Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: BASIC MECHANICAL ENGINEERING

Lecture No.: 9

Topic: Refrigeration and Air conditioning

Sub topic: Introduction to Refrigeration and Air conditioning:

Department of Mechanical Engineering

Introduction toRefrigeration and Air conditioning

Refrigeration:

- Refrigeration may be defined as the process of achieving and maintaining a temperature below that of the surrounding, as the lower temperature is to be maintain continuously the system must operate on cycle.
- One of the most important application of refrigeration is the preservation of perishable food product by storing them at low temperatures

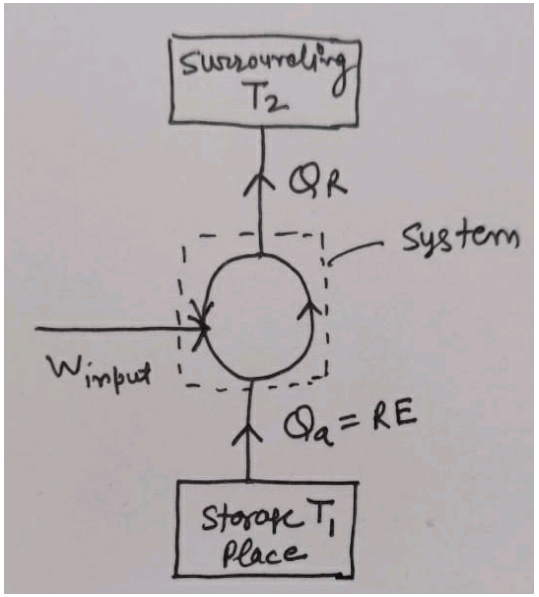
Unit of Refrigeration

- The practical unit of refrigeration is expressed in terms of ‘tonne of refrigeration’. A tonne of refrigeration is defined as the amount of refrigeration effect produced by uniform melting of one tonne of ice at 0° to water at 0° in 24 hours

1TR=3.5 kW

Refrigeration effect

- It is the amount of heat which is to be extracted from storage place in order to maintain lower temperature is known as refrigeration effect
- Refrigeration or refrigerator is Outcome of clausius statement Of second law of thermodynamics



Coefficient of performance(COP)

- Coefficient of performance is defined as the ratio of refrigeration effect to the work input

$$\text{COP} = \frac{\text{Refrigeration effect}}{Work\ input}$$

Air conditioning

Air Conditioning refers to the simultaneously control of four parameters of air as temperature, moisture content, cleanliness, odor, and circulation, as required by occupants, a process, or products in the space.

Refrigerant

- A refrigerant is the working fluid in a refrigerator. It is capable of absorbing heat at lower temperature and rejecting the heat at a higher temperature in the form of sensible heat or latent heat or both
- Example of refrigerant are R11,R12,R134a, ammonia, air, carbon dioxide

Types of Refrigeration System

1. Natural Cooling

- Art of Ice making by Nocturnal Cooling
- Evaporative Cooling
- Cooling by Salt Solutions

Types of Refrigeration System

2. Artificial Refrigeration

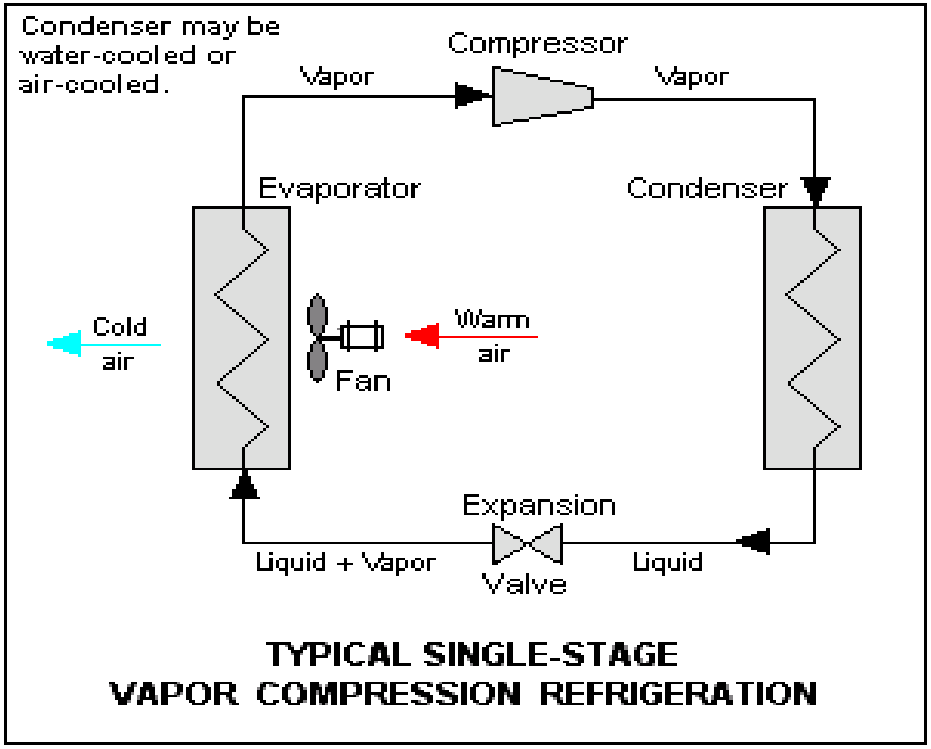
- Vapour Compression Refrigeration Systems
- Vapour Absorption Refrigeration Systems
- Solar energy based refrigeration systems
- Gas Cycle Refrigeration
- Steam Jet Refrigeration System
- Thermoelectric Refrigeration Systems
- Vortex tube systems
- Electrolux Refrigeration System

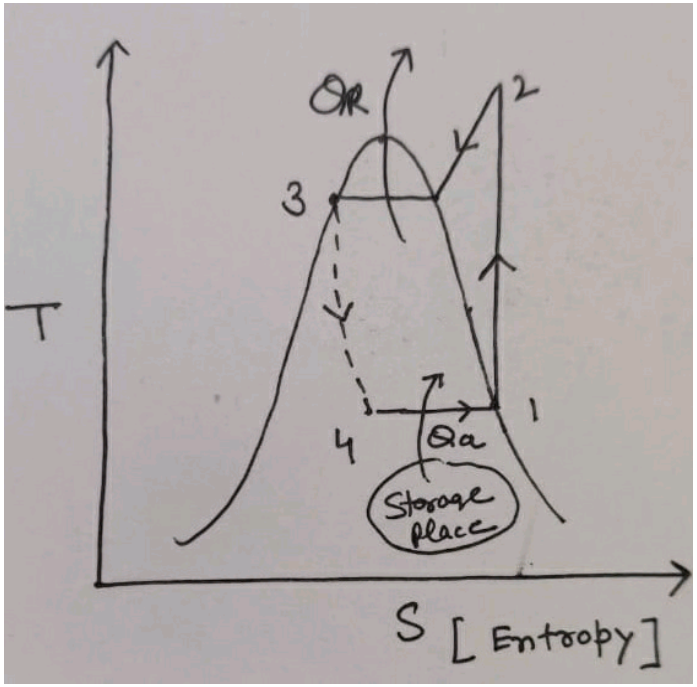
Classification of Refrigeration system

Mainly refrigeration system are classified in two category

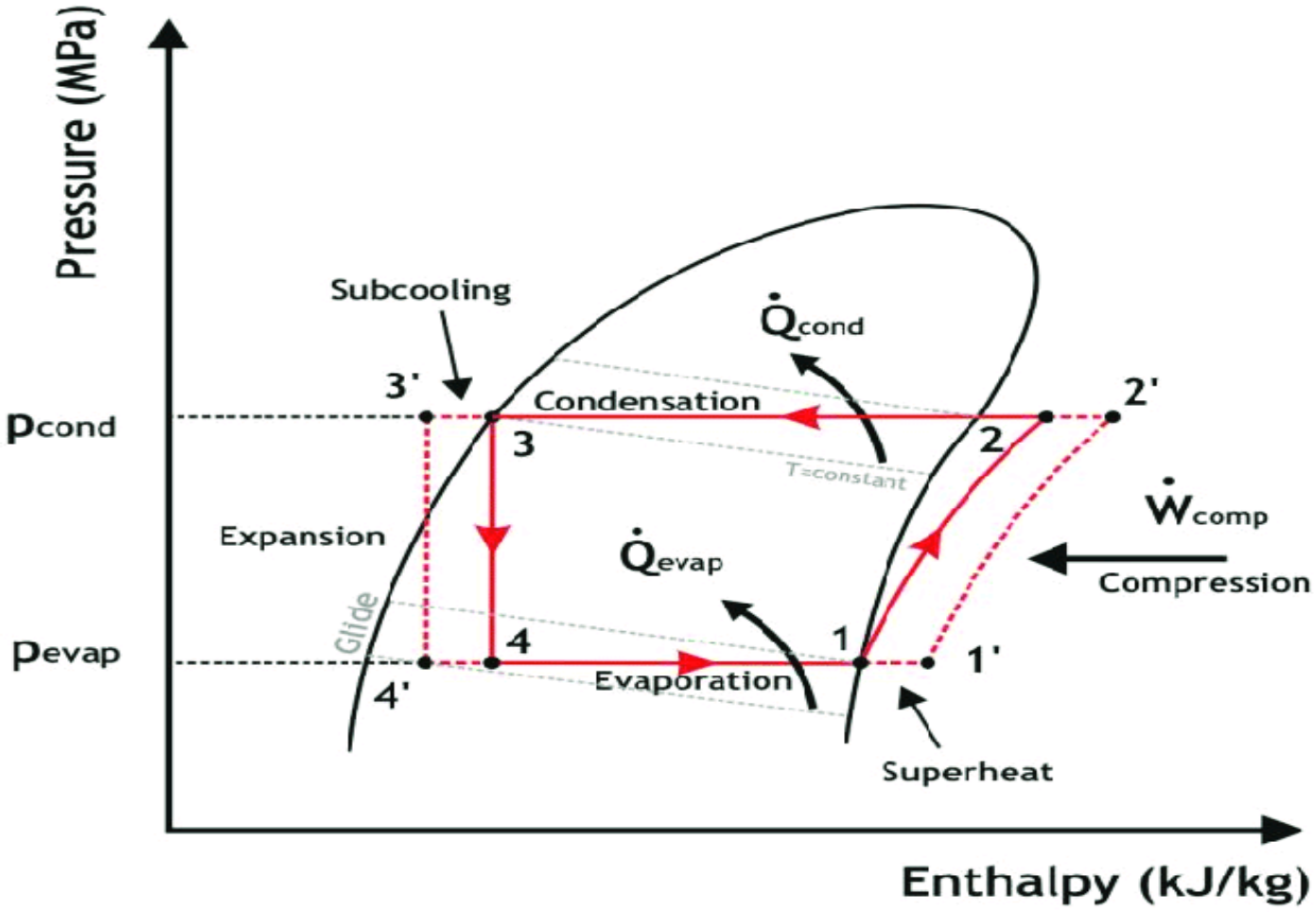
- 1 vapour compression refrigeration system
- 2 vapour absorption refrigeration system

vapour compression refrigeration system





vapour compression refrigeration system



vapour compression refrigeration system

- Components of Vapour compression refrigeration system:

1. Compressor
2. Condenser
3. expansion device
4. evaporator

vapour compression refrigeration system

- **Working**
- Vapour compression cycle is an improved type of air refrigeration cycle in which a suitable working substance, termed as refrigerant, is used.

- The refrigerants generally used for this purpose are ammonia (NH3), R11, R12, R134a, carbon dioxide (CO2), and sulfur-dioxide (SO2).

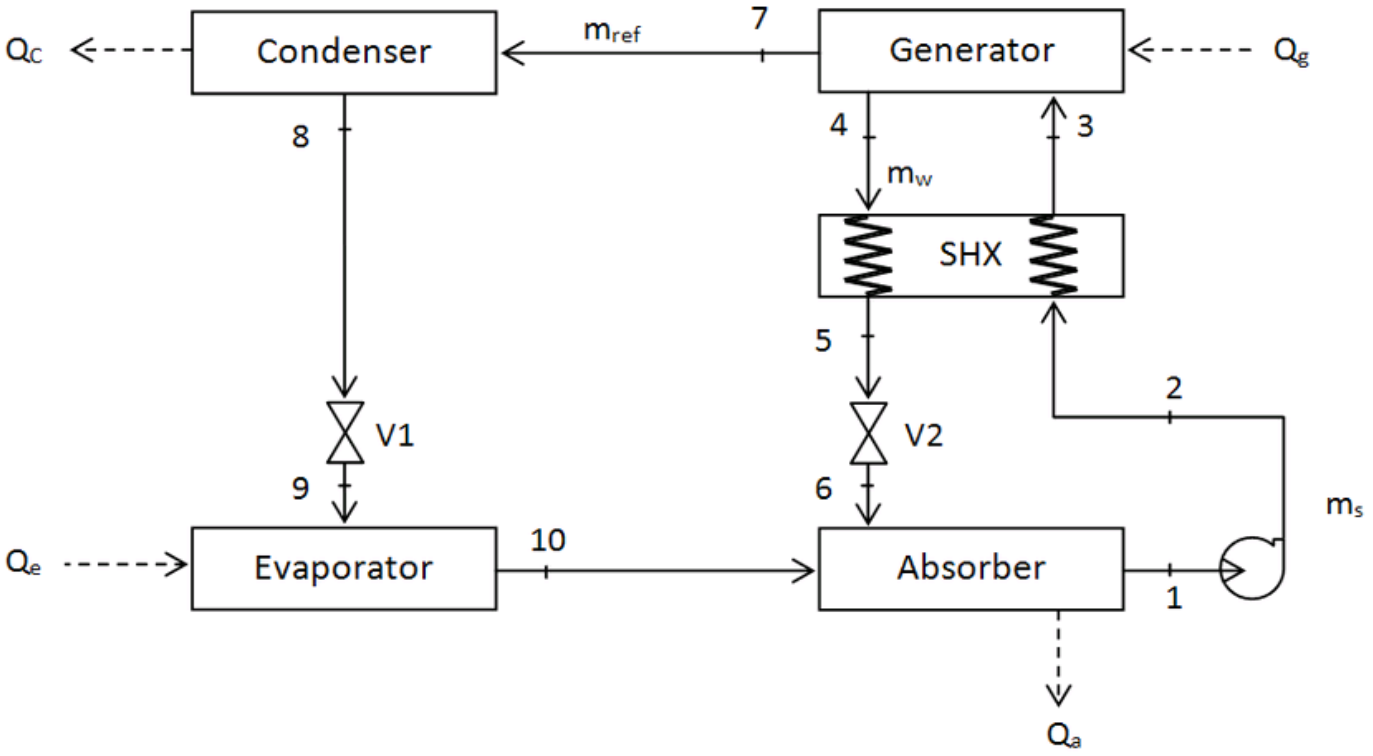
- The refrigerant used does not leave the system but is circulated throughout the system alternately condensing and evaporating. In evaporating, the refrigerant absorbs its latent heat from the solution which is used for circulating it around the cold chamber and in condensing; it gives out its latent heat to the circulating water of the cooler.

- The vapor compression cycle which is used in the vapor compression refrigeration system is nowadays used for all-purpose refrigeration. It is used for all industrial purposes from a small domestic refrigerator to a big air conditioning plant.

vapour compression refrigeration system

- Dervivation of COP of VCRS

vapour absorption refrigeration system



Simple Schematic diagram of vapour absorption cycle

vapour absorption refrigeration system

- Components of Vapour absorption refrigeration system:

1. Generator
2. Condenser
3. Expansion device
4. Absorber
5. Pump

vapour absorption refrigeration system

- **Working**
- The vapor absorption refrigeration is a heat operated system. It is quite similar to the vapor compression system. In both systems, there are evaporators and condensers.

- The process of evaporation and condensation of the refrigerant takes place at two different pressure levels to achieve refrigeration in both cases. The method employed to create the two pressure levels in the system for evaporation and condensation of the refrigeration makes the two processes different. Circulation of refrigerant in both the cases is also different.

- In the absorption system the compressor of the vapor compression system is replaced by the combination of absorber and generator.

- A solution known as the absorbent, which has an affinity for the refrigerant used, is circulated between the absorber and the generator by a pump (solution pump).

vapour absorption refrigeration system

- The absorbent in the absorber draws (or sucks) the refrigerant vapor formed in the evaporator thus maintaining a low pressure in the evaporator to enable the refrigerant to evaporate at low temperatures.

- In the generator the absorbent is heated. Thereby releasing the refrigerant vapor (absorbed in the absorber) as high-pressure vapor, to be condensed in the condenser. Thus the suction function is performed by absorbent in the absorber and the generator performs the function of the compression and discharge.

- The absorbent solution carries the refrigerant vapor from the low side (evaporator–absorber) to the high side (generator-condenser). The liquefied refrigerant flows from the condenser to the evaporator due to the pressure difference between the two vessels; thus establishing the circulation of the refrigerant through the system.

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: BASIC MECHANICAL ENGINEERING

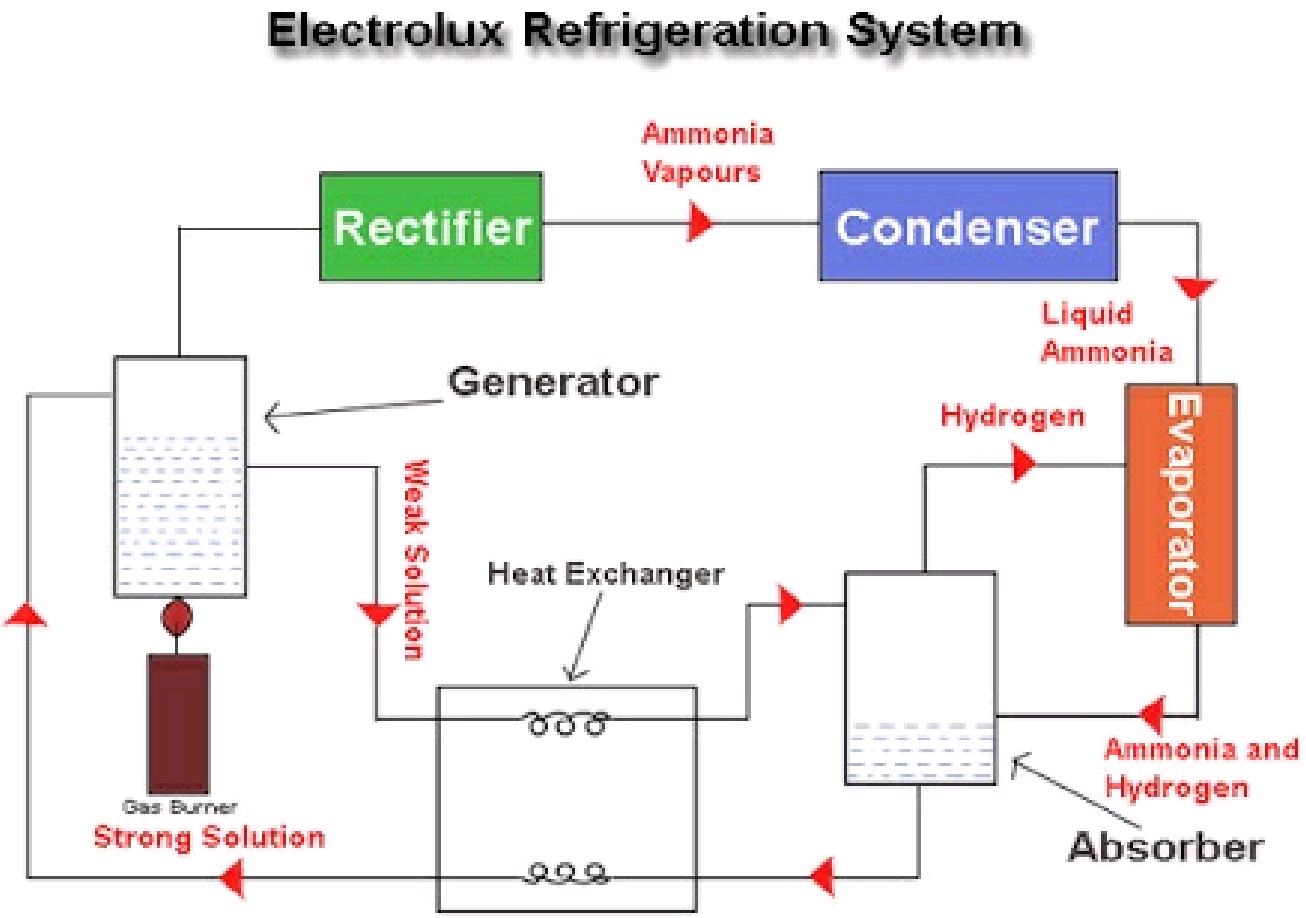
Lecture No.: 11

Topic: Refrigeration and Air conditioning

Sub topic: Electrolux Refrigeration System and Air conditioning:

Department of Mechanical Engineering

Electrolux Refrigeration System



Electrolux Refrigeration System

Electrolux Refrigeration System is consist of the following parts.

- Heat exchanger
- Absorber
- Evaporator
- Condenser
- Water separator
- Boiler & Burner (Generator)

Electrolux Refrigeration System

- **Heat exchanger**

The heat exchanger is used to transferring heat to NH3.

- **Absorber**

It is used to remove the hydrogen from ammonia.

- **Evaporator**

It is used to evaporate the NH3 with the help of H2.

- **Condenser**

It is used to condense the NH3 into liquid.

- **Water separator(Rectifier)**

The water separator is used to separate the water particle from the vapor Ammonia.

- **Boiler and Burner (Generator)**

It is used to generate the Ammonia vapor and supply only the strong solution of ammonia.

Electrolux Refrigeration System

- In Electrolux refrigeration system NH3 gas coming out from the boiler is passed through the rectifier or water separator and then to the condenser.

- The whole plant is charged to a pressure of about 14 kgf/cm2 and the evaporator contains hydrogen at a pressure of 12 kgf /cm2. Therefore as soon as NH3 enters the evaporator, its pressure falls to 12kgf/cm2 and its temperature being about 18-degree centigrade.

- Due to this low temperature, NH3 evaporator taking its latent heat from the refrigerated space and produces a cooling effect.

Electrolux Refrigeration System

- The dense mixture of NH_3 vapor and H_2 then passes into the absorber where it meets with H_2O coming from boiler and NH_3 is absorbed in H_2O, while H_2 rises and returns to evaporator.

- The strong solution of NH_3 then passed through the heat exchanger and burner and supplied to the boiler at pressure head h.

Air conditioning

- **Psychrometry**
- It is the branch of science which deals with the study of moist air.
- **Psychrometric term**

1. **Specific humidity or humidity ratio.**

It is defined as the ratio of mass of vapour to the mass of dry air.

Air conditioning

- **Relative humidity.**
- It is defined as the ratio of mass of vapour to the mass of vapour under saturation condition in the same volume and at the same temperature

Air conditioning

- **Dry bulb temperature(DBT)**
- It is the temperature of air measured by an ordinary thermometer.

- **Wet bulb temperature(WBT).**
- It is the temperature measured by thermometer whose bulb is covered by a wet cloth.

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: BASIC MECHANICAL ENGINEERING

Lecture No.: 12

Topic: Refrigeration and Air conditioning

Sub topic: Application of refrigeration and air conditioning

Department of Mechanical Engineering

Application of refrigeration and air conditioning

The applications of refrigeration can be grouped into following four major equally important areas.

- Food processing, preservation and distribution.
- Chemical and process industries
- Special applications
- Comfort air conditioning

Application of refrigeration and air conditioning

- **Refrigeration in Food processing, preservation and distribution.**
- Food preservation is one of the most important application of refrigeration. It is well known that food products can be preserved for a longer time, if stored them at lower temperatures. Both the live and dead products can be preserved for longer time using refrigeration.
- Live products stands for the products like fruits, vegetables and dead products for the products like fist, meat etc.

Application of refrigeration and air conditioning

- **Refrigeration in Chemical and Process Industries.**
- For separation and liquefaction of gases in petrochemical industries.
- For removal of heat of reaction in various chemical industries.
- For dehumidification of process air in pharmaceutical industries.
- For recovery of solvents, storage of low boiling point liquids.

Application of refrigeration and air conditioning

- **Special Applications of refrigeration.**
- Cold treatment of metals in the manufacture of precision parts, cutting tools to improve dimensional accuracy, hardness, wear resistance and tool life.
- For storage of blood plasma, tissues, etc.
- For manufacture and storage of drugs.
- In surgery for local anesthesia.
- In construction for setting of concrete and for freezing wet soil to facilitate excavation.
- Desalination of water by freezing.
- Manufacture of ice, ice cubes, flakes, etc.
- For storage of vaccines, medicines in remote and rural areas

Applications of Air Conditioning

- **Air conditioning is required for**

1.Providing thermal comfort to humans and other living beings - **Comfort air conditioning**.

2.Providing conditions required for various products and processes in industries **- Industrial air conditioning.**

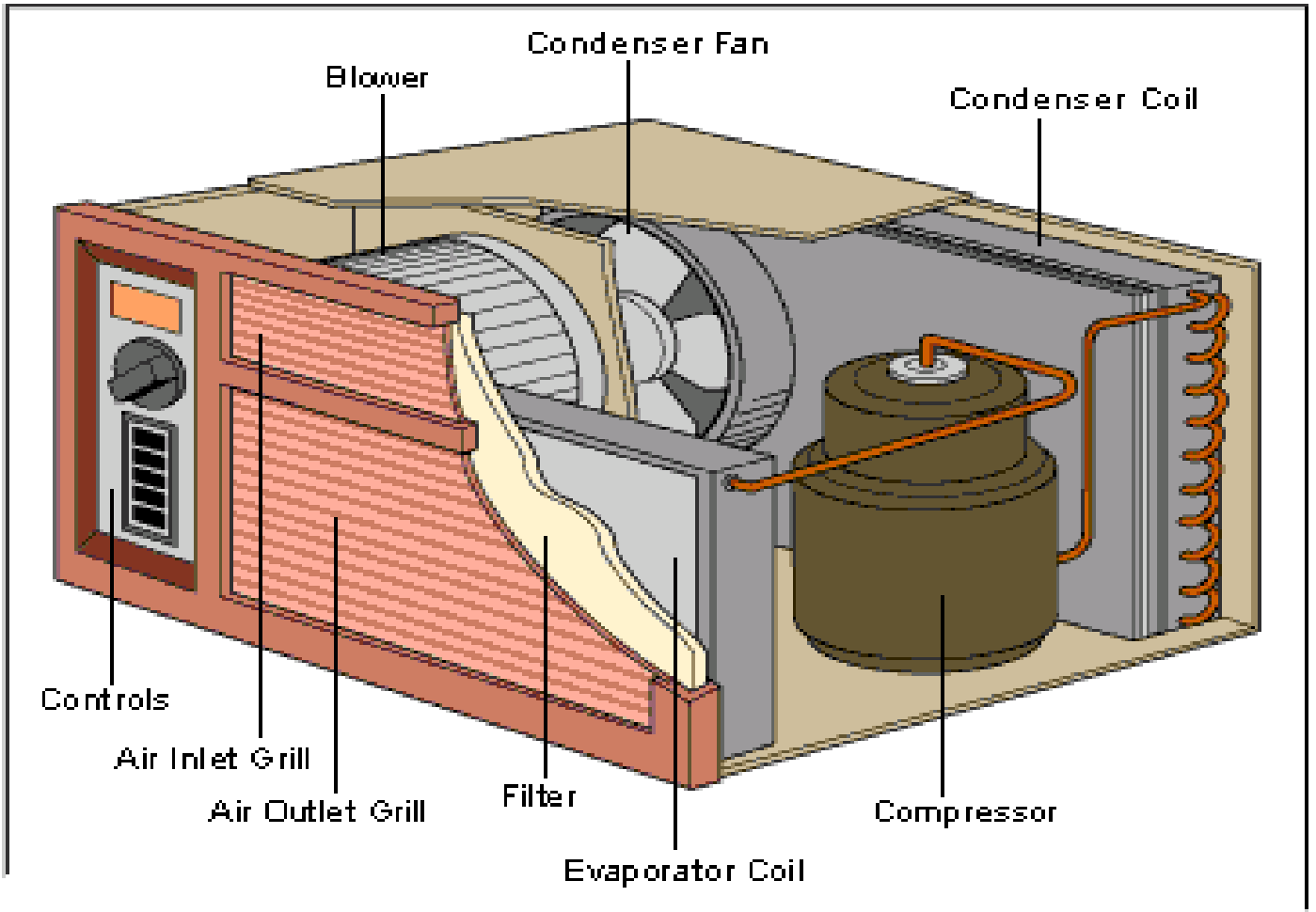
Comfort Air Conditioning

- **Comfort Air Conditioning .**
- The objective of this is to provide thermal comfort to the occupants.
- **Thermal comfort** may be defined as the state of mind that expresses satisfaction with its surroundings.
- The requirement of thermal comfort for human body the temperature to be maintained about 22 to 24 degrees Celsius and relative humidity is 55%.

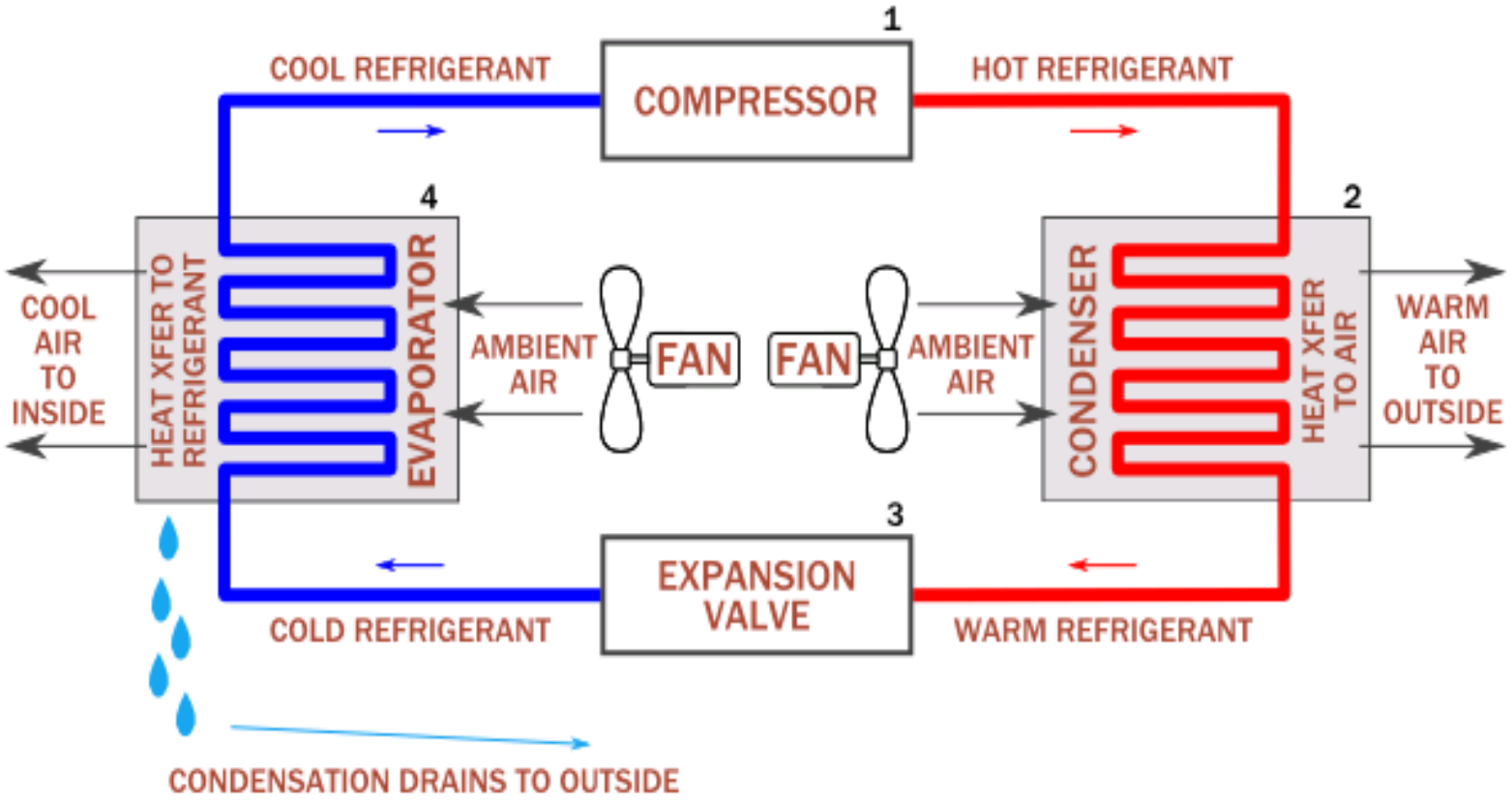
- **Classification of comfort air conditioning systems.**
- Air conditioning systems for residences.
- Commercial air conditioning system.
- Air conditioning system for hospitals.
- For comfort of passengers in cars, buses, trains, aeroplanes.

Air Conditioning systems

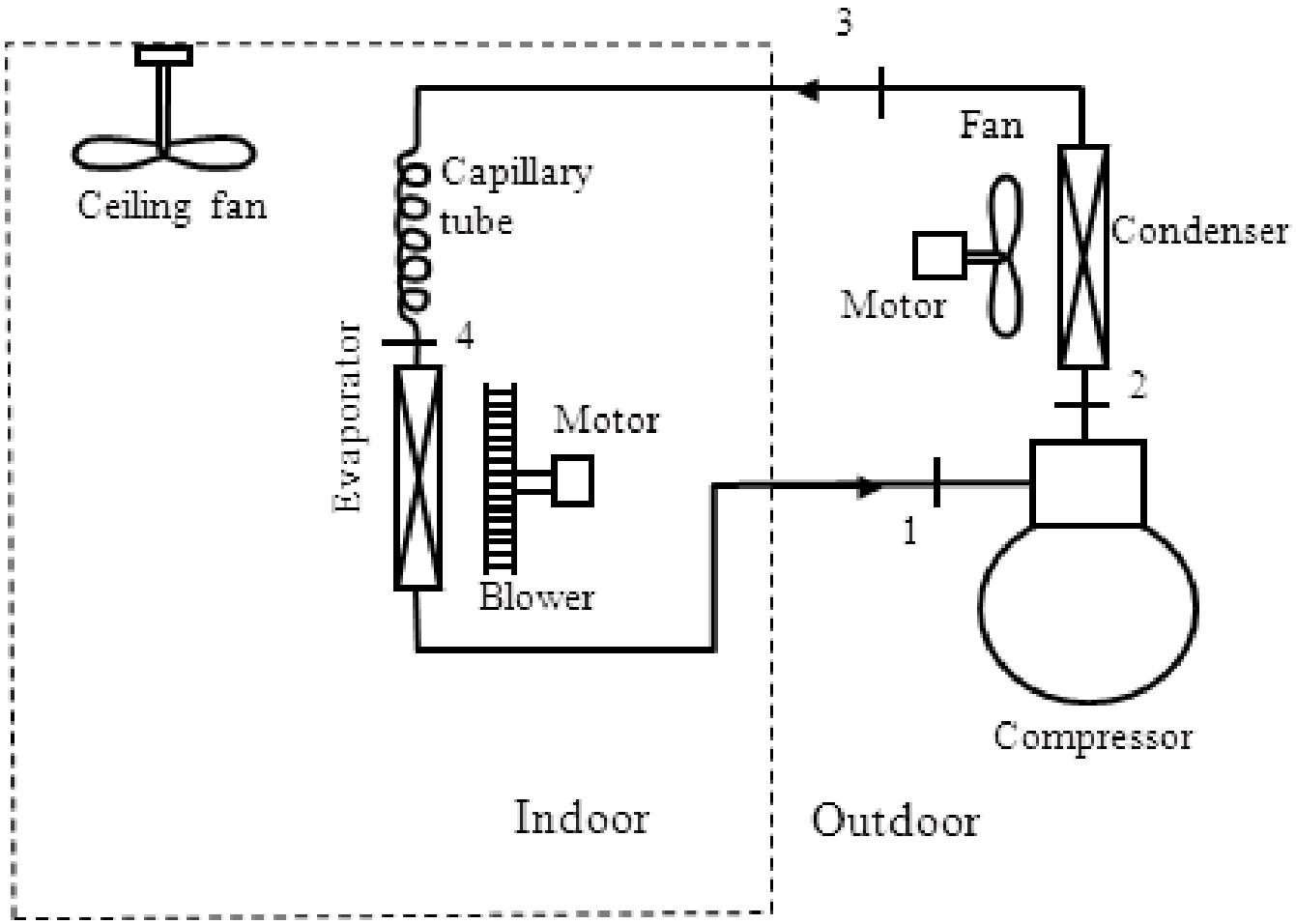
- Window air conditioner.



Window air conditioner



Split air conditioner



thermoelectric cooling

- Thermoelectric cooling works on peltier effect
- **Peltier effect**:
- When an electric current is passed through a circuit of a thermocouple, heat is evolved at one junction and absorbed at the other junction. This is known as the Peltier Effect.