1. Write short notes / define

a) Pressure b) Critical temperature c) Critical pressure d) Refrigeration e) Air-conditioning f) Specific heat g) sensible heat h) Latent heat i) BTU j) calorie k) Ton of refrigeration l) DBT m) WBT n) Humidity o) Relative humidity

a) PRESSURE:- Pressure is the force exerted per unit area. Unit of pressure is pounds per square inch(PSI) or.kilogram per.square centimeter(kg/cm^2)

Atmospheric Pressure : This is the pressure exerted at mean sea level (appro.14.7 PSI)

Absolute pressure:-It is the pressure measured from the vacuum(PSI a)

Gauge pressure:- It is the pressure measured from atmospheric pressure(PSIg)

b) CRITICAL TEMPERATURE:- It is the temperature at or above which the gas cannot be liquefied

c) CRITICAL PRESSURE:- It is the pressure at or above which the liquid cannot change in to vapour state

d) REFRIGERATION:- May be defined as "the process of removing heat from the substance under controlled conditions

e) AIR CONDITIONING: It is the process of removal of heat or adding of heat to the air. And to control the velocity of air , purity of the air and humidity present in the air. In simple words we can say the air is processed to human comfort condition.

f) SPECIFIC HEAT:- The amount of heat required to raise the temperature of a unit mass of any substance through one degree.

g) SENSIBLE HEAT:- It is defined as the change in temperature with out changing its state.

h) LATENT HEAT:- It is defined as the change in state without changing its temperature.

i) BRITISH THERMAL UNIT:- It is the amount of heat required to raise one pound of water through one degree Fahrenheit.

j) CALORIE:- It is the amount of heat required to raise one gram of water through one degree centigrade.

1 BTU=252 calories

1 Kcal=3.97 BTU or 4 BTU approx.

k) Ton of refrigeration:- It is the rate of cooling produced by 2000pounds(lbs) of ice when melting at 32ºF (oºC) in 24 Hours (one day)
The latent heat of fusion of ice 144BTU/lb
Heat required to melt 2000 lbs of ice = 2000 X 144
= 2.88.000 BTU/day
=2,88,000/24 = 12000 BTU/Hour
(**Note**: One American Ton = 2000 pounds)
This definition is given by ASHRAE (American Society of Heating & Refrigeration and Air Condition Engineers).
Heat required to melt 900Kg of ice =900 X 80 Kcal=72000 Kcal/day=3000Kcal/Hr.
(latent heat of fusion of ice is 80 Kcal/Kg)

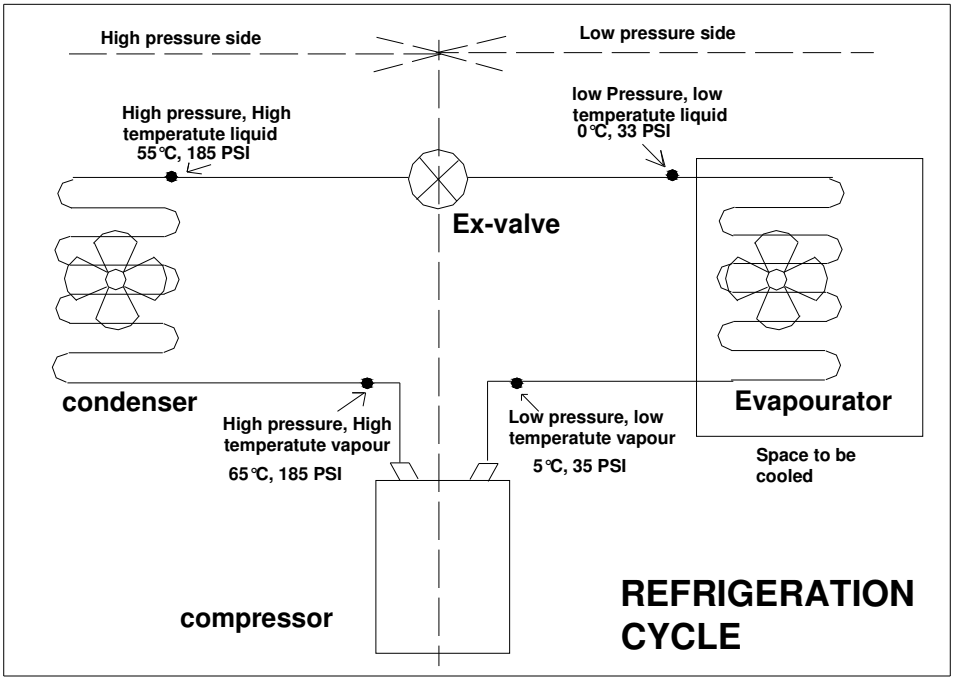
Dry Bulb Temperature(DBT): The temperature of air measured by an ordinary thermometer .

Wet Bulb Temperature (WBT): It is the temperature of air measured by a thermometer when its bulb is covered by wet cloth exposed to the air.

Humidity : It is the mass of water vapour present in one pound of dry air.(its unit is Grains. One pound of air contains 7000 Grains of moisture).

Relative Humidity(RH) : It is the ratio between actual amount of water vapour present in air to the amount of water vapour required to saturate the same air. It is normally expressed in percentage.

2. Draw of a refrigeration cycle and explain components in the system. Mention temperature and pressure at various points?



Refrigeration cycle

- In the refrigeration cycle the low pressure low temperature refrigerant vapour is converted in to high pressure high temperature refrigerant vapour by the compressor.
- This high pressure high temperature refrigerant vapour is converted in to High pressure high temperature refrigerant liquid in the condenser section.
- This high pressure high temperature refrigerant liquid is converted in to low pressure low temperature refrigerant liquid in the expansion device.
- Then this low pressure low temperature refrigerant liquid is converted into low pressure low temperature refrigerant vapour by absorbing heat in the evaporator.
- Then the vapour will enter in to the compressor ,the cycle going on repeats. The expansion device and compressor which divides the system in to low side and high side of the system.

3. Write down the various properties of refrigerant?

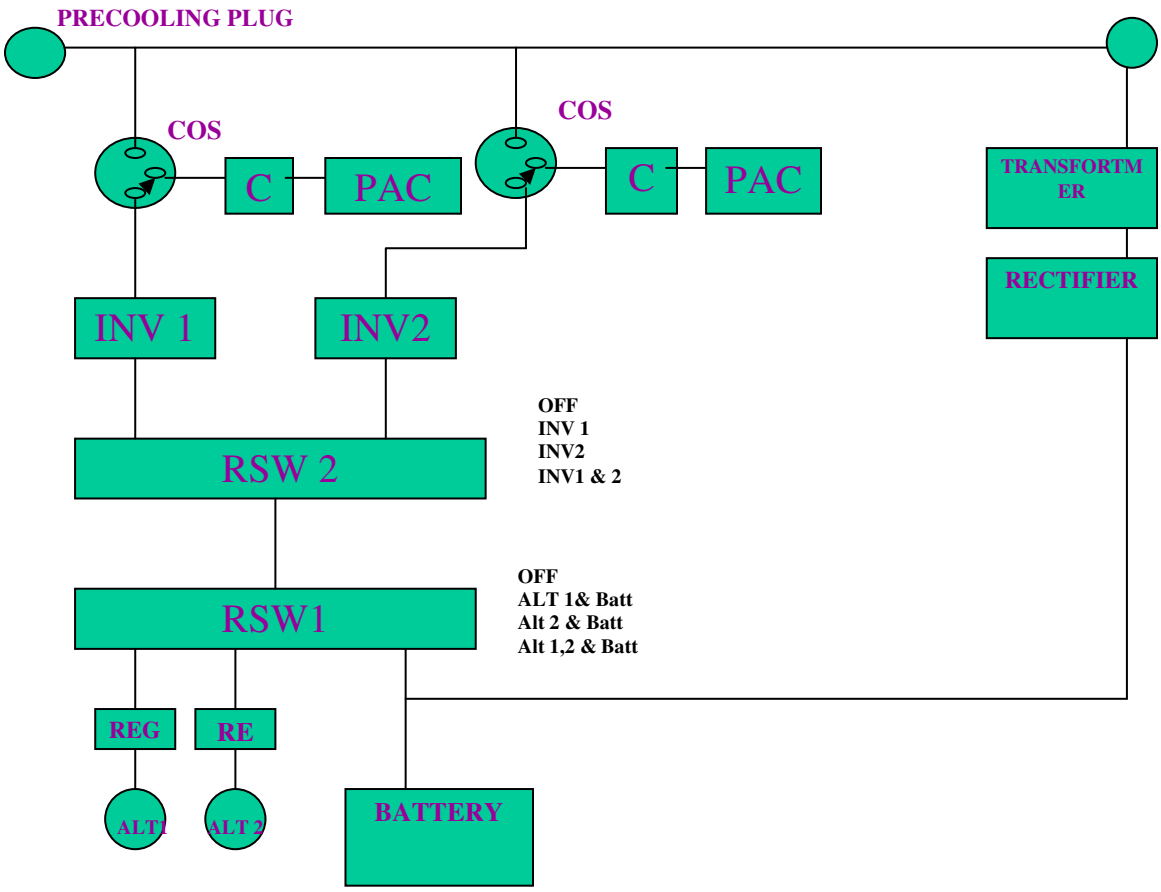
Desirable properties of refrigerants

1. It's boiling point should be low.
2. Its freezing point should be low.
3. Its critical temperature should be high.
4. Its critical pressure should be low.
5. Evaporator and condenser pressure should be positive.
6. It should have high latent heat of vapourisation.
7. It should be non –corrosive.
8. It should be non-inflammable.
9. It should be non-toxic and non-irritating.
10. It should be non-poisonous.
11. It should be non explosive.
12. It should have high di-electric strength
13. It should freely mix with lubricating oil
14. It should not have any effect on precious materials
15. Leak detection should be easy
16. It should be cheap and easily available in market

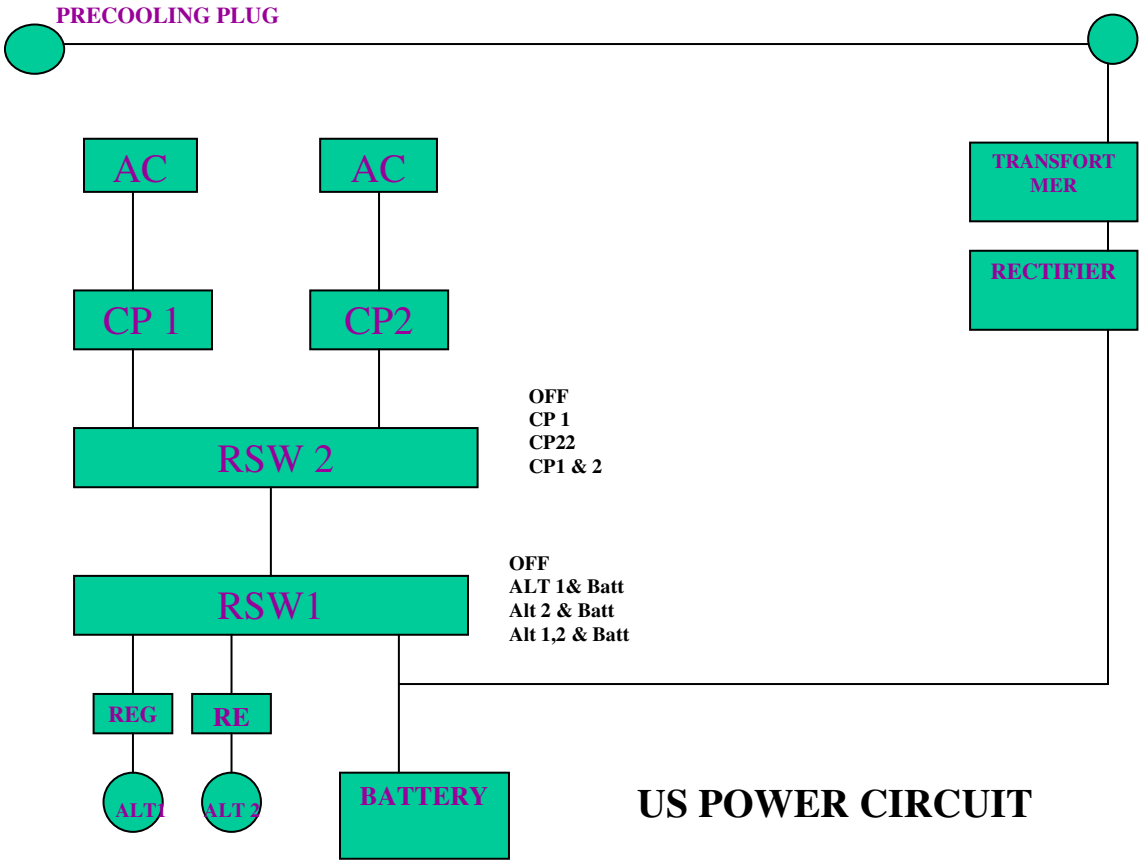
4. Compare RMPU & Under Slung AC system?

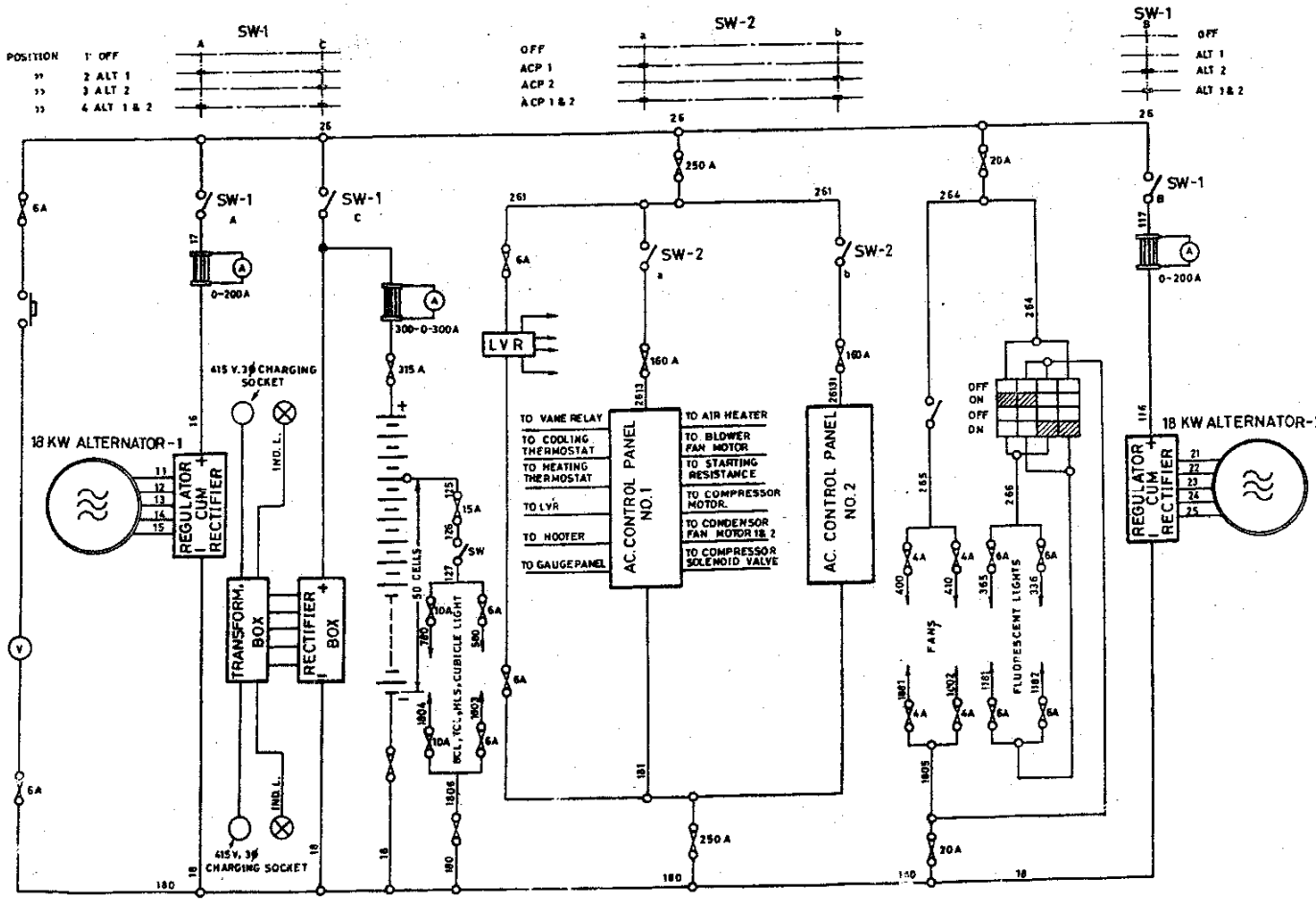
S No	Under slung	RMPU
1	System voltage is 110V DC	System voltage is 415V AC
2	DC motors are used	AC motors are used
3	Open type compressor – 5 Ton x 2 nos	Hermetically sealed compressors used – 3.5 Ton x 4 nos
4	R12 gas is used	R22 gas is used
5	Working pressure max 180 psi	Working pressure max 300 psi
6	No inverters used	inverters used
7	Battery 800 AH flooded	Battery 1100 AH VRLA
8	Prone for damages due to ballast hit	No damage due to ballast hit
9	HP and LP gauges used	No HP and LP gauges
10	Pipe line damages are more and plant failures are more due to leakages	Failure rate is very low
11	Drip tray water leakage causes inconvenience to passengers	No inconvenience due to water leakage
12	No WRA	2 Nos of WRAs with accessories used for water
13	Diamond duct is used	Diagonal ducting is used
14	No 3 tier system	3 tier sleeper is available
15	Accumulation of dust is more in condenser coil, causes less heat transfer during summer for which water is sprayed over condenser	Accumulation of duct is minimum, no arrangement for water spray over condenser coils.
16	DC fans are used.	AC fans used
17	18 KW alternators and regulators used	25 Kw alternators used.

5. Draw the power circuit of an RMPU coach?



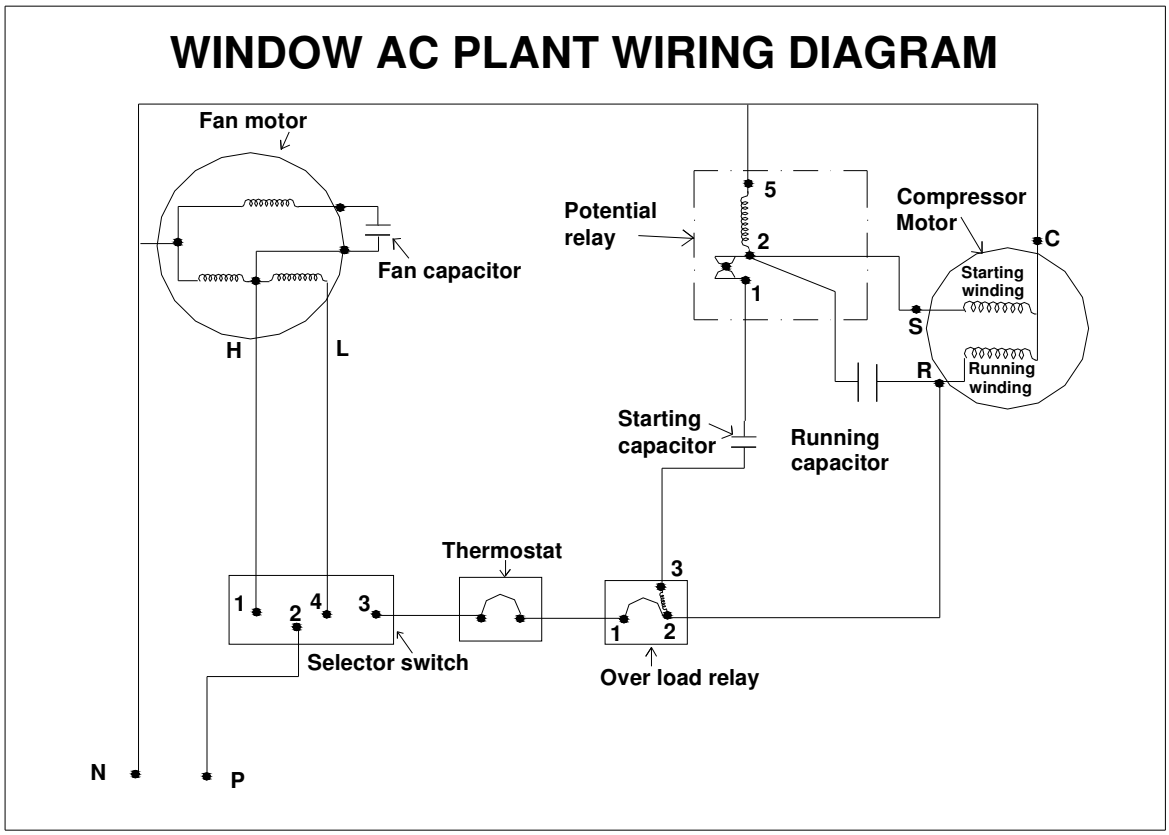
6. Draw the power circuit of a U/S AC system?





POWER SCHEME OF SELF GENERATION AC COACHES WITH TWO AC PLANTS

7. Draw the electric circuit of WAC plant?



8. Write short notes on (a) Water cooler b) split AC c) Deep Freezer (d) Desert cooler e) Package AC (d) Central AC plant?

Water Coolers:

The Water coolers are mainly classified as two types as follows

1. Instantaneous type (or) Pressure type
2. Storage type

In the both the types Simple Vapour Compression cycle with hermetically sealed compressor, air cooled condenser with fan and capillary tube as throttling device are used The evaporator unit which consists of a storage tank with copper tube rounded over the tank is used in the storage type. The water Temperature is maintained at 15˚C to 16˚C The cooling capacity of the pressure type water coolers from 20ltr/hr to 40 ltr/hr The capacity of storage type's are from 40ltrs/hr to 750ltr/hr. The available capacities of water coolers are 15,20,40,45,60 and 110 liters per hour.

Instantaneous type water cooler

Instantaneous type water cooler is that cooler in which water is cooled instaneously without storing it in a water storage tank. In this type of water jacket surrounding the drain tube where it is precooled by the waste cold water in the drain. The outlet water tube leaves the cooling chamber at the bottom and is connected to the bubbler or to the faucet .The waste water flows to the drain tube through a basin strainer fitted under the bubbler or faucets. The cooling chamber is insulated by some heat insulating material like glass wool. It temperature is maintained in the range of 50 to 60˚F by a thermostat switch.

Storage type water cooler:

It consist of large double wall stainless steel water storage tank equipped with air tight lid. The space between walls is filled with some heat insulating material like glass wool on a side near the top of water tank the water inlet connection has been controlled by a float value, while on the other side near the bottom of the tank, water taps have been fitted. An over flow connection has also been made near the inlet. The water taps have been guarded by a stainless steel splash guard and drip pan.

Split Air-Conditioners

In split units the indoor and outdoor sections of the room AC are separated out into two casings or units.The indoor unit consists of evaporator coil evaporator blower with its own separate motor, capillary tube, control panel, Airfilter, supply and return air grills etc, it is installed inside the room to be conditioned. It can be ceiling suspended, wall mounted or kept on floor and is generally known as the fan coil unit.

The out door unit has the other parts of the system like the compressor, air cooled condenser, condenser fan and its own motor are installed outside. The liquid line and suction line of the refrigeration system has to be laid at site after the outdoor and indoor units are installed in position, therefore pressure testing, evacuation & charging of the refrigeration system have to be done very cautiously. The distance between indoor & out door unit is to be kept as small as possible. As this distance increases the pressure drop in the suction line and liquid line also increases resulting in reduction of the unit capacity.

Deep Freezer:

Deep freezers are used in restaurants and cold storages to preserve fish, meat etc., for a long period of time. It is also used for keeping ice creams. Mostly F12 is charged in the system and suction pressure is maintained at 4PS1g. The Construction of the deep freezer is just like a water cooler(storage type). The evaporator is same as water cooler and bottom side,a portion is used for compressor & condenser and its fan motor a simple refrigeration cycle is used. In addition to that light and lid switch is provided. The operation of the compressor is controlled by thermostat and the light is controlled by lid switch. So the wiring is similar to that of a refrigerator. A mercury switch is some times used as lid switch. A signal light is sometimes used in the electrical circuit of deep freezer. A special thermostat is required to control this signal light also. When the inside temperature becomes unsafe (or) When this temperature increases above 15˚F(the cutout temperature). Signal light indicates the condition by going "OFF". If there is no sufficient cooling inside due to power failure or the defect of electrical or refrigeration system. Signal light gives indication to prevent the spoilage of costly food materials inside. The temperature range of deep freezer is -15^{o}C.

Desert cooler:

The desert cooler works on the principal of evaporative cooling. A fan sucks out side air through a continuously wetted pad. The air is passing through the wetted pad gets cooled and humidified and this air is circulated in to the room, where it picks up sensible heat and maintains fairly comfortable conditions. As fresh air is continuously pumped in to the room .The air from the room should be allowed to escape out through an opening at the farthest end of the room.

Package Air-Conditioners:

Package air-conditioner is used to cool large rooms like restaurants and auditoriums where high cooling capacity is required. More than one evaporator fan is required to circulate the air water cooled or air cooled condenser is used as condenser and compressor is sealed, semi sealed or open type. All parts are assembled as a single unit otherwise simply said as factory assembled unit.

If condenser is air cooled a duct is used to bring the outside air and to discharge this air outdoors again. Water cooled unit require plumbing connections for both fresh water and drain. The same drain tube is used to drain out the moisture condensed by the evaporator. The refrigerant control is generally a thermostatic expansion value.

The water outlet of some of the water cooled condenser is connected to cooling tower .In some plants this hot water is drained out. A single package unit can be used

for a large number of rooms, hot air from the rooms passes through return duct to the unit. After cooling this air passes through supply duct and enters to the room. The capacity of the plants available from 3 to 5 tons or above.

Central air-conditioning Plant using Water as Secondary Refrigerant:

The above fig shows parts & the diagram of the central Air conditioning plant. Mostly F22 and in some plants ammonia is used as refrigerants in the system. The working of cycles was studied in the previous chapters. The condenser water pump draws the cold water from the water tank at the bottom of the cooling tower through a strainer and circulates through the condenser to absorb heat of condensation. This hot water is again sprayed at the top of the cooling tower by pressure given by the condenser pump. A float value is connected to the water supply line to the cooling tower to make-up water lost by evaporation.

By the operation of the air circulating fan (or) blower the air at high temperature from the conditioned room passes through return air duct, air filter and finned evaporator. Then this cold and filtered air returns to the room through supply air duct, which passes through the centre of return air duct.

Return air duct is insulated to present the transfer of heat from hot temperature air to the cold air passing through the ducts. The fresh air door is provided to allow to mix the out side air to the circulating air when ever required.

To heat the air in winter season air circulating fan is operated after stopping the compressor and energizing the strip heater. To prevent the decrease of relative humidity while heating. The air water drops are allowed to vaporize in it. The hot and humidifier air is supplied to the room at this time by pass dampers are opened to prevent the passage air through the evaporator.

1. **Describe briefly the following equipments in the AC system. A) Evaporator unit b) Expansion valve. C) Compressor. D) Condenser e) High pressure cut out.**

Evaporator

It is the most important part of the refrigerating system. The liquid refrigerant from the expansion valve enters in to the evaporator. In this evaporator the liquid refrigerant will absorb the heat from the substance to be cooled and will be converted in to low pressure low temperature refrigerant vapour. Then enter in to the compressor.

There are two types of evaporators

1.Natural convection evaporators

2. Forced convection evaporators

Expansion device

The main purpose of expansion device is to reduce the pressure of the liquid refrigerant coming from the condenser and regulate the flow of the refrigerant as per the load on the evaporator. The expansion device are also called as refrigerant flow control or throttling device.

There are different types of expansion valves used but, two types of expansion valves are mainly used ,they are Thermostatic expansion valve and capillary tube

Capillary tube

This is very simple in construction nothing but a small diameter tube having a diameter of 0.5mm to 2.5mm the length varies from 0.5 to 5.0 meters. The pressure drop is achieved due to heavy frictional resistance offered by small diameter . The main advantages of the capillary tube is simple in construction ,maintenance free and low cost, also this reduces the starting torque of the compressor motor.

Thermostatic expansion valve

The thermostatic expansion valve is the most commonly used expansion device it is also called constant super heat valve .In this type of expansion valve a diaphram and capillary tube fitted with feeler bulb is filled with volatile gas (i.e. same gas used in the system) and this is fixed in the bottom side of the suction line . when the suction line pressure drops the same pressure will be inside the bulb due to this low pressure the diaphragm moves upwards and reduces the flow of the liquid refrigerant . like wise when suction pressure increase it will permit more amount of liquid refrigerant to the evaporator.

Compressor

Which is the heart of the refrigeration system. The main functions of the compressor is to keep the flow of the refrigerant in the system and to increase the pressure and temperature of the refrigerant vapor. The low pressure and low temperature refrigerant vapor from the evaporator is drawn in to the compressor and delivers the high pressure and high temperature refrigerant vapor to the condenser

According to the working principles the compressors are classified in to three type, they are mainly 1)Reciprocating compressor,2)Rotary compressor, 3)Centrifugal compressor.

Condenser

The function of the condenser is to reject the total heat which is absorbed in evaporator and added by the compressor and to convert the refrigerant vapor in to liquid state. The high pressure high temperature refrigerant vapor is entered in to the condenser coil and heat is removed by the medium either air or water thus converted in to high pressure low temperature refrigerant liquid, which will leave from the condenser coil

High pressure cut out

. The high pressure cut-out is essentially a safety device against build up of excessive delivery pressure and protects the compressor and piping system from damage. It is a pressure operated switch which switches off the compressor drive motor when the pressure exceeds a preset value (the setting is between 200 and 250 p.s.i. gauge). The plant cannot be restarted unless the cut-out Is reset manually.

2. What is the safety precaution provided in the AC coaches to prevent fire.

- Ensure the use of proper sizes of cables in different circuits has per standard designs of production units.
- Positive and Negative cables working with 110V DC should be run in separate conduits.
- Minimize the number of joints in the junction boxes.
- Use of PVC grommets for the cables travels through holes, Orifices, slits etc.
- Cable should not have any intermediate joints and should be terminated in junction boxes.
- The Laptop and mobile charging terminals should be marked to avoid the usage of radio, Electric shaver or any other appliances.
- Earth checking should be done periodically.
- Air clearance of 10 mm has been specified between any live part and coach body and 4 mm between parts of opposite polarities.
- At cable terminals, cable Lugs should always be provided with heat shrinkable sleeves.
- The insulation resistance of the coach should be check periodically and the value should be minimum 2 MOhm. Under fair weather.
- Rewiring of coach shall be planned on the basis of cable life of 12 years.
- Proper functioning of vane relay should be ensured.
- Ensure proper working of thermostat for heater circuit.
- Wiring for Lights and fan points shall be terminated in the connector.
- The canvas ducts for AC system should be of fire retardant quality.
- Fire extinguisher provided in the coach for electrical fire should be DCP type.