UNIT-3: Air Conditioning

Question Bank

1. Explain the factors on which air conditioning depends.
2. Explain comfort and industrial air conditioning. What do you mean by effective temperature.
3. Describe complete arrangement of centrally air conditioning plant.
4. Explain desert cooler with the help of neat sketch
5. Describe room air conditioning system with the help of neat sketch.
6. Explain Winter air conditioning system with neat sketch.
7. Explain the difference between refrigeration and air conditioning.

Definition, Factors, and Types of Air Conditioning

In this notes we will discuss:-
1. Definition of Air Conditioning
2. Requirements of Air Conditioning
3. Factors
4. Equipment
5. Types
6. Vapor Absorption System.

Definition of Air Conditioning:

Air conditioning can be defined as the treatment of indoor air to control certain conditions required for human comfort. The desirable conditions may be temperature, humidity, dust particle level, Odor level, and air motion.

It is known that the physical properties of air can be controlled by cooling, heating, humidification, and dehumidification. These processes may be employed to maintain specific conditions desirable for comfort. Thus, simultaneous control of temperature, humidity, air motion, and cleanliness is known as air conditioning.

Requirements of Air Conditioning:

Human body releases about 100 W to 450 W per person depending on the activity of the person due to metabolism. The body temperature is maintained to be 97°C. But the body surface temperature changes according to the surrounding temperature and relative humidity. The body heat must be dissipated from body surface to the surroundings. If the surrounding temperature is less than the body temperature, the flow of heat from body becomes quite easy and normal flow. If the surrounding temperature is low as in winter, the rate of flow of heat from the body is rapid and the person will feel cold. If the surrounding temperature is too hot, there would be no flow of heat.

In such situation, sweat glands become activated. The moisture of body gets evaporated which brings the temperature normal. If the outside temperature is hot and humid, little evaporation of moisture will occur from the body skin and so the person will feel hot and uncomfortable. The movement of air by fan helps to keep body comfortable.

When the room temperature becomes high due to heat gain, it causes human discomfort. When the room moisture becomes high, the increased humidity causes difficulties in disposing the body heat. For human comfort, the indoor temperature of 20°C and relative humidity 60% is quite good. Any air conditioning unit will be able to achieve the above requirement and maintain the conditions for comfort.

Factors Affecting Air Conditioning:

The process of air conditioning in auditorium, office building, houses, and classrooms is meant for maintaining comfort conditions for occupants.

The four important factors for comfort conditioning are to be observed and maintained:

(a) Temperature,
(b) Humidity,
(c) Purity/cleanliness,
(d) Air Flow.

(a) Temperature:
The control of temperature is necessary in air conditioning. Even though the outdoor temperature is varying, the indoor temperature is maintained to be constant which is the desired condition. The heat may be either removed or added to the conditioned space depending upon the surrounding conditions. The person may feel comfortable when the temperature is 20°C and relative humidity is 60%.

(b) Humidity:
Humidity control means an increase or a decrease in moisture content inside the space to be air-conditioned. It is necessary not only for human comfort but also to increase the working capability. In summer, the relative humidity should be 60% and in winter it should it should be 40%.

(c) Purity/Cleanliness:
It is one of the most important factors which affect the air conditioning. In addition to the control of temperature and humidity for human comfort, it is necessary to clean air, i.e., to make the indoor air free from dust, dirt, and odor. It is necessary that proper filtration and purification of air should be done and the supply of air free from dust and dirt should be made in air-conditioned space.

(d) Air Flow:
Air motion or proper circulation of air is also a factor affecting human comfort. In order to maintain constant temperature throughout the conditioned space, there must be equal distribution of conditioned air in the space. The air movement is maintained at the desirable velocity of about 8 m/min using appropriate distribution systems, grills, etc.

Equipment Used for Air Conditioning:
Following are the important equipment used for air conditioning:
(a) Air circulation fan.
(b)Air-conditioned unit-This will have cooling and dehumidification system or heating and humidification system.
(c) Supply duct
(d) Supply outlet (grill)
(e) Return outlet duct
(f) Filter

Difference between Comfort Air Conditioning and Industrial Air Conditioning

Sr. No.	Comfort Air Conditioning	Industrial Air Conditioning
1.	It is used in residential/commercial areas	It is used in industries to control the process parameters.
2.	It provides human comfort conditions, thereby increasing efficiency during work hours and decreasing fatigue on workers.	It improves the efficiency and quality of the product.
3.	Conditions to be maintained may change from process to process.	Human beings feel comfortable at 21°C and relative humidity. However, approximate range of temperature is 20°C to 40°C and relative humidity 40% to 60% is said to be optimum.
4.	Applications: Homes, restaurants, offices, hotels, cinema theatres, seminar halls etc.	Applications: Printing industry, photography, textile mills, machine tool industry, chemical industries etc.

Types of Air Conditioners:

There are mainly two types of air conditioners:
(a) Window air conditioner
(b) Central air conditioner

(a) Window Air Conditioner/Room Air Conditioner:
Window air conditioner is a simple air conditioning unit fitted with the room wall or window. In this unit air is not supplied to the room through duct system. This consists of a complete vapor compression system having compressor, condenser, evaporator, expansion device with motor, blower, fan, air filter, grills, fresh air damper, and control panels as shown in Fig. 6.16.

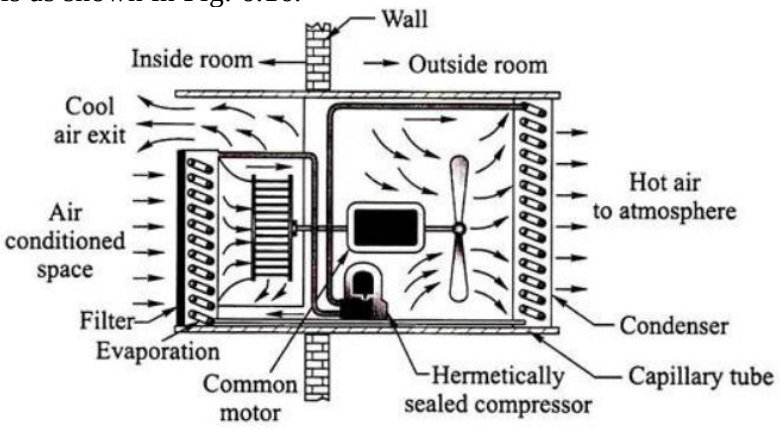


Fig. 6.16 Window air conditioner

The unit draws air continuously from the space to be cooled and it is cooled by cooling the coil of the unit and delivered back into the same space to be cooled. The process of drawing, cooling, and recirculation cools the space at a lower temperature required for the comfort. Regarding the installation of this unit, the evaporator unit should be mounted inside the room and the condenser will be mounted on the outer side of room wall.

The air supply grills have adjustable louvers or deflectors for changing the direction of air flow. It is generally operated with a 220-V single phase ac supply. The cooling capacities for such unit are available in market between 0.5 TR and 3 TR.

(b) Central Air Conditioning:
Centralized air conditioning system is a large-capacity plant which has a cooling capacity of 30 TR or more. This is also adopted when the air flow requirement is more than 5 m^3/s. The systems employed for air conditioning of theater, restaurant, auditorium, and public buildings [Figs. 6.17(a) and 6.17(b)].

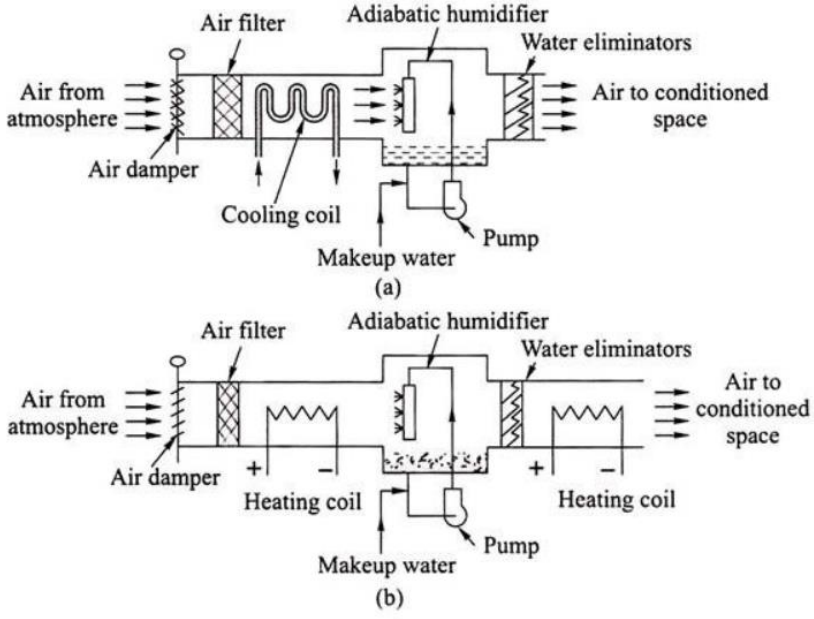


Fig. 6.17 (a) Summer air conditioning for hot weather and (b) winter air conditioning system

There is a separate machine room and the conditioned air is distributed to different places to be cooled using a ducting system. The unit will have the provision of cooling and dehumidification, heating and humidification, and proper ventilation in the room. The system will have the provision of return air ducting system also. The system includes a complete refrigeration system, blower, air ducts, and a plenum where the outdoor air is mixed with indoor air.

Central Air Conditioning

In a central station air conditioning system, all the components of the system are grouped in one central room and conditioned air is distributed from the central room to the required places through extensive ductwork. The central air conditioning system is generally used for load above 25 tonnes of refrigeration and 2500 m^3/min of conditioned air.

The whole system can be divided into three parts,
• Plant room, which includes compressor, condenser and motor.
• Air handling unit room (AHU room).
• Air distribution system (Ducting).

The plant room is located away from room to be air-conditioned. Other components are grouped in an AHU and conditioned air is circulated through air distribution system i.e. ducting with the help of fan or blower to the room to be air-conditioned. As shown in Fig. 1, the air, that is to be conditioned, is directly allowed to flow over the evaporator coil. Low-pressure and low-temperature refrigerant passing through evaporator coil absorbs heat from the air. Thus, the air gets cooled.

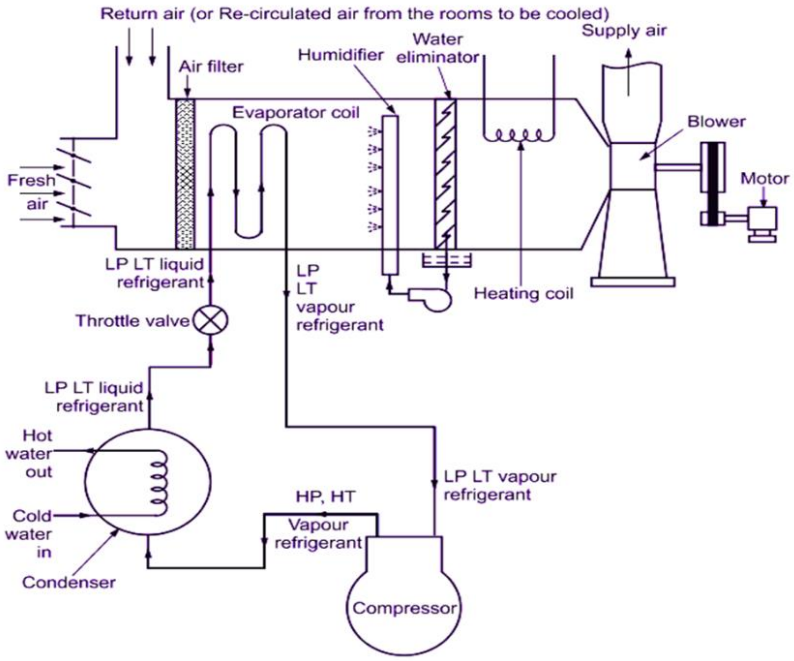


Fig. 1: Central air conditioning system

When several rooms in the building are to be air conditioned at approximately same temperature and relative humidity, then central air conditioning system is chosen instead of unitary air conditioning. This type of system is used for load above 25 TOR.

Types of Central Air Conditioning System

There are two types of central air conditioning systems.

Direct-type central air conditioning system
• In this system, the air from the space to be air conditioned is circulated over the cooing coil (i.e. evaporator coil) of a refrigerant plant, in which, the low pressure liquid refrigerant is boiling.
• The latent heat of vapourization for the liquid refrigerant is taken from
the air being circulated over the coil. Due to rejection of heat, the air gets cooled.

• This type of direct central air conditioning system is also known as 'Direct Expansion (DX) System'.

Indirect type central air conditioning system

• In this system, chilled water or brine from the refrigeration plant is circulated through the cooling coil (i.e. evaporator coil) located in the air handling unit to cool and dehumidify the room

• This type of direct central air conditioning system is also known as 'Central Chilled Water (or Brine) System'.

Advantages of Central Air Conditioner

• Low investment (capital) cost per unit of refrigeration as compared to to- tal cost of separate units.

• Space occupied is less as compared to a room conditioner unit, which needs to be placed in the room.

• Better accessibility for maintenance.

• The running cost is less per unit of refrigeration.

• Noise and vibration troubles are less to the people in air conditioned places, as the air conditioning plant is far away from the air conditioned places.

• The exhaust a-r can be returned and maximum possible quantity of ex- haust air is recirculated again, which reduces the cost of refrigeration.

Disadvantages of Central Air Conditioner

1. Central air conditioner results in large size ducts, which are cost y and occupy large space.
2. Though insulation is provided, thermal losses are likely to occur due to long ducting.

Air coolers/Desert Cooler

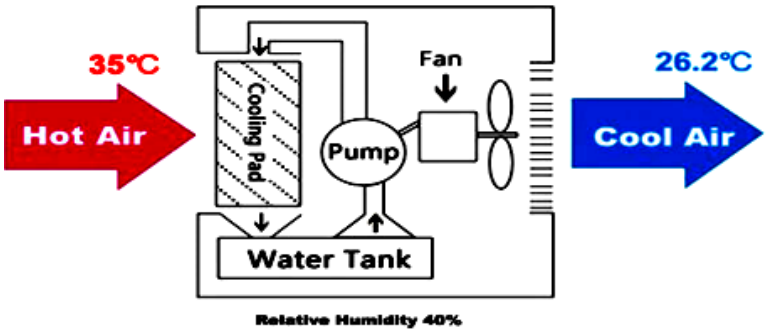
1. Air coolers work on the principle of cooling by the evaporation of water which is present in them.
2. These coolers are also called **desert coolers or swamp coolers** and they require water, which is filled in these coolers.
3. The cooling effect is produced due to the transition in phase from liquid state to vapour state.
4. Various parts that are needed to make an evaporative cooler or a simple air cooler are:
   1) Fan and vents- A fan is needed to direct the cool air towards the room. These fans continuously flow cool air in the rooms.
   2) Water source- Evaporative cooler uses water so it is necessary to fill the cooler with water so that the cooling can take place.
   3) Cooling pads- The purpose of cooling pads is to absorb water and to pass air through them.
   4) Distributor- Water needs to be distributed properly to these cooling pads. This is done by cooling pumps and various pipes that interconnect the cooling pads. These cooling pads should aways be in saturated state otherwise the water will evaporate away from these pads.

Working Principle: Water, when evaporates it needs heat called 'latent heat of evaporation'. In the cooler the water that is sprayed over the pads when evaporates takes the required latent heat from the atmospheric air surrounding them which on losing its heat cools down. This cooled air is blown inside the room by the exhaust fan fitted on the cooler and thus the room temperature drops making the ambiance inside comfortable. The main parts of the cooler are:

1) Fan

2) Pump with water distribution flexible pipelines

3) Porous pads normally made of special grass or shavings of synthetic material and a box made of steel sheets on which the above-mentioned items are mounted securely.



Winter air conditioning system with neat sketch.

What is Winter Air Conditioning System? Construction & Working

In winter, the atmosphere is generally cool and humid, i.e. near to 15°C dry bulb temperature and 70% relative humidity. Even though relative humidity is high, but specific humidity of atmospheric air is very less than desired value required for human comfort. For such atmosphere, winter air conditioner is used, in Which, "heating With humidification" is done.

Construction of Winter Air Conditioning System

Winter air conditioning system consists of filter, primary heating coil, water eliminator and secondary heating coil (Figure 1).

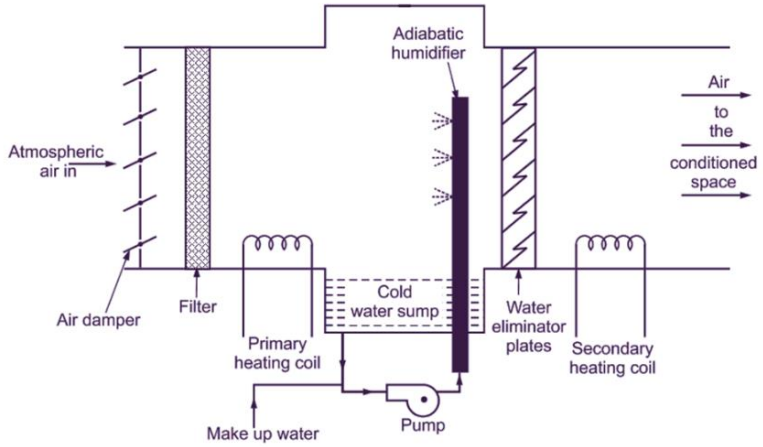


Fig. 1: Winter air conditioning system

Working of Winter Air Conditioning System

The air is first allowed to pass through a filter for cleaning and then over the primary heating coil. Due to high temperature of coil, the air temperature increases, but relative humidity decreases. In order to increase rel- ative humidity, the air is passed through an adiabatic humidfier. Cold water having temperature ess than dry bulb temperature of air, but more than its dew point temperature is sprayed in the path of air. Thus, the air gets humidified. This humid air is passed through the water elim- inator to remove water droplets from the conditioned air. However, due to this adiabatic humidification, temperature of air decreases. It is again increased up to required value by passing the air over secondary heat- ing coil. This process is shown on psychrometric chart. Process 1-2 and 4- 6 represents sensible heating, whereas, process 2-4 represents adiabatic humidification of air (Figure 2).

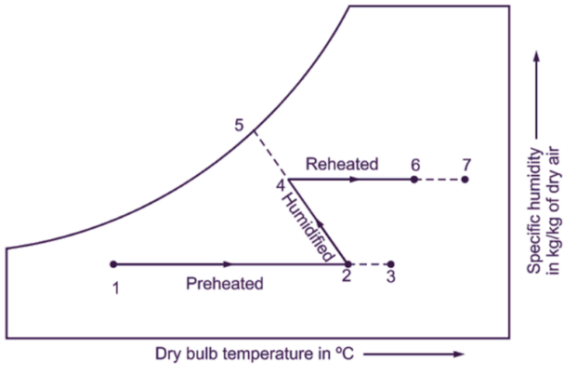


Fig. 2: Representation of winter air conditioning on psychrometric chart