राज्य अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, नीलोखेड़ी

State Institute of Engineering & Technology, Nilokheri

(Formerly Govt. Engineering College)

LABORATORY MANUAL

REFRIGRATION AND AIR CONDITIONING LAB

MEC-308 LA

Department of Mechanical Engineering

STATE INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Affiliated to K.U. University)

NILOKHERI – 132117, KARNAL

Ref & Air Cond. Lab

List of Experiments

1. To study and perform experiment on basic vapour compression refrigeration cycle.
2. To find C.O.P. of water cooler.
3. To study and perform experiment on vapour absorption apparatus.
4. To find the performance parameter of cooling tower.
5. To study various components in room air conditioner.
6. To find RH of atmospheric air by using Sling Psychrometer.
7. To study different control devices of a refrigeration system.
8. To find the performance of a refrigeration test rig system by using different expansion devices.

EXPERIMENT NO – 1

AIM: To study and perform experiment on basic vapour compression Refrigeration Cycle.

Theory:

Vapour compression refrigeration cycle

A vapour compression refrigeration system is an improved type of air refrigeration system in which a suitable working substance, termed as refrigerant is used. It condenses and evaporates at temperatures and pressures close to the atmospheric conditions.
The refrigerant used does not leave the system but is circulated throughout the system alternately condensing and evaporating. The vapour compression refrigeration system is now days used for all-purpose refrigeration. It is used for all industrial purpose from a small domestic refrigerator to a big air conditioning plant.
The vapour compression refrigeration cycle is based on the following factor:

- Refrigerant flow rate.
- Type of refrigerant used.
- Kind of application viz air-conditioning, refrigeration, dehumidification etc.
- The operation design parameters.
- The system equipments/ components proposed to be used in the system.

The vapour compression refrigeration cycle is based on a circulating fluid media, viz, a refrigerant having special properties of vaporizing at temperatures lower than the ambient and condensing back to the liquid form, at slightly higher than ambient conditions by controlling the saturation temperature and pressure. Thus, when the refrigerant evaporates or boils at temperatures lower than ambient, it extracts or removes heat from the load and lower the temperature consequently providing cooling.
The super-heated vapour pressure is increased to a level by the compressor to reach a saturation pressure so that heat added to vapour is dissipated/ rejected into the atmosphere, using operational ambient conditions, with cooling medias the liquid from and recycled again to form the refrigeration cycle.
The components used are:

1. **Evaporator**
2. **Compressor**
3. **Condenser and receiver**
4. **Throttling device**

The refrigeration cycle can be explained schematically in the two diagrams i.e.. Pressure enthalpy diagram Temperature entropy diagram

The working of vapour compression refrigeration cycle and function of each above component is given below.

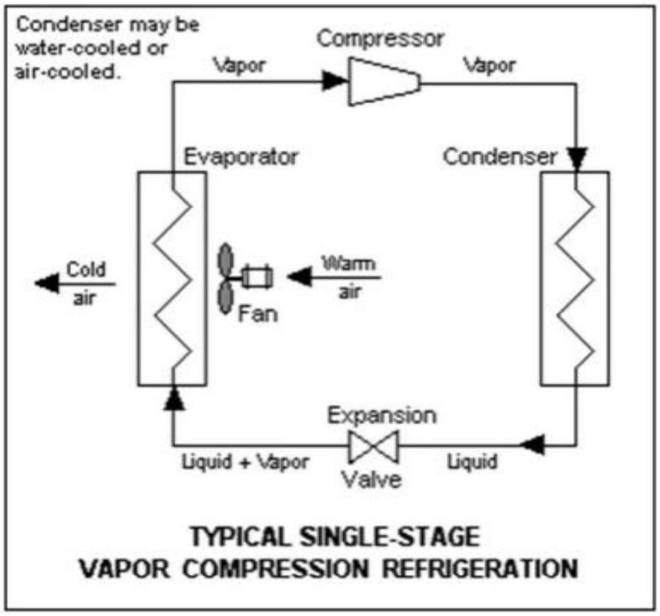


Figure: Components of vapour refrigeration system

(a) Evaporator:

The liquid refrigerant from the condenser at high pressure is fed through a throttling device to an evaporator at a low pressure. On absorbing the heat to be extracted from Media to be cooled, the liquid refrigerant boils actively in the evaporator and changes state. The refrigerant gains latent heat to vaporizes at saturation temperature/ pressure and further absorbs sensible heat from media to be cooled and gets fully vaporized and super heated. The "temperature-pressure relation chart" table can determine the pressure and temperature in the evaporator.

(b) Compressor

The low temperature, pressure, superheated vapour from the evaporator is conveyed through suction line and compressed by the compressor to a high pressure, without any change of gaseous state and the same is discharge into condenser. During this process heat is added to the refrigerant and known as heat of compression ratio to raise the pressure of refrigerant to such a level that the saturation temperature of the discharge refrigerant is higher than the temperature of the available cooling medium, to enable the super heated refrigerant to condense at normal ambient condition.

Different types of compressors are reciprocating, rotary and centrifugal and are used for different applications.

(c) Condenser The heat added in the evaporator and compressor to the refrigerant is rejected in condenser at high temperature/ high pressure. This super heated refrigerant vapour enters the condenser to dissipate its heat in three stages. First on entry the refrigerant loses its super heat, it then loses its latent heat at which the refrigerant is liquefied at saturation temperature pressure. This liquid loses its sensible heat, further and the refrigerant leaves the condenser as a sub cooled liquid. The heat transfer from refrigerant to cooling medium (air or water) takes place in the condenser. The sub-cooled liquid from condenser is collected in a receiver (wherever provided) and is then fed through the throttling device by liquid line to the evaporator.

There are several methods of dissipating the rejected heat into the atmosphere by condenser. These are water-cooled, air cooled or evaporative cooled condensers.

In the water-cooled condenser there are several types viz. Shell and tube, shell and coil, tube in tube etc. In Evaporative cooled condenser, both air and water are used. Air-cooled condensers are prime surface type, finned type or plate type.

The selecting of the type depends upon the application and availability of soft water.

(d) Throttling device

The high-pressure liquid from the condenser is fed to evaporator through device, which should be designed to pass maximum possible liquid refrigerant to obtain a good refrigeration effect. The liquid line should be properly sized to have minimum pressure drop.

The throttling device is a pressure-reducing device and a regulator for controlling the refrigerant flow. It also reduces the pressure from the discharge pressure to the evaporator pressure without any change of state of the pressure refrigerant.

The types of throttling devices are:

- Capillary tubes
- Thermostatic expansion valves
- Hand expansion valves
- Hand valves.

The most commonly used throttling device is the capillary tube for application upto approx. 10 refrigeration tons. The capillary is a copper tube having a small dia-orifice and is selected, based on the system design, the refrigerant flow rate, the operating parameters (such as suction and discharge pressures), type of refrigerant, capable of compensating any variations/ fluctuations in load by allowing only liquid refrigerant to flow to the evaporator.

Result: Various components of the vapour compression system have been studied.

Experiment No.-2

Aim: To find COP of water cooler.

Apparatus used: Water cooler trainer.

Theory: Temperature–entropy diagram

That results in a mixture of liquid and vapour at a lower temperature and pressure as shown at point 4. The cold liquid-vapour mixture then travels through the evaporator coil or tubes and is completely vaporized by cooling the warm air (from the space being refrigerated) being blown by a fan across the evaporator coil or tubes. The resulting refrigerant vapour returns to the compressor inlet at point 1 to complete the thermodynamic cycle.

The above discussion is based on the ideal vapour-compression refrigeration cycle, and does not take into account real-world effects like frictional pressure drop in the system, slight thermodynamic irreversiblity during the compression of the refrigerant vapour, or non-ideal gas behavior (if any).

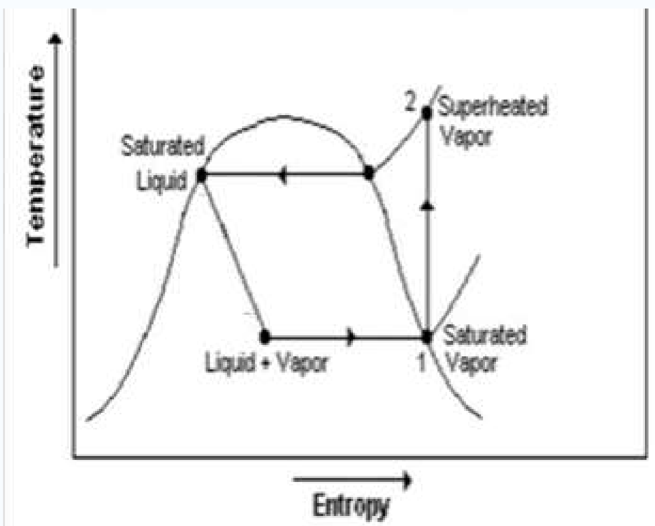


Figure: T-S diagram of vapour compression refrigeration system

Where

P_1=suction pressure
P_2=dischage pressure
T_1= temperature before entering to compressor
T_2=temperature after exit from compressor
T_3=temperature after condensor
T_4=temperature after expansion valve
MR =rotameter reading (kg/min.)

OBSERVATION TABLE:

S.NO.	P_1	P_2	T_1	T_2	T_3	T_4	MR
1.							
2.							
3.							

Coefficient of performance: - The coefficient of performance is defined as the ratio of heat extracted in the evaporator to the work done on the refrigerant

$$\text{C.O.P} = \frac{Q}{W}$$

Using points (P_1,T_1) ; (P_2,T_2) ;T_3 and T_4 locate points 1,2,3,4 on the p-h chart for R-22 and obtain the enthalpy values h_1,h_2, h_3, h_4

$$\text{THEORETICAL C.O.P} = \frac{h1-h4}{h2-h1}$$

Result: The C.O.P. of the system is……………..

Experiment No – 3

Aim: To study and perform experiment on vapour absorption apparatus.

Theory:

The vapour absorption refrigeration system is one of the oldest method of producing refrigerating effect. The principle of vapour absorption was first discovered by Michael Faraday in 1824 while performing a set of experiments to liquefy certain gases. A french scientist Ferdinand carre developed the first vapour absorption refrigeration machine in 1860. This system may be used in both the domestic and large industrial refrigerating plants. The refrigerant, commonly used in a vapour absorption system, is ammonia.

The vapour absorption system uses heat energy, instead of mechanical energy as in vapour compression systems, in order to change the conditions of the refrigerant required for the operation of the refrigeration cycle.

In the vapour absorption system, an absorber, a pump, a generator and a pressure-reducing valve replace the compressor. These components in vapour absorption system perform the same function as that of a compressor in vapour compression system. In this system, the vapour refrigerant from the evaporator is drawn into an absorber where it is absorbed by the week solution of the refrigerant forming a strong solution. This strong solution is pumped to the generator where it is heated by some external source. During the heating process, the vapour refrigerant is driven off by the solution and enters into the condenser where it is liquefied. The liquid refrigerant then flows into the evaporator and thus the cycle is completed.

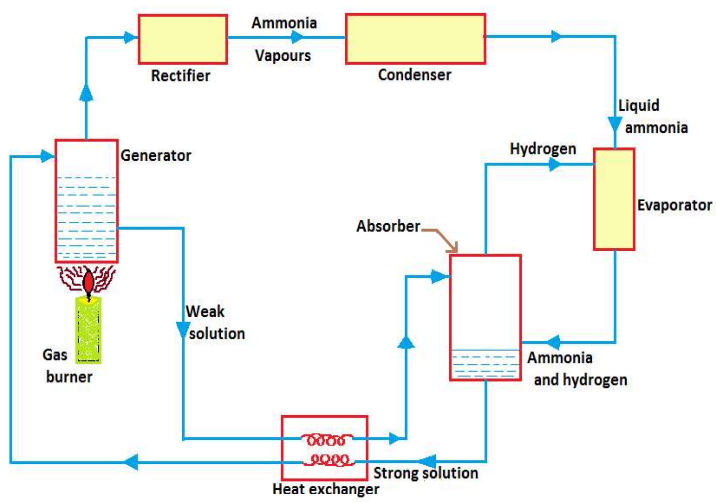


Figure: Electrolux vapour absorption system

Working:

The domestic absorption type refrigerator was invented by two Swedish engineers **Carl Munters and Baltzer Van Platan in 1925** while they were studying for their under-graduate course of royal institute of technology in Stockholm. The idea was first developed by the **'Electrolux Company' of Luton, England.**
This type of refrigerator is also called **three- fluids absorption system**. The main purpose of this system is to eliminate the pump so that in the absence of moving parts, the machine becomes noise-less. The three fluids used in this system are **ammonia, hydrogen and water.**

- The ammonia is used as a refrigerant because it possesses most of the desirable properties. It is toxic, but due to absence of moving parts, there are very little changes for the leakage and the total amount of refrigeration used is small.
- The hydrogen being the lightest gas is used to increase the rate of evaporation of the liquid ammonia passing through the evaporator. The hydrogen is also non-corrosive and insoluble in water. This is used in the low-pressure side of the system.
- The water is used as a solvent because it has the ability to absorb ammonia readily.

The strong ammonia solution from the absorber through heat exchanger is heated in the generator by applying heat from an external source usually a gas burner. During this heating process, ammonia vapour are removed from the solution and passed to the condenser. A rectifier or a water separator fitted before the condenser removes water vapour carried with the ammonia vapour, so that dry ammonia vapour are supplied to
The condenser. These water vapour, if not removed, they will enter into the evaporator causing freezing and choking of the machine. The hot weak solution while passing through the exchanger is cooled. The heat removed by the weak solution is utilized in raising the temperature of strong solution passing through the heat exchanger. In this way, the absorption is accelerated and the improvement in the performance of a plant is achieved.
The ammonia vapour in the condenser is condensed by using external cooling source. The liquid refrigerant leaving the condenser flows under gravity to the evaporator where it meets the hydrogen gas. The hydrogen gas which is being fed to the evaporator permits the liquid ammonia to evaporate at a low pressure and temperature according to Dalton's principal. During the process of evaporation, the ammonia absorbs latent heat from the refrigerated space and thus produces cooling effect.
The mixture of ammonia vapour and hydrogen is passed to the absorber where ammonia is absorbed in water while the hydrogen rises to the top and flows back to the evaporator.

The main disadvantage of electrolux refrigerator is:

It can not be used for industrial purpose as the COP of the system is very low.

Result: Vapour refrigeration refrigeration system.

Experiment No.-4

Aim: To find the performance parameter of cooling tower.

Apparatus used: Cooling tower test rig.

Theory: The cooling tower is conjunction with the water-cooled condenser. Water is passing through the condenser water tubes only gets warmed up but does not get contaminated. It can, therefore, be used again, after cooling. The cooling tower cools the warm water for re – circulating it in the condenser. It is thus water conservation equipment. The heat removed by the refrigeration system from the space or product to be cooled is ultimately thrown to the atmosphere through the cooling tower in a water-cooled condenser system. Thus the cooling tower should function efficiently for the refrigeration system to perform well.

The warm water from the condenser is pumped to the top of the cooling tower. From there it is allowed to fall down a substational height to the cooling tower tank or through at the bottom. The falling water droplets are cooled by the air circulating through the tower. The cooling is brought about by sensible heat transfer and by the evaporation of a portion of the water. To facilitate heat transfer, the water from the cooling tower in fine droplets or film. This is accomplished in:-

1.) The atmospheric cooling tower by the use of spray nozzles which spray water from the top of the cooling tower.

2.) The forced draft or induced draft cooling tower, by increasing the surface area of water. Water is allowed to trickle over the special type of fiber material closely packed in the cooling tower. Water spreads over the fiber martial thus creating the large surface area for heat transfer between water and air.

The water vapour produced by the evaporation of water is carried away by the air circulating through the tower. Thus the air coming out from the cooling tower will be humid and warm.

Capacity of cooling towers:

The capacity of cooling tower depends upon the amount of evaporation of water that takes place. The amount of evaporation of water in turn, depends upon the following factors:

1. The amount of water surface exposed to the air.
2. The length of the exposure time
3. The velocity of air passing over the water droplets formed in cooling tower.
4. The wet bulb temperature of the atmospheric air.

Note: - When the wet bulb temp. of air decreases the air can absorb more water vapour and therefore evaporate more water. Thus the capacity of the cooling tower increases.

Types of cooling towers:

1. Natural draft cooling tower
2. Mechanical draft cooling tower

1. Natural draft cooling tower: Since the air circulating through the natural draft cooling tower is atmospheric air, therefore these cooling towers are known as natural draft cooling tower.

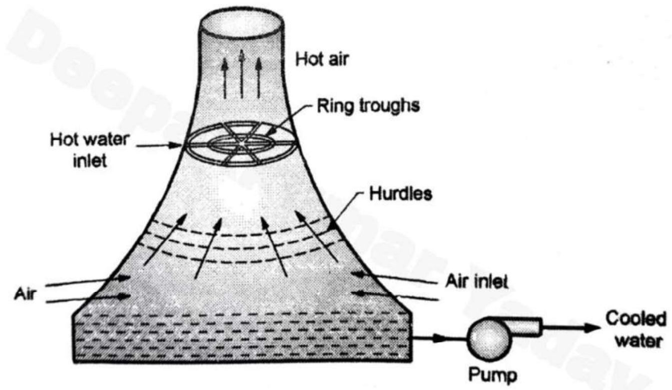


Figure: Natural draft cooling tower

2. Mechanical draft cooling tower: - The mechanical draft cooling towers are similar to atmospheric natural draft cooling towers except that the fans or blowers which are used to force air through them.

Advantages of mechanical draft cooling towers:

1. These are smaller in size than natural draft cooling tower of same capacity.
2. The cooling capacity of mechanical draft cooing tower can be controlled by controlling the amount of forced air.
3. Mechanical draft cooling tower can be located inside the building because they do not depend upon atmospheric air.

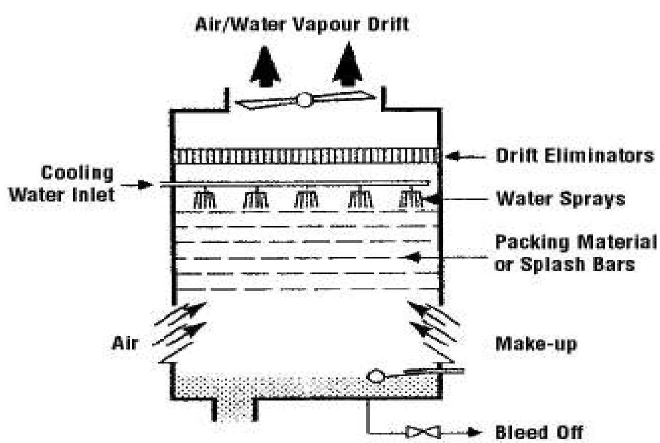


Figure: Forced draft cooling tower

Disadvantages of mechanical draft cooling towers:

1. Mechanical draft cooling tower requires additional power to operate the fans.
2. The maintenance of fans, motors and control increases the operating cost.

Introduction to test rig

The unicool cooling tower consists of about 1.2 meter length of tower made form transparent acrylic sheet for the clear visualization fitted over the conical housing.

The main m.s. tank of capacity of about 80 ltr. Is provided through which centrifugal pump sucks water and delivers to the geyser through flow meter. In geyser the temp. of water gets increases and it sprays on the top of cooling tower through spray nozzles over the decking material (fiber). Then water is allowed to trickle over the decking material closely packed in the cooling tower. Water spreads over the fiber martial thus creating the large surface area for heat transfer between water and air. A centrifugal type blower with control valve is used to blow air inside the cooling tower. The falling water droplets are cooled by the air circulating through the tower. The cooling is brought about by sensible heat transfer and by the evaporation of a portion of the water.

The water vapour produced by the evaporation of water is carried away by the air circulating through the tower.

Observation table:

S.no.	**Temp. Of water inlet to cooling tower** (T_1)	**Temp. Of water outlet to cooling tower** (T_2)	**Wet bulb temp. Of atmospheric air** (T_3)

Calculations:

$$\text{Efficiency of cooling tower} = \frac{\text{Actual cooling obtained}}{\text{Theoretical cooling to be obtained}}$$

$$\text{Efficiency of cooling tower} = \frac{T_1 - T_2}{T_1 - T_3} = \_\_\_\_\_\_\_\_\_\_\%$$

Result: The efficiency of cooling tower is………

Experiment No.-5

Aim: To study various components in room air conditioning system.

Apparatus: Window air conditioning trainer.

Theory:

Window air conditioner is sometimes referred to as room air conditioner as well. It is the simplest form of an air conditioning system and is mounted on windows or walls. It is a single unit that is assembled in a casing where all the components are located.

This refrigeration unit has a double shaft fan motor with fans mounted on both sides of the motor. Oneat the evaporator side and the other at the condenser side.

The evaporator side is located facing the room for cooling of the space and the condenser side outdoor for heat rejection. There is an insulated partition separating this two sides within the same casing.

Front Panel

The front panel is the one that is seen by the user from inside the room where it is installed and has a user interfaced control be it electronically or mechanically. Older unit usually are of mechanical control type with rotary knobs to control the temperature and fan speed of the air conditioner.

The newer units come with electronic control system where the functions are controlled using remote control and touch panel with digital display.

The front panel has adjustable horizontal and vertical(some models) louvers where the drection of air flow are adjustable to suit the comfort of the users.

The fresh intake of air called VENT (ventilation) is provided at the panel in the event that user would like to have a certain amount of fresh air from the outside.

Indoor Side Components

The indoor parts of a window air conditioner include:

- **Cooling Coil** with a air filter mounted on it. The cooling coil is where the heat exchange happen between the refrigerant in the system and the air in the room.
- **Fan Blower** is a centrifugal evaporator blower to discharge the cool air to the room.
- **Capillary Tube** is used as an expansion device. It can be noisy during operation if installed too near the evaporator.
- **Operation Panel** is used to control the temperature and speed of the blower fan. A thermostat is used to sense the return air temperature and another one to monitor the temperature of the coil. Type of control can be mechanical or electronic type.
- **Filter Drier** is used to remove the moisture from the refrigerant.

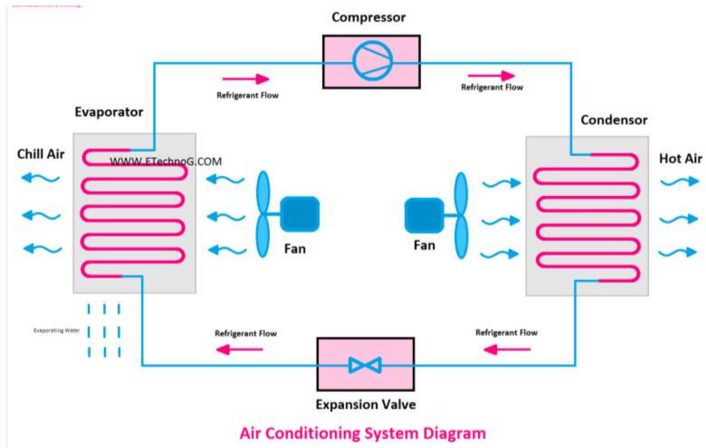
- **Drain Pan** is used to contain the water that condensate from the cooling coil and is discharged out to the outdoor by gravity.

Figure: Components of air conditioning system

Outdoor Side Components

The outdoor side parts include:

- **Compressor** is used to compress the refrigerant.



- **Condenser Coil** is used to reject heat from the refrigeratn to the outside air.
- **Propeller Fan** is used in air-cooled condenser to help move the air molecules over the surface of the condensing coil.
- **Fan Motor** is located here. It has a double shaft where the indoor blower and outdoor propeller fan are connected together.

Operations

During operation, a thermostat is mounted on the return air of the unit. This temperature is used to control the on or off of the compressor. Once the room temperature has been achieved, the compressor cuts off.

Usually, it has to be off for at least 3 minutes before turning on again to prevent it from being damaged. For mechanical control type, there is usually a caution to turn on the unit after the unit has turned off for at least 3 minutes. For electronic control, there is usually a timer to automatically control the cut-in and cut-out of compressor.

The evaporator blower fan will suck the air from the room to be conditioned through the air filter and the cooling coil. Air that has been conditioned is then discharge to deliver the cool and dehumidified air back to the room. This air mixes with the room air to bring down the temperature and humidity level of the room.

The introduction of fresh air from outside the room is done through the damper which is then mixed with the return air from the room before passing it over the air filter and the cooling coil. The air filter which is mounted in front of the evaporator acts as a filter to keep the cooling coil clean to obtain good heat-transfer from the coil. Hence, regular washing and cleaning of the air filter is a good practice to ensure efficient operation of the air conditioner.

Heat Pump Window Air Conditioner

In temperate countries, heating of the room is required. A heat pump window air conditioner unit is able to cool the room during summer and heat the room during winter. A reversing valve (also known as 4-Way-Valve) is used to accomplish this.

During heating operation, it reverses the flow of the refrigerant which results in the evaporator to act as a condenser and the condenser as evaporator.

Result: Various components of room air conditioner have been studied.

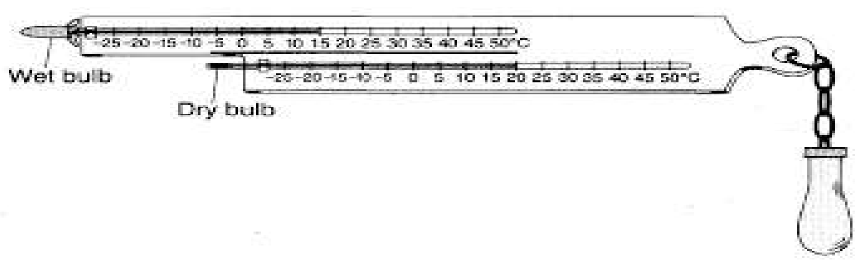
Experiment No.- 6

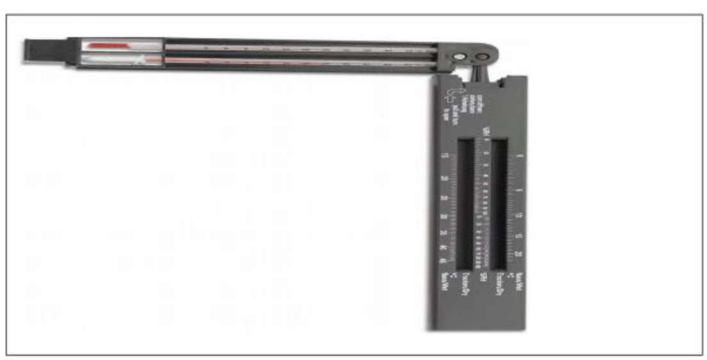
Aim:- To find RH of atmospheric air by using Sling Psychrometer.

Theory:- There are four properties of air that account for its behavior under varying conditions. These properties are dry bulb temperature, wet bulb temperature, dew point temperature, and relative humidity A Psychrometer is an instrument for measuring the aqueous vapor in the atmosphere. A difference between a wet bulb thermometer and a dry bulb thermometer is an indication of the dryness of the air. A Psychrometer, then, is a hygrometer, which is a device for measuring water content in air. A psychometric chart indicates the different values of temperature and water moisture in air. The dry bulb temperature is located in one place and the wet bulb in another. If the two are known, it is easy to find the relative humidity and other factors relating to air being checked. To obtain the relative humidity of air it is necessary to use two thermometers. One thermometer is a dry bulb; the other is a wet bulb. The device used to measure relative humidity is the sling Psychrometer. It has two glass-stem thermometers. The wet bulb thermometer is moistened by a wick attached to the bulb. As the dual thermometers are whirled, air passes over them. The dry and wet bulb temperatures are recorded. Relative humidity is determined by graphs, slide rules, or similar devices.

Figure:- Sling Psychrometer

A sling Psychrometer is an instrument that measures relative humidity (a hygrometer). The sling has two thermometers, a dry bulb and a wet bulb thermometer, mounted together on a chain. The wet bulb thermometer is wrapped in muslin that is moistened with distilled water. The user then swings the sling until the temperatures stabilize, then quickly notes the two temperatures. To interpret the readings and determine the humidity, a chart is then used for the specific altitude at which the reading was taken.





The Sling Psychrometer

Basically, the drier the air is, the more moisture evaporates from the moistened muslin-covered thermometer, and the greater the difference between the two thermometers. If the relative humidity is 100%, then the two temperatures will be the same. Slings have been around for years, and are becoming less and less used for many reasons. With the advent of digital hygrometers, it's just easier to pull out a device and read the screen. Additionally, besides being cumbersome and time consuming, slings contain mercury, a hazardous material, and must be handled with care. A sling will typically read 5-10% high due to user error.

PROCEDURE:-

1. Wet the cotton gauze with water the gauze should be damp but not dripping cover the one bulb of thermometer with the wet gauze and secure the gauze to the thermometer with the rubber band.
2. Place both thermometers nest to each other under the same conditions. Use a folder or a piece of cardboard to blow air over the thermometers. The fanning will not significantly change the temperature of the air but it will catalyze evaporation. If possible wait several minutes for the thermometers to adjust to the temperature of the air. Water will evaporate from the gauze if relative humidity allows. Slightly cooling the wet bulb thermometer and allowing a temperature difference between two.

   Example: If dry bulb temperature if 24^0 C and there is 2^0 C temperature difference between wet bulb and dry bulb temperature then your environment has 84% relative humidity.

Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Experiment No.-7

Aim: **To study various control devices used in refrigeration system.**

Theory:

Over load protector

The basic function of an over load protector is to protect compressor motor from damaged, due to over current draw and overheating over its operating range and under over load conditions of temporary valve which might occur occasionally. It is always try to select an overload protector which will cut off compressor supply before it reaches the critical winding temperature level and the sometime ensuring that the over load does not interfere at the acceptable winding temperature over its entire operating range.

High pressure control / cut off

A high pressure cut out is a pressure control device used as a safety control on the discharge line of a compressor or a group of compressor. In case of condenser failure, or other operating conditions that cause the discharge pressure to rise above a set point the high pressure cut out, opens the compressor motor controls circuit to prevent further pressure increase. The control can also be wired to actuate an alarm circuit.

Low pressure control cut / out

A low pressure cut out is a similar type pressure controller. It is so arranged that the contact are opened when the pressure falls below a given point. It is sometimes used a safety control to prevent the suction pressure from falling to a point where the compressor ratio will be too great for the compressor design. It also prevents the suction pressure from falling to a point where other damage can occur from low temperature such as freezing up of a water cooler. This cut out is often used as the control device to stop the compressor when pressure (and therefore temperature) conditions have been satisfied. These controls also have an adjustable range and differential.

Relay for starting of motors in refrigerant

At the time of starting, the motor takes heavy passes through the coil which pulls up the plunger and the controls are closed bringing the starting winding into current. Once the motor catches the speed, the current is reduced which automatically release the plunger and the starting winding is cut off. Only running winding is kept in the circuit. Over current element which is a bimetallic strip disconnect the supply to the motor when excessive current is taken by the motor. Bimetallic strip and the contacts are broken.

Thermostat

It is used to control the temperature of the refrigeration. The bulb of the thermostat is clamped to the evaporator or freezer. The thermostat bulb is charged with few drops of refrigerant. The thermostat can be set to maintain different temperature at a time. When the desired temperature is obtained, the bulb of the thermostat senses it, the liquid in it compresses and operates the bellows of the thermostat and open compressor motor contacts. The temperature at which the compressor motor stops called cut out temperature.

Experiment No.-8

Aim: To find performance of various types of expansion devices on Refrigeration test Rig.
Apparatus: Refrigeration trainer containing different expansion devices.
Theory:

Capillary tubes expansion devices

Though the capillary tube is not a valve, it does the purpose of expansion valve in, domestic units and in some small commercial units such a refrigerator, water cooler, cooling equipments. It is a coil or a length of a fine tubing that a very small orifice, usually 0.30 to 0.10 inch in diameter. The high pressure is dissipated in forcing the liquid through this small orifice and a predetermined amount of liquid of at a reduced pressure is allowed to flow to the evaporator. The capacity is determined by the diameter and length of tubing used. The operation of capillary tube is simple and full proof. It is simple in construction and no maintenance is required. System using this device does not require receiver. The disadvantages associated with this device, the refrigerant must be free from moisture and dirt otherwise it will chock the tube and stop the flow of refrigerant. It cannot be used with high fluctuating load conditions.

Hand expansion valve/ needle valve

A hand expansion valve is a globe valve with a needle seat in a smaller sizes and a plug type tapered seat in the longer sizes. The chief advantages of a hand expansion valve is simple construction, there is very little can get out of order. The main disadvantage is that an operator must available at all the times to make the necessary adjustments to met changing load conditions. At one time it was the only expansion valve available, but it rapidly being replaced by automatic devices. This valve is still used in large system as by pass valve around automatic control valve to allow operation in case of automatic valve failure and during repairs. Some flooded evaporator control system also has a hand expansion valve, for liquid control. These have a float switch and solenoid as the over riding control.

Thermostatic expansion valve

The thermostatic expansion valve controls the flow of refrigerant through the evaporator will always in super heated condition. Its operation is used on maintaining a constant degree of super heat at the evaporator outlet. The valve motion is to allow less refrigerant to maintain constant degree of super heat at the evaporator outlet is controlled by the processes (1) pressure in the bulb (2) spring tension (3) pressure in the evaporator. Under normal operating condition the pressure exerted by vapour in the controlling bulb on the diaphragm is balanced by the spring tension and the pressure in the evaporator.

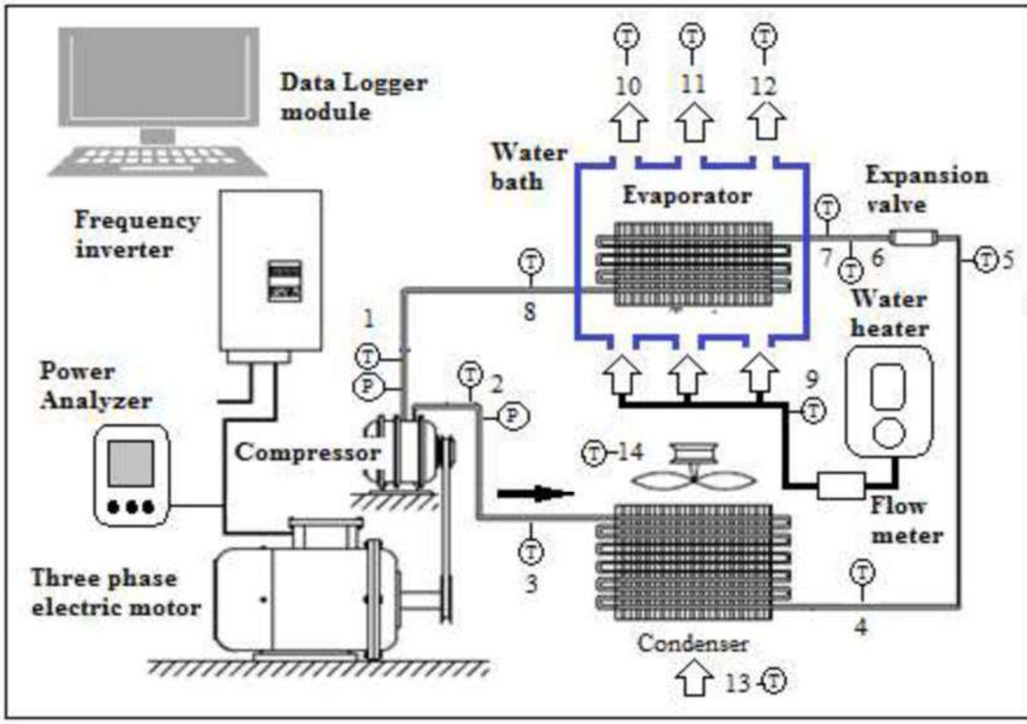


Figure: Schematic diagram of Refrigeration Test Rig.

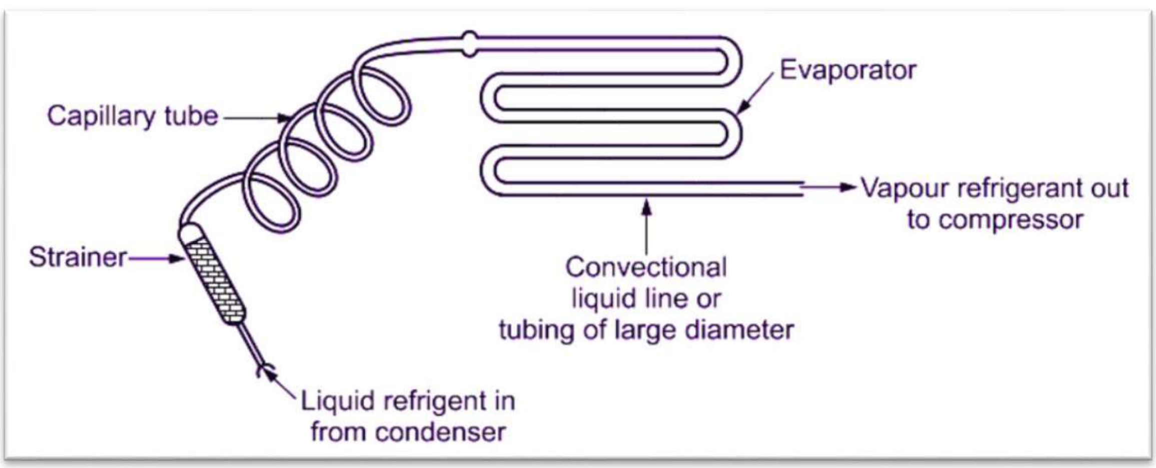
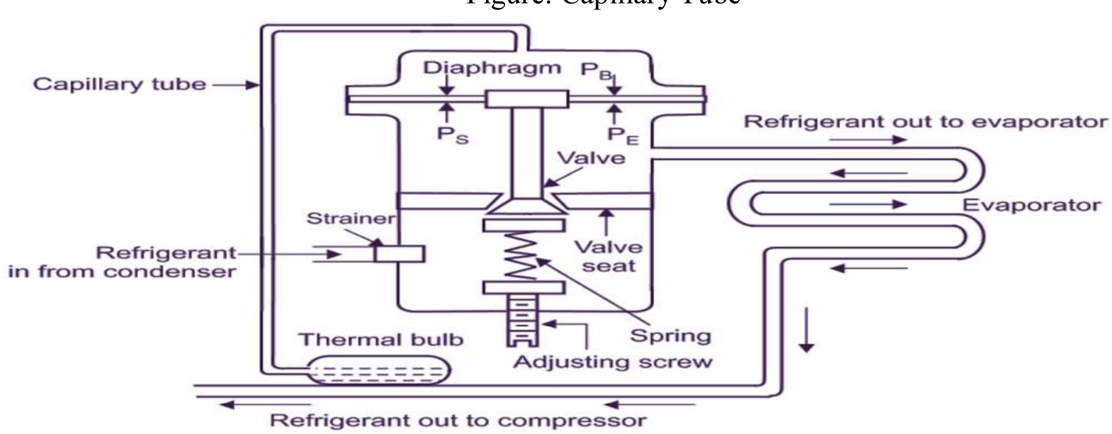


Figure: Capillary Tube



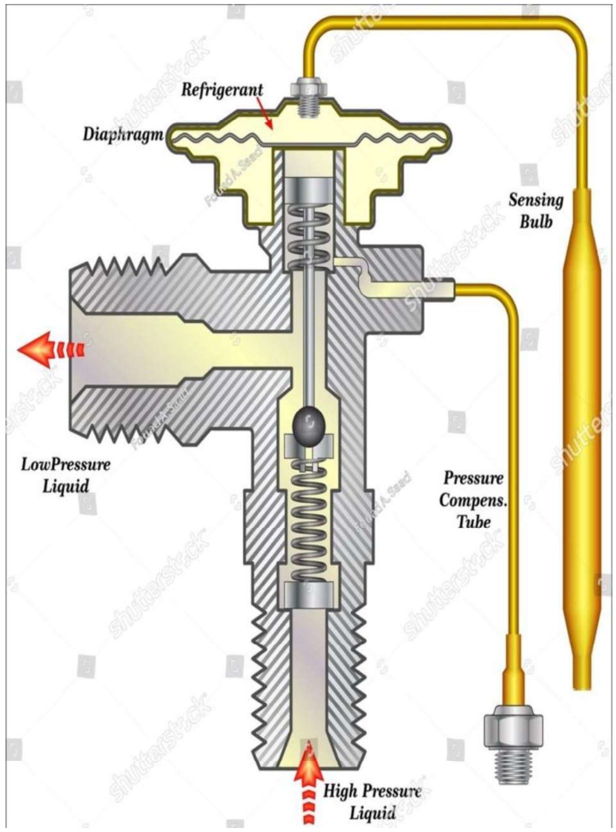


Figure: Expansion Valve