluid cooler will require periodic maintenance and cleaning.

4. Open-loop Evaporative Cooling Systems

The next system, an open-loop evaporative cooling system is completely different than the first three listed above. This system has the ability to use the design wet bulb as the basis for the outlet temperature of the cooling water. For example if the design dry bulb for the location is 95^0 F and the design wet bulb is 75^0 F, the system can provide approximately 82^0 F water to the load.

The open-loop evaporative cooling system cascades water through the honeycomb PVC fill material in the tower along with ambient air blown or drawn through the fill to evaporate the water. During the evaporation, the remaining water is cooled to as close as 7^0 F or higher above the wet bulb temperature. The evaporated water is replaced with some type of make-up water system like a float valve. The remaining water and the make-up water are collected in a basin and then pumped to the load and the cycle repeats. On average an open-loop evaporative cooling system requires 4 GPM of make up and blow down water per 1,000,000 Btu/hr of heat rejected.

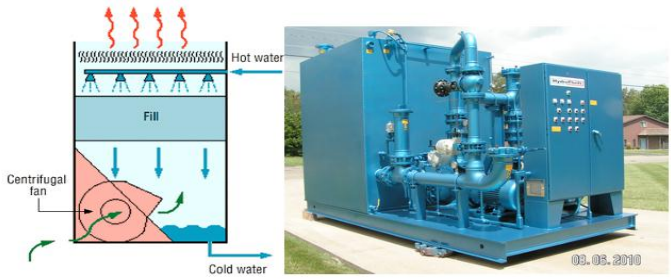


Fig 1.3 Open-loop Evaporative Cooling Systems

The advantage of this system is that the equipment is typically inexpensive. The systems can be simple to employ in warmer climates but may require more controls in colder climates. The weaknesses of this type of system are that they normally require an extensive water treatment system. The water treatment system uses expendable chemicals to keep the calcium and dissolved minerals in suspension. The chemical treatment is necessary to ensure that the cooling tower, piping, and heat exchangers do not become fouled. An inherent issue with the open tower evaporative system is that the water that flows through the tower is also the heat transfer fluid that is pumped through the load. This water comes in contact with the dirty atmosphere. It picks up pollutants such as dust, vegetation, etc. These contaminates end up in the heat exchangers and piping and can cause significant maintenance issues. Open towers can have control issues in the winter months. They are designed to run at full load. They do not always perform well under part-loading in very cold climates. If the basin is part of the tower, a heater is required for cold weather operation to keep the basin water from freezing when the load is not present. The piping will normally require insulation and heat trace in cold climates to prevent freezing. A drain will be required for blow-down of the water to keep the conductivity in check from the constant evaporating and concentrating of the dissolved solids. Make-up water is continually required from external source such as city water or treated well water, etc. Biological control of bacteria, slime, and mold are major concerns for proper operation of an open evaporative tower system.

5. Closed-loop Evaporative Cooling Systems

A closed-loop evaporative system is a hybrid system. The closed loop evaporative system is an open tower with a closed-loop heat exchanger built into the tower. The tower water stays outside in the tower and does not circulate through the coolant piping. The coolant piping is a closed loop, with a glycol/water solution flowing from the tower to the load and back. The separate tower water is pumped from the basin to the top of the tower and sprays across the heat exchanger (normally an array of tubes) with air blown or drawn through the tower across the heat exchanger where evaporation of the water transfers the heat from the closed coolant loop to the ambient air. The remaining tower water falls to the basin where it is again pumped up to the top of the tower and repeats the process. The closed-loop evaporative system tower water requires make-up water, chemical treatment, a drain, cold weather basin heater, and blow-down just like the open-loop evaporative system discussed above.

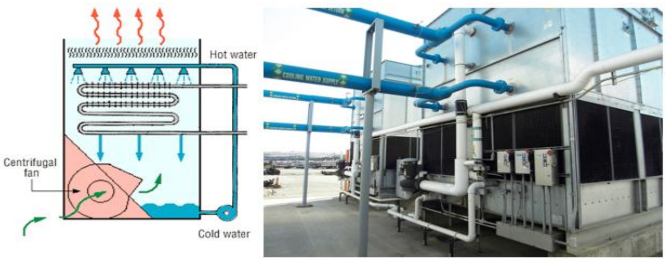


Fig 1.4 Closed-loop Evaporative Cooling Systems

The advantage of the closed-loop evaporative system is that it can deliver closed loop coolant to the load at approximately 7^0 to 10^0 F above the wet bulb temperature. The closed-loop coolant remains free of contaminates and allows the equipment heat exchanger and piping to remain clean. Any contaminates from the atmosphere will stay outside with the tower. Fewer water treatment chemicals will be used because they are only treating the open water in the tower and not the coolant in the piping and system heat exchangers. The drawbacks of a closed-loop evaporative system are that you will need water treatment, blow-down, and make-up water for the tower water side of the system. The system will require a drain and heat-traced and insulated piping for cold weather applications. There is a basin heater required to prevent freezing of the basin in cold weather off-time operation. The system requires an additional pump connected to the tower which circulates the basin water.

6. Chilled Water Cooling Systems

The last type of cooling system we will discuss is the chilled water system. A chiller normally has a mechanical compression device that converts energy into compressed refrigerant by using some type of compressor. The compressed refrigerant is piped to a condenser that rejects the heat from the refrigerant to the atmosphere or some type of liquid coolant. The compressed refrigerant changes state from a gas to a liquid in the condenser and is piped to an evaporator where it is metered or expanded in the evaporator. The expansion of the high pressure liquid refrigeration reduces the temperature of the evaporator. The liquid to be cooled is pumped through the evaporator heat exchanger and heat is transferred to the refrigerant. The low pressure vapor is carried back to the compressor and the cycle begins again for the refrigerant. The coolant flows from the evaporator heat exchanger to the load where the heat is transferred to the coolant in the load heat exchanger and then returns back to the evaporator to repeat the cycle.

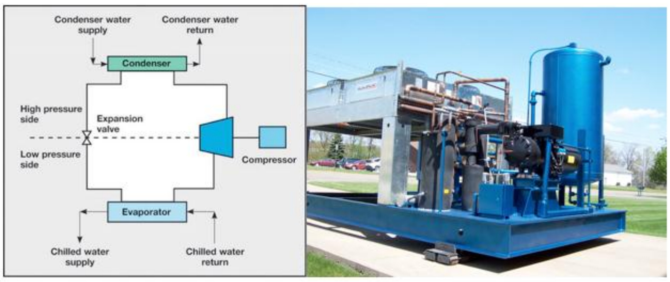


Fig1.5 Chilled Water Cooling System

1.2.1 Advantages of vapour compression refrigeration system:

1. The only moving part of the entire system is a pump which has a small motor. Thus the operation of the system is quiet and is subjected to little wear.

2. The vapour absorption system uses heat energy to change the condition of refrigerant from the evaporator.

3. The load variations does not affect the performance of vapour absorption refrigeration system.

4. The vapour absorption refrigeration system can be built in any capacity well above 1000 TR.

5. The space requirements &automatic control favour the absorption system more as the designed evaporator pressure drops.

6. In the vapour absorption refrigeration system, the liquid refrigerant leaving the evaporator has no bad effect on system except that of reducing the refrigerating effect.

7. Simple Control

8. Easy Maintainance

9. Gives Constant Temperature

10. Less Noise

1.2.2 Dis–advantages of vapour compression refrigeration system:

1. Higher capital cost.

2. It takes more time to produce refrigerating effect.

3. Charging of the refrigerant is difficult.

Applications of refrigeration:

The various Applications of refrigeration are

1. Preservation of food

2. Food processing and candy manufacturing

3. Bakery product storage

4. In chemical and process industries

5. Petroleum refineries

6. Paper & pulp industries

7. Precision parts & clean room

8. Cold storage

9. De-salting of sea water

10. Tempering &hardening of metals

11. Environmental laboratories

12. Ice cream manufacturing & beverage storage

CHAPTER 2

LITERATURE REVIEW

Vaibhav K. Dongare [1] has discussed the future phase-out of hydro chloro fluoro carbons (HCFCs) used in air conditioning system. Most commonly used refrigerant is R-134 a. In field of refrigeration everyone trying to find alternative refrigerants for R-134 a. Because hydro chlorofluorocarbons(HCFCs) including R-134 a is promised to be banned as per the Montreal protocol. Several refrigerants like R290, R407C, R410A, R134a are emerged as substitutes to replace R-134 a, the most widely used Fluoro carbon refrigerant in the world.

Prof. S.M.Shaikh, Prof. A.M.Patil[2]they presents Window Air Conditioner is available on various capacities& various manufactures in global market. During actual use it is not possible to evaluate the performance of window Air conditioner. The effect of condenser temperature on evaporator temperature on performance. At present manufacturer specifies the data such as cooling capacity, EER power consumption on the basis of star rating. Energy star rating of window Air conditioner one star less efficient and five star is more efficient as it is regulated by BEE. In this research, for investigation of performance parameter for window AC, Window AC test rig is developed. In this, Psychrometric test chamber is prepared and investigated the parameters with three different operating procedures.

K. R. Aglawe[3] has reported about Coefficient of performance improvement and reduction of energy consumption of an window air conditioning system when retrofitted with evaporative cooling in the condenser of window air conditioner is reviewed in this paper. The condensing unit is retrofitted with a cellulose corrugated pad. It doesn't require either any change in refrigeration system or requires minimum changes. The evaporative cooled condenser can exchange heat with the cooled ambient air cooled with evaporative cooling which is much lower in temperature than atmospheric air. By application of evaporative air cooling it is possible to exchange more heat than the un-wetted exchanger. In this paper a window air conditioner is introduce by putting two cooling pads in the both sides of the air conditioner and injecting water on them in order to cool down the air before it passing over the condenser.

Fu wing U etal. 2005[4] investigated how the COP of these chillers can be improved by a new condenser design, using evaporative pre-coolers and variable-speed fans. A thermodynamic model for an air-cooled screw-chiller was developed. It is found that the chiller COP can be maximized by adjusting the set point based on any given chiller load and wet-bulb temperature of the outdoor air. A 5.6-113.4% increase in chiller COP can be achieved from the new condenser design and condenser fan operation.

Madhur behl, 2012[5] this paper presents a green scheduling approach with chilling plants to reduce their peak power demands. A green scheduling approach means the use of thermal energy storage with VCR system, this thermal energy storage stores the energy in peak hours and uses that power in the time of need. When main system is shutoff for any reason. Using this system it is found that a green scheduling approach has a potential to save average monthly electricity bill by 17 % as compared to system without thermal energy storage.

Ho Yin Chun[6] discussed about simulation study on how to increase the coefficient of performance (COP) of an air-cooled screw chiller equipped with high static condenser fans. A thermodynamic chiller model was developed and validated using the operating data and specifications of the chiller. The simulation results show that reducing the condensing temperature as low as possible is incapable of maximizing the chiller COP when the rated condenser fan power is high by up to 77 W per kW cooling capacity. Depending on the load conditions, the chiller COP could increase by 1.7-84.8% when variable speed condenser fans and the optimum set point of condensing temperature are applied to existing air-cooled screw chillers.

CHAPTER 3

PRESENT WORK

From the literature review, it shows that the window air conditioning trainer has been a subject of keen interest , which paves a way for more experiments and investigations. So, this study is conducted to obtain the performance of window air conditioner to discuss the effect of different parameters .The present work is entitled as " **EXPERIMENTAL PERFORMANCE ANALYSIS OF WINDOW AIR CONDITIONING TRAINER"**

3.1 METHODOLOGY

The present work is conducted on a fabricated window air conditioning trainer built in reference to the size of industrial window air conditioner for small scale use. Cooling chamber is made of mild steel plate and covered with a fiber glass of size(59mmX69mm).cooling chamber dimensions are(59mmX69mmX59mm).compressor of 0.5ton capacity, thermostat, temperature indicator of 12^0 temperatures display, capillary tube 0.5 to 2.28 mm diameter, condenser and evaporator. Equipment is first tested for no load conditions then after cooling artificially chamber is heated with four filament bulbs in which two are 60 Watts and two are 200 Watts. Then with the help of heater control we can control the voltage of bulbs manually. Then time for ten pulses of energy meters of compressor and bulbs are noted and results are calculated. The performances are determined under ambient conditions at room temperature of 37^oC during the month of April 2018.

3.2 OBJECTIVES

The enormous activities in the field of Air conditioning lead to the many Technologists and Engineers to use the materials and design of the system which enhances the efficiency and performance of the system for various wide ranges of applications. Here in this study, an effort is made to determine the following points as mentioned below,

- To determine theoretical c.o.p.
- To determine actual c.o.p.
- To determine Carnot cop.
- To determine capacity of system.

3.3 EXPERIMENTAL SETUP

The experimental set up of window air conditioning trainer consists of an Compressor, condenser flow meter(LPH) , Evaporator, K type Thermocouple wires , capillary tube of 0.5mm diameter, Filter four bulbs and two energy meters. Fig 3.1 shows the experimental set up of window air conditioning trainer.

Photo 3.1 Experimental setup of Window air conditioning trainer

Six thermocouple wires are inserted in the equipment, first one is at the condenser inlet, second one is at the condenser outlet, third one is at the evaporator inlet, fourth one is at the evaporator outlet, fifth one is at the cooling chamber temperature and is at the ambient temperature. These thermocouple wires are of k-type measuring up to 280^0c and having accuracy $\pm 2.5\%$, to, 0.75%

3.4 Components

3.4.1. Compressor

Fig 3.1: Compressor

It uses a hermetically sealed compressor .The low pressure and temperature vapour refrigerant from evaporator is drawn into compressor through the inlet or suction valve where it is compressed to high pressure & temperature & discharged through discharge valve.

3.4.2 Condenser

Fig 3.2: condenser

Condensers are devices which accept a vapor stream and convert it to a liquid using heat transfer or compression. A condenser may refer to a heat exchanger used specifically for cooling gases and process fluids below their boiling points. However, condensing units (such as those in air conditioners) are used in systems which cool the outside environment. These systems may include a compressor, an evaporator, fans, and other components in addition to a heat exchanger (condenser) section.

3.4.3 Capillary tube

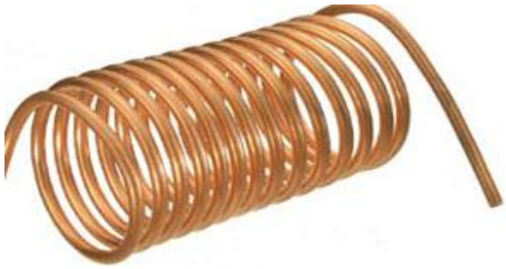


Fig 3.3: capillary tube

Capillary tube is one of the most commonly used throttling devices in the refrigeration and the air conditioning systems. The capillary tube is a copper tube of very small internal diameter. It is of very long length and it is coiled to several turns so that it would occupy less space. The internal diameter of the capillary tube used for the refrigeration and air conditioning applications varies from 0.5 to 2.28 mm (0.020 to 0.09 inches). Capillary tube used as the throttling device in the domestic refrigerators, deep freezers, water coolers and air conditioners.

3.4.4 Evaporator

An evaporator is a device in a process used to turn the liquid form of a chemical substance such as water into its gaseous-form/vapor. The liquid is evaporated, or vaporized, into a gas form of the targeted substance in that process. 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 flowing 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 warm air.

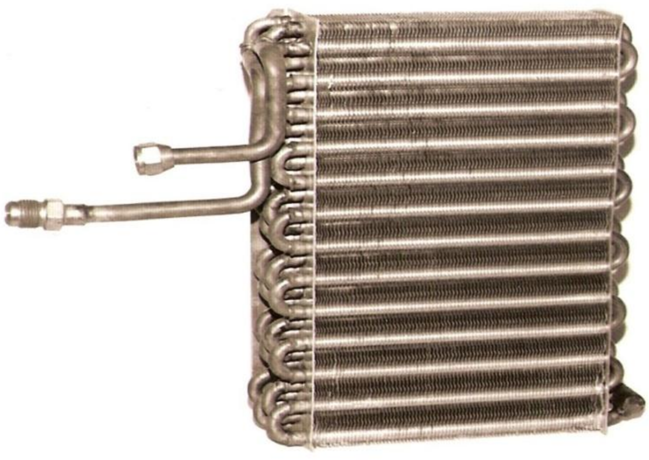


Fig 3.4: Evaporator

3.4.5. Pressure gauge

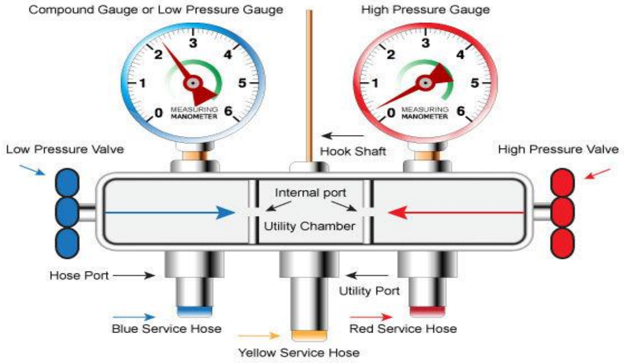
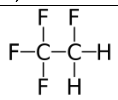


Fig 3.5: pressure gauge

Air conditioner gauges is chamber device that is design to control the flows of pressure or gases. It holds both compound and Air conditioning gauges is used to measure air conditioner units pressure within closed-system to evaluate or troubleshoot the central air units. Gauges manifold set is the most frequently used item when it comes to refrigerant or pressure.

3.5 SPECIFICATIONS

PARTS	SYSTEMS	DESCRIPTION
COMPRESSOR	Capacity 0.5 TR at Rated test conditions	Compressor Hermetically sealed. Make :Emerson Climate Tech.
Tecumseh Products India Ltd./ Danfoss Ltd./or any(LG)	equivalent make.	Condenser Forced convection air cooled.
Condenser fan Axial flow.	Drier/ filter Provided.	Expansion device Capillary Tube.
Evaporator Forced convection air cooled.	Evaporator Fan Axial Flow Type	Dehumidifier or
Reheater	1000 Watts; Finned Type.	Humidifier Provided
Refrigerant R-134a.	Structure: 	Chemical formula : 1,1,1,2 Tetrafluroethane
HP / LP Cut-out Alco/ or Danfoss / or Indfoss or any equivalent make.	Temperature five Channel facility with digital display.	Pressure two Nos: Dial type pressure gauges.

3.6 EXPERIMENTAL PROCEDURE

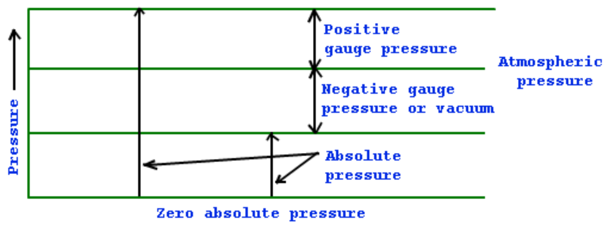
- Switch “ON” the main switch, note down the temperature of air. Now, first start the fan and then start the compressor, temperature of air will start dropping down.
- Never start the compressor before putting on the fan.
- Now start the heaters one by one, and keep the room temperature constant. Adjust heater input if required by dimmer.
- Operate all the knobs and controls gently.
- Never start the heater when compressor is off.
- When the room temperature remains steady, note down the temperatures and pressures.
- Put “OFF” the heaters one by one.
- Leave at least one meter space around the equipment.

CHAPTER 4

PERFORMANCE ANALYSIS

4.1 Absolute condensing pressure

Any pressure measured above the absolute zero of pressure is termed as absolute pressure. It is equal to gauge pressure plus the atmospheric pressure. It is measured using barometer.

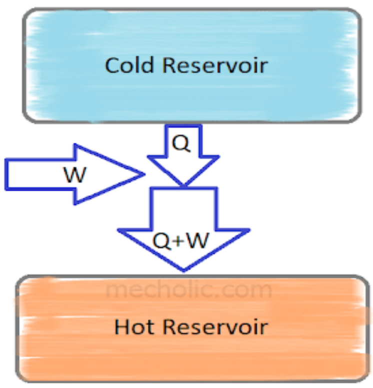


$$P_{abs} = P_{atm} + P_{gauge}$$

1. Absolute condensing pressure $-P_c$ = [p_c + 1.0332 kg/cm^2] *0.98 bar
2. Absolute Evaporating pressure $-P_e$ = [p_e+ 1.0332 kg/cm^2] *0.98 bar

Atmospheric pressure is assumed to be 1.0332 kg/cm^2(NOTE - 1 bar = 1.0332 kg/cm^2)

4.2 Theoretical COP



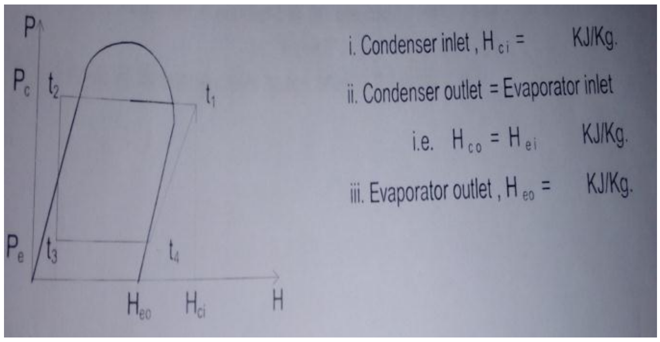
The refrigerator is a device that extracts heat from colder part/ reservoir of the system and delivered it to the hotter sink/ environment. According to the second law of thermodynamics, the heat flow from a cold body to a hot body occur only by doing some outside work.

The coefficient of performance of a refrigerator is defined as the ratio of useful cooling effect provided by the refrigerator to the work required.

Mathematically theoretical coefficient of performance of refrigeration is denoted as follows Theoretical C.O.P. = Q/W

Where, Q = the total heat extracted in refrigeration (amount of cooling effect) W = amount of work done by the refrigeration system

Plot the cooling cycle on P-H (Pressure - Enthalpy) chart of R-134a and find out enthalpy values.



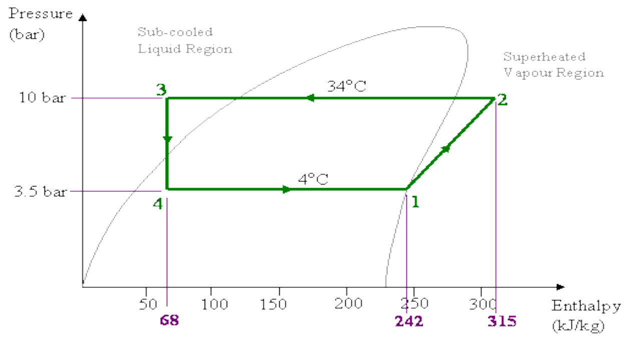
Compressor work =H_{ci} – H_{eo}

Refrigerating effect =H_{eo} – H_{ei}

Refrigerating effect

Theoretical COP = --------------------------

Compressorwork



p-H Diagram of Refrigeration Cycle for 134a

4.3 Actual refrigerating effect

Energy meter constant for heater energy meter constant, EMC_e =3200 imp / kwh

3600*10

Heater work or input = ------------------kw

T_{het} * EMC_h

Energy meter constant for Compressor energy meter constant, EMC_c =3200 imp / kwh

3600*10

Compressor work or input = ------------- kw

T_{com} * EMC_c

4.4 Actual COP

It is defined as ratio of heater input to the compressor input

Heater input

Actual COP = ------------------------

Compressor input

Calculations

- To calculate Actual C. O. P. of the system.
- To calculate Theoretical C. O.P. of the Cycle.

- To plot operating cycle on P-H chart.

TRAIL 1

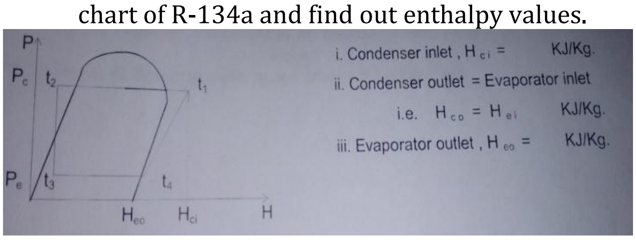
1. Absolute condensing pressure P_c = [12.5 + 1.0332 kg/cm²] *0.98 = 13.26 bar

2. Absolute Evaporating pressure P_e = [3.6 + 1.0332 kg/cm²] *0.98= 4.54 bar

Atmospheric pressure is assumed to be 1.0332 kg/cm²

(Note 1 bar = 1.0332 kg/cm²)

3. Plot the cooling cycle on P-H (Pressure - Enthalpy) chart of R-134a and find out enthalpy values.



Compressor work = $H_{ci} - H_{eo}$

Refrigerating effect = $H_{eo} - H_{ei}$

418-210
Theoretical COP =----------------- = 5.62
455-418

1. Actual refrigerating effect

Energy meter constant for heater energy meter constant, EMC_e =3200 imp / kwh

3600*10 Heater work or input = --------------- = 0.34 kw
33*3200

Energy meter constant for Compressor energy meter constant, EMC_c =3200 imp / kwh
3600*10 Compressor work or input = ---------------= 0.25 kw
45*3200

2. Actual COP = 1.36

Tabular column:

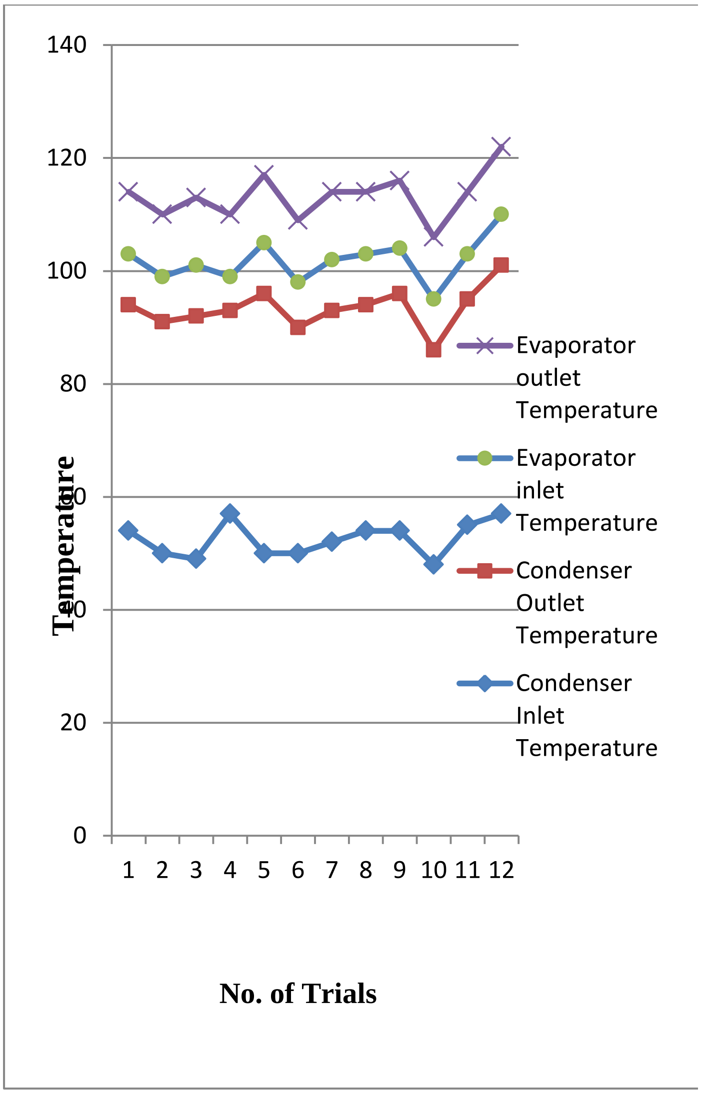
Condensing Pressure(kg /cm²)	Evaporating Pressure(kg /cm²)	Temperatures					Time (10pulse) In sec For compressor	Time (10pulse) In sec For bulbs(heater)	Theoretical cop	Heater Work Or input	Compressor work or input	Actual cop
		T 1	T 2	T 3	T 4	T 5						
12.5	3.6	54	40	9	11	19	45	33	5.62	0.34	0.25	1.36
12.2	3.4	50	41	8	11	19	43	30	4.975	0.34	0.25	1.43
12	3.2	49	43	9	12	20	40	33	6.33	0.34	0.28	1.208
13	3.8	57	36	6	11	26	51	26	5	0.43	0.22	1.96
12.8	3.5	50	46	9	12	27	40	33	5.28	0.34	0.28	1.21
12	3.2	50	40	8	11	23	36	30	5	0.37	0.31	1.19
12.2	3.4	52	41	9	12	26	40	32	5.58	0.31	0.25	1.24
12.5	3.6	54	40	9	11	19	42	28	5.62	0.34	0.25	1.36
12.4	3.4	54	42	8	12	20	40	32	5.1	0.35	0.28	1.25
11.8	3	48	38	9	11	19	38	28	6	0.40	0.29	1.37
12.2	3.4	55	40	8	11	20	36	28	5.2	0.35	0.29	1.35
12.8	3.6	57	44	9	12	22	39	28	5.9	0.39	0.28	1.39

5.1 Results and Discussions

The condensation process evolved in three regions: gas region (characterized by superheated vapor), wet region (characterized by two phase flow) and liquid region (characterized by sub-cooled liquid). An increase in ambient temperature results eventually in an increase in the saturation temperature and saturation pressure of refrigerant. This leads to a decrease in the area available for the two phase region in the condenser as shown in delineate the effect of ambient temperature on the pressure drop in two phase, gas and liquid regions, respectively for both four and eight circuits' condenser. The two phase region has the biggest contribution to the total pressure drop in the condenser, due to momentum change. For example, the wet region pressure drop contributed by about 80% of the entire drop at 30°C ambient temperature. Also it can be seen from the figure that as the ambient temperature increases, the pressure drop decreases as a result of the reduction in the area available for this region. Figure 4 shows also that four circuits' condenser has higher pressure drop as compared with that of eight circuits' condenser, attributed to the longer path of flow in the former. From Figs. 4 and 5, it can be seen that the pressure drop in gas and liquid regions for both four and eight circuits' condenser increases with the increase in ambient temperature. This behavior is caused by the increase in specific volume, as well as due to the increases in the lengths of these regions at the expense of wet region.

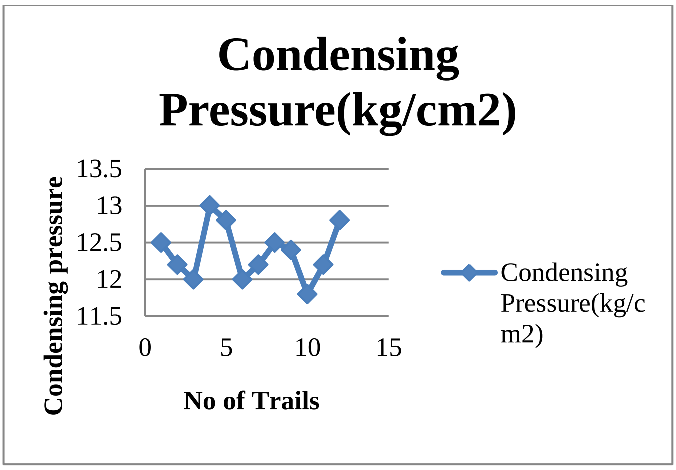
Graphical representation of Theoretical C.O.P. and Actual C.O.P. for Window Air Conditioner

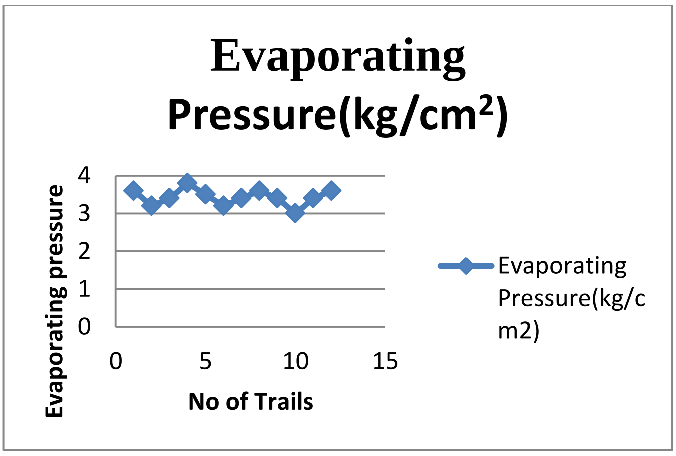
Graphical representation of Theoretical C.O.P. and Actual C.O.P. for Window Air Conditioner

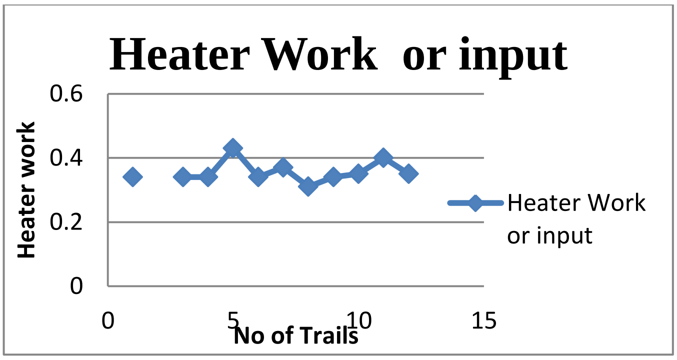


Many preliminary experiments were performed to prepare the set up for getting reliable data. In order to have a basis for comparison and also to specify the effect of evaporative cooling on the air conditioner, each experiment was performed in two consequent stages. In the first stage, conventional air conditioner was used in the experiment without using media pad and the data were recorded after steady state condition was established. Then, the air conditioner was turned off and the condenser of air conditioner was retrofitted by evaporative cooling very fast and the second stage of the experiment was performed. The time difference between two stages was small (about one hour.), so the weather condition for two experiments was the same. In all experiments the data were recorded after steady state condition was established and the properties of refrigerant and air remained constant. Many tests were performed to determine the effect.

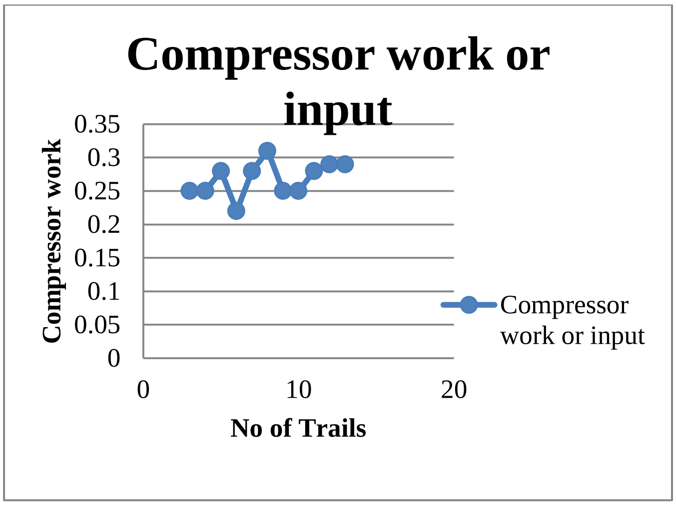
Graphical representation of Window Air Conditioner







Graph 4- Represents the Heater work or input



Graph 5- Represents the compressor work or input

CONCLUSION

The domestic refrigerators now a day are becoming essential part of life. These refrigerators are available in different capacities as well as different working models. These are having single door double door options, frost free refrigerators; quick chill refrigerators are also available. To make the refrigerators smart now a day the condensers are sealed and refrigerators are mode flat back. The compressors used in household refrigerator are hermetically sealed reciprocating units. Now a days noise free rotary hermetically seals compressors are also used. The refrigerant R-12 which was popularly used in household refrigerators is discarded due to its ODP (ozone depletion potential). It is replaced by R-134(a).The current project work is to demonstrate the working of window air conditioner to evaluate the performance parameter. During experimental investigation, it is found that the system is able to produce and maintain the different load condition in the psychrometric test chamber. It is found that the Experimental set up can produce the EER and validate the star rating. Thus, the system can be successfully used for different capacities of Window Air Conditioner, Retrofit or Modified Air Conditioner with some alteration.

Future scope

The air output temperature attained by this project can be reduced to lower temperature by providing custom engineered indoor units in this project is designed to handle this type of refrigerant (air).

By replacing indoor units of this project AC, it can also be an air cooler by providing additional components like fan and an enclose fixed with the cooling pads fixed at the side similar to the ordinary cooler.

As it makes use of refrigerator components which are economic compared to AC components it is more efficient further use of suitable refrigerants comparatively lower temperatures can be achieved.

Although time required to attain the temperature is more a proper installation systems can be employed which might decrease the overall time required for cooling in order to achieve an output similar to the AC.

REFERENCES

1. **Vaibhav K. Dongare [1]** has Discussed The future Phase-Out Of Hydro Chloro Fluoro Carbons (Hcfcs) Used In Air Conditioning System.
2. **Prof. S.M.Shaikh,Prof. A.M.Patil[2]**They Presents Window Air Conditioner Is Available On Various Capacities& Various Manufactures In Global Market.
3. **K. R. Aglawe[3]** Hasreported About Coefficient Of Performance Improvement And Reduction Of Energy Consumption Of An Window Air Conditioning System When Retrofitted With Evaporative Cooling In The Condenser Of Window Air Conditioner Is Reviewed In This Paper.
4. **Fu Wing U Etal. 2005[4]** Investigated How The Cop Of These Chillers Can Be Improved By A New Condenser Design, Using Evaporative Pre-Coolers And Variable-Speed Fans.
5. **Madhur Behl, 2012[5]** This Paper Presents A Green Scheduling Approach With Chilling Plants To Reduce Their Peak Power Demands.
6. **Ho Yin Chun[6]** Discussed About Simulation Study On How To Increase The Coefficient Of Performance (Cop) Of An Air-Cooled Screw Chiller Equipped With High Static Condenser Fans.
7. **Prof. S.M.Shaikh1, Prof. A.M.Patil2, Prof. A. M. Vibhute[7]** ISSN: 2278-1684, PP: 32-37 Performance Investigation of Window Air Conditioner.
8. **C.P.Arora,** 2006 "Refrigeration and Airconditioning", secondedition, TataMcGrawHill, India,ISBN0-07-463010-5.
9. **ENGINEERING JOURNAL** Volume 21 Issue 1, ISSN 0125-8281 (http://www.engj.org/)

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