UNIT - 6

AIR CONDITIONING SYSTEM

Introduction:

Air conditioning is the process of removing heat and moisture from the interior of an occupied space to improve the comfort of occupants. Air conditioning can be used in both domestic and commercial environments. This process is most commonly used to achieve a more comfortable interior environment for humans in vast range of applications.

Since humans perspire to provide natural cooling by the evaporation of perspiration from the skin, reducing relative humidity can promote occupant comfort. An air conditioner designed for an occupied space typically will create a 30% to 60% relative humidity in the occupied space to balance comfort, microbial growth, and other indoor air quality factors.

Factors effecting Comfort Air Conditioning:

Following are the Factors affecting Comfort Air conditioning:

1. Temperature
2. Humidity
3. Air movement
4. Air Purity.

1. Temperature:

Convection Heat transfer depends upon the temperature difference. So an adequate difference between body temperature and ambient temperature would ensure the convection heat transfer. Temperature difference would cause chilling effect as in winter. Preferred temperature is in between 20- 25 Degree.

2. Humidity:

At higher ambient temperature convection heat transfer is either not adequate or is in reverse direction. The evaporation of perspiration by body heat is the only means of heat dissipation. Ambient air contains some water vapour in it and water evaporation depends upon vapour pressure difference. So we can say that higher humidity would reduce evaporation of sweat from out body. Even at low temperature water vapour is given out through body pores due to vapour pressure difference. So in dry climate excessive loss of moisture leads to drying of skin and blister on the skin. So humidity maintain in between 30 to 70 %.

3. Air Movement:

Convection heat transfer depends upon air movement and evaporation rate also can be maintained by constantly carrying away the vapour from evaporation surface. So it would be helpful for giving comfort and heat dissipation takes place properly .If the air movement is high it would cause the noise discomfort. Similarly we maintained higher air movement of fan in summer and slow air movement in winter for better comfort. The limited air velocity ranging is in between 8–15 m/min.

4. Air Purity:

The air conditioner supplies conditioning air for comfort. Atmospheric air has many impurities in it. The range of impurities like dust, pollen, and other carbon particles is in microns i e. Nearly 180 micron and for virus and bacteria size rang is 0.05 micron. At some point odorous gases makes you feel discomfort. So air conditioner needs to remove unwanted impurities as per requirement.

Classification of Air Conditioning Systems:

The air-conditioning systems are classified as

1. According to the purpose
    (a) Comfort air-conditioning system
    (b) Industrial air conditioning system
2. According to the season of the year
    (a) Winter air conditioning system
    (b) Summer air conditioning system
    (c) Year round air conditioning system
3. According to the arrangement of equipment
    (a) Unitary air conditioning system
    (b)Central air conditioning system

Terminology of Air Conditioning System:

The basic terminology with which we often specify the most important functions of an air conditioning system are Psychrometry & Psychrometric terms.

6.3.1. Psychrometry & Psychrometric Terms:

Psychrometry is a science dealing with behaviour of water vapour present in atmospheric air. The device which measures the relative humidity in the atmosphere through the use of two thermometers is called Psychrometer.

Psychrometric Terms:

1. Dry Air:

The dry air is considered as a mixture of Nitrogen, Oxygen and neglecting the percentage of other gases.

2. Moist Air:

It is also called atmospheric air. The moist air considered as a mixture of dry air and water vapour. The quantity of water vapour present in air depends upon the temperature of the air. When water vapour contains dry air it becomes cold. Moist air is heavier than the dry air.

3. Saturated Air:

Saturated air is air that holds water vapour at its highest level. Air is composed of moisture or water vapour, regardless of the amount of pressure and temperature levels. Adding more moisture to the air at a specific temperature and in an enclosed area causes the air to absorb the moisture. It is visible as fog or condensation on the cold surfaces.

4. Degree of Saturation:

Degree of Saturation is the ratio of the humidity ratio of moist air - to the humidity ratio of saturated moist air at the same temperature and pressure. The Degree of Saturation can be expressed as. $\mu = x / xs$.

5. Humidity:

Humidity is the concentration of water vapour present in the air. Water vapour, the gaseous state of water, is generally invisible to the human eye. Humidity indicates the likelihood for precipitation, dew, or fog to be present.

If the water vapour present in the 1kg of dry air is known as humidity ratio or specific humidity.

6. Absolute Humidity:

Absolute humidity is the measure of water vapour (moisture) in the air, regardless of temperature. It is the mass of water vapour present in the 1 m^3 of dry air. It is expressed as grams of moisture per cubic meter of air (g/m^3).

7. Relative Humidity:

Relative humidity is the ratio of the partial pressure of water vapour to the equilibrium vapour pressure of water at a given temperature. Relative humidity depends on

temperature and the pressure of the system of interest. The same amount of water vapour results in higher relative humidity in cool air than warm air.

8. Dry Bulb Temperature (DBT):

When there is no moisture in the air, it is dry air and human does not feel comfort. Dry air contains dust also. Its temperature is dry bulb temperature and is recorded by an ordinary thermometer. This temperature increases and decreases according to the dryness of the air. The DBT for human comfort is 25^0C.

9. Wet Bulb Temperature (WBT):

Wet bulb temperature is temperature at which liquid or solid water by evaporating into the air can bring the air to saturation at the same temperature. Wet bulb temperature is measured by an ordinary thermometer then whose glass bulb is covered with wet cloth.

10. Dew Point Temperature (DPT):

The quantity of moisture contained in air having a relative humidity is less than 100%, the maximum possible at some lower temperature. This lower temperature is the dew point and if the air is cooled to a temperature slightly below the dew point moisture will to condense. Dew point temperature is the saturation temperature corresponding to existing humidity ratio and barrow metric pressure.

11. Wet Bulb Depression:

It is the difference between dry bulb temperature and wet bulb temperature at any given point. This difference indicates relative humidity.

12. Dew Point Depression:

It is the difference between dry bulb and dew point temperatures of air.

Equipment Used in Air conditioning System:

1. Fans & Blowers.
2. Ducts.
3. Supply air outlets.
4. Return air outlets.
5. Filter and dust collectors.
6. Heating and cooling coils.

Fans & Blowers:

Fans and Blowers are used for circulation of air in Air- Conditioning plants which create positive pressure in the air and maintained desired speed and rate in the desired space or room. The fan is used to handle small quantity of air where as the blower is used to handle large quantity of air.

Fans may be classified according to the direction of air flow as

1. Axial fan- In this air moves parallel to the impeller shaft.
2. Centrifugal fan – In this air moves radial direction or perpendicular to the impeller shaft.

Ducts:

The duct system convey the conditioned air from the air-conditioning system to the space being conditioned and carry the return air from rooms or conditioned space to the air conditioning equipment for reconditioning and recirculation. Like any other fluid passing through a pipe, air in passing through a duct suffers a pressure drop due to friction. Larger quantity of air passing through a given cross sectional area of the duct, greater will be the frictional loss and pressure drop.

Ducts are defined as the passage way provided for conveying the conditioned air to specified location in order to provide comfort conditions. Smooth surface are desirable for ducts as they offer minimum resistance to the flow of air. The system should also be air tight so that the conditioned air does not leave out to the space not being conditioned

Ducts may be classified as

1. **Supply Air Duct:** Supply air duct carry the conditioned air from equipment to the space or room to be conditioned.
2. **Return Air Duct:** Return duct carry the return air from the space or room to the equipment for reconditioning or recirculation.
3. **Fresh Air Duct:** Fresh air duct carries the atmospheric air in to the air-conditioned equipment.
4. **Low Pressure Duct:** In this, the static pressure is less than 50 mm of water gauge.
5. **Medium Pressure Duct:** In this, the static pressure is from 50mm to 150 mm water gauge.

6. **High Pressure Duct:** In this, the static pressure is from 150mm to 250 mm of water gauge.
7. **Low Velocity Duct:** In this , the velocity of air less than 600 m/min
8. **High Velocity Duct:** In this, the velocity of air is more than 600 m/min.

Supply Air Outlet

The conditioned air enters the conditioned space through supply air outlets. These are designed to distribute air uniformly and prevent noise.

According to their design and construction, they may be classified as

1. Grill outlets
2. Slot diffuser outlets
3. Ceiling diffuser outlets
4. Perforated ceiling panels.

Return Air Outlets:

Return air outlets are the openings in a room space which allow the exhaust air to enter the return duct. Return duct may be connected to air conditioning equipment if recirculation is necessary to the atmosphere if the system is designed for 100 percent fresh air. They can be mounted on ceiling, walls or floor. The selection of outlets depends on the size of the room, quantity of air required and discharge velocity of air.

Filters & Dust Collectors:

Filters

The basic requirement of air conditioned system is that the conditioned air must be free from dust, dirt, smoke, bad odour etc. One of the major functions of an air conditioning system is to clean and purify the air. As the heating and cooling coils are used for controlling the temperature and humidity of the air similarly various cleaning devices are used for controlling the dust, pollen, odour and smoke. Filters and dust collectors are installed in air conditioning system to clean the contaminated air. Air used in an air conditioning system must be filtered to clean the contaminated air, outside air contains always contaminants such as bacteria, pollens, insects, soot, ash, dust, and dirt. The return air contains contaminants such as dust, lint, soot ash etc.

The various types of filters are commonly used in air conditioning system as follows

1. Dry filters
2. Viscous filters
3. Wet filters
4. Electronic filters

Dust Collectors

Sucking dust and water drops. When cleaning A/C fins, can use this machine to such the dust on the fins before water flushing. Also can absorb dust or water drops on the ground after finish cleaning work.

Heating and Cooling Coils:

These are used to increase and decrease the temperature of air respectively. Heating and Cooling of air without changing its moisture content is termed as sensible heating and sensible cooling respectively. Sensible cooling of air takes place when it flows over cooling coil whose surface temperature is lower than the temperature of air. The cooling medium may be chilled water or brine as the secondary refrigerant.

Auto Air Conditioning System:

Automotive air conditioning is the process by which the air is cooled and cleaned, the humidity lowered and the air circulated. The manifold and hand valves allow the system to be purged of refrigerant, evacuated of air and moisture, and recharged with new refrigerant.

Necessity of automobile Air Conditioning System:

The purpose of the vehicle air conditioning system is to cool the air entering the passenger compartment and remove the moisture from the air so it feels more comfortable in the vehicle. In many vehicles, air conditioning also cycles during the defrost setting, pulling the humidity from the windshield to improve visibility.

Construction & Working of AC in an Automobile:

The most common components which make up these automotive systems are the following:

1. Compressor
2. Condenser
3. Evaporator
4. Orifice tube
5. Thermal expansion valve
6. Receiver-drier
7. Accumulator

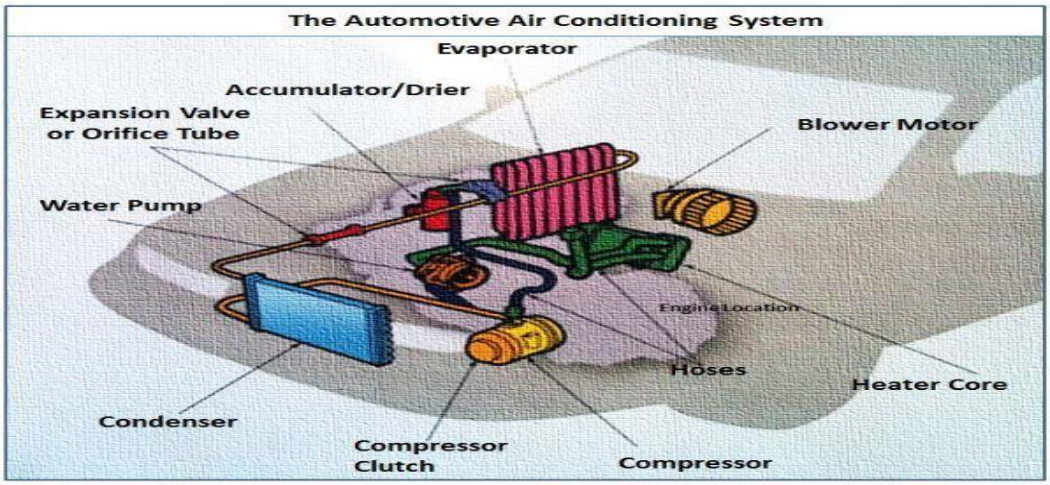

Fig 6.1 Air Conditioning in Automobile

Compressor:

Commonly referred to as the heart of the system, the compressor is a belt driven pump that is fastened to the engine. It is responsible for compressing and transferring refrigerant gas.

The A/C system is split into two sides, a high pressure side and a low pressure side; defined as discharge and suction. Since the compressor is basically a pump, it must have an intake side and a discharge side. The intake, or suction side, draws in refrigerant gas from the outlet of the evaporator. In some cases it does this via the accumulator.

Once the refrigerant is drawn into the suction side, it is compressed and sent to the condenser, where it can then transfer the heat that is absorbed from the inside of the vehicle.

Condenser:

As hot compressed gasses are introduced into the top of the condenser, they are cooled off. As the gas cools, it condenses and exits the bottom of the condenser as a high pressure liquid.

Evaporator:

The evaporator serves as the heat absorption component. As the refrigerant begins to boil, it can absorb large amounts of heat. This heat is then carried off with the refrigerant to the outside of the vehicle.

Orifice tube:

It is located in the inlet tube of the evaporator, or in the liquid line, somewhere between the outlet of the condenser and the inlet of the evaporator.

Thermal expansion valve:

This type of valve can sense both temperature and pressure, and is very efficient at regulating refrigerant flow to the evaporator. Several variations of this valve are commonly found. Another example of a thermal expansion valve is Chrysler's "H block" type. This type of valve is usually located at the firewall, between the evaporator inlet and outlet tubes and the liquid and suction lines. These types of valves, although efficient, have some disadvantages over orifice tube systems. Like orifice tubes these valves can become clogged with debris, but also have small moving parts that may stick and malfunction due to corrosion.

Receiver Drier:

The receiver-drier is used on the high side of systems that use a thermal expansion valve. This type of metering valve requires liquid refrigerant. To ensure that the valve gets liquid refrigerant, a receiver is used.

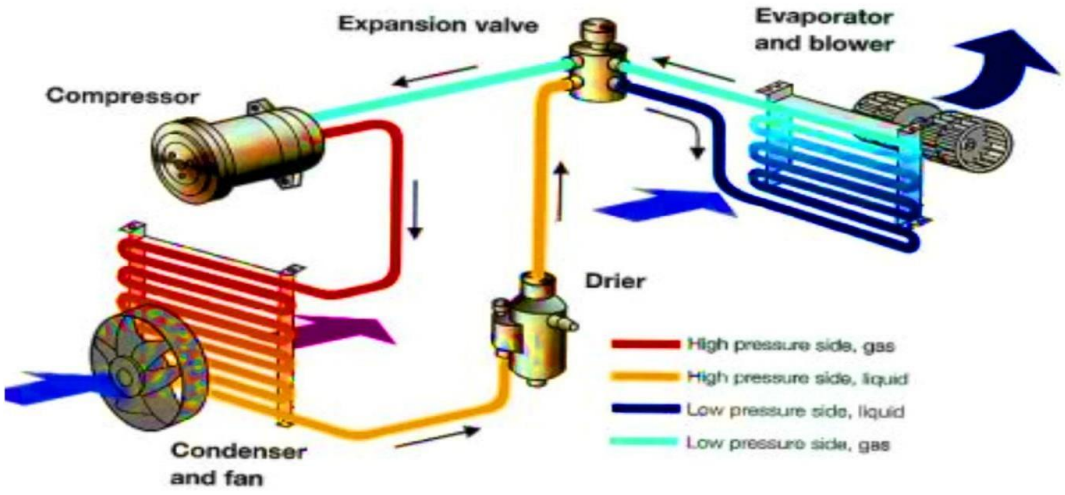

Fig 6.2 View of Air Conditioning System in Car

Receiver Drier:

The receiver-drier is used on the high side of systems that use a thermal expansion valve. This type of metering valve requires liquid refrigerant. To ensure that the valve gets liquid refrigerant, a receiver is used. The primary function of the receiver-drier is to separate gas and liquid. The secondary purpose is to remove moisture and filter out dirt. The receiver-drier usually has a sight glass in the top. This sight glass is often used to charge the system. Under normal operating conditions, vapour bubbles should not be visible in the sight glass.

Accumulator:

Accumulators are used on systems that accommodate an orifice tube to meter refrigerants into the evaporator. It is connected directly to the evaporator outlet and stores excess liquid refrigerant. Introduction of liquid refrigerant into a compressor can do serious damage. Compressors are designed to compress gas not liquid. The chief role of the accumulator is to isolate the compressor from any damaging liquid refrigerant. Accumulators, like receiver-driers, also remove debris and moisture from a system. It is a good idea to replace the accumulator each time the system is opened up for major repair and anytime moisture and/or debris is of concern.

Working:

The whole working starts with the Compressor. It compresses or pressurizes the refrigerant and converts it into the liquid from its gaseous state. The compressed liquid refrigerant has to pass through certain tubes located in the condenser. Here, the fresh air

from outside comes in the contact with liquid refrigerant. The condenser contains a high-temperature liquid and that's why there is a temperature incline between liquid and fresh air. Later, the heat moves from the liquid and mix with air.

Then, the refrigerant moves into the receiver drier or accumulator. The desiccant removes the moisture from the air and refrigerant that leads to the creation of a cooler refrigerant while maintaining the system.

The refrigerant, which is already in the cool liquid state, flows into the expansion valve or orifice tube. This process reduces overall fluid pressure and allows it to move to the evaporator (another component of AC).The converted refrigerant will then move to the evaporator. The air from the car will be drawn into the evaporator and go inside the evaporator core. Till now, the refrigerant temperature is cooler and it can convert the outside heat into the cold air.

Fans near the passenger seat help in blowing the cold air through vents and make the car's temperature cool. This process also removes moisture from the air and allows you to enjoy the fresh and dry air. (During this process, the collection and draining of the condensate also takes place). As the liquid refrigerant in the AC system becomes hotter after working, it again turns into a gaseous state.

This hot and low-pressure gaseous refrigerant again circulates and goes back to the compressor. This is how the new cycle takes place and you get the cool, dry and fresh air.

Short Answer Questions

1. What are the factors effecting the comfort air conditioning system.
2. Write the classification of air conditioning system
3. Explain the heating & cooling coils in air conditioning system.
4. Write importance of air conditioning system for an automobile.

Long Answer Questions

1. Write about the equipment used in air conditioning system.
2. Explain the construction and working of air conditioning system in passenger car with a neat sketch.