

## **Refrigeration Systems, VCRS**

### **Expected Learning Outcome**

- Necessity of Refrigeration and Air conditioning in the present scenario
- Methods of refrigeration and their working principles
- Most commonly used refrigeration system in food preservation

### **2.1.Introduction**

Refrigeration contributes to the raising of living standards for the people of all lands. The advances made in refrigeration in recent years are the result of a team approach in which technicians, craftsmen, engineers, scientists, and others, pool their skills and knowledge. The foundation on which new substances and materials are built are provided by science. This knowledge is applied to the refrigeration field by those who design, manufacture, install and maintain refrigeration equipment and practical application. The application of refrigeration principle is limitless. The most common use, and one that is readily recognized is the preservation of food. Almost all products in the home, on the farm, in business, in industry or in the laboratories are in some way affected refrigeration. Thus, refrigeration has become an essential commodity in modern living.

The most important thing in refrigeration is the removal of heat. The natural tendency of the heat to flow from warm body to cold body. If two substances are at the same temperature, no heat flows between them. If there is a temperature difference between them, heat flows from the warm substance to the colder one. Thus it is said that heat is transferred from higher temperature to lower temperature. The heat that must be transferred enters a refrigerated space in the following ways.

- \* The heat leaks through the wall surrounding the space to be cooled.
- \* As the door open, outside heat rushes into the refrigerated space.
- \* The heat of the food stuff material is introduced into the refrigerated space.
- \* So all the heat enters a refrigerated space should be removed by means of refrigeration.

### **2.2.Refrigeration**

Refrigeration is the artificial withdrawal of heat, producing in a substance or within a space a temperature lower than that which would exist under the natural influence of surroundings.

### **Air conditioning**

Air-conditioning is an application of refrigeration system. It is defined as the control of air movement, temperature, humidity and its cleanliness in a required space. Air-conditioning consists of both cooling and heating. Therefore, air-conditioning system should be able to add and remove the heat from the desired space. The air-conditioning system should also be able to control the humidity in the air in the required space. The system should also make necessary movement of air, remove smell, dust and impurities from the air.

### **2.3.Applications of refrigeration and Air-conditioning**

- In India mangoes are harvested during the summer season and demand for the same persists throughout the year.
- Fishermen are going for harvesting fish during a particular season and same thing can be demanded throughout the year.
- Poultry products show better yield if appropriate humid environment is created compared to relatively hot and dry weather.
- Scientific equipments will work satisfactorily if proper temperature is maintained

- Death rate of premature babies has been reduced considerably, due to nursing in controlled environment.
- Curing persons suffering from high fever.
- To preserve food in sufficient quantities to feed the growing urban population
- Human blood can be preserved in the blood bank ( $-5^{\circ}\text{C}$  to  $-7^{\circ}\text{C}$ ) and can be reused for saving human lives.
- Refrigeration used in processing, freezing, storage, transportation and display of perishable products.
- Air conditioning used in building, cinema theater, hotels, offices, restaurants, Ice manufacturing, cold drinking water etc.,

### **2.3.1. Classification of Refrigeration**

#### **A) Non mechanical**

- Cooling by evaporation of liquids like water ( $0^{\circ}\text{C}$ )
- Ether ( $-116.3^{\circ}\text{C}$ )
- Liquid  $\text{N}_2$  ( $-160^{\circ}\text{C}$ ) At 1 atmospheric pressure
- Cooling by the melting of solids like Ice – Natural or manufactured
- Cooling by endothermal mixture like
- Ice and Salt
- Water and Ammonia Salt
- Acid and Salt
- Cooling by sublimation like
- Dry ice ( $\text{CO}_2$ )

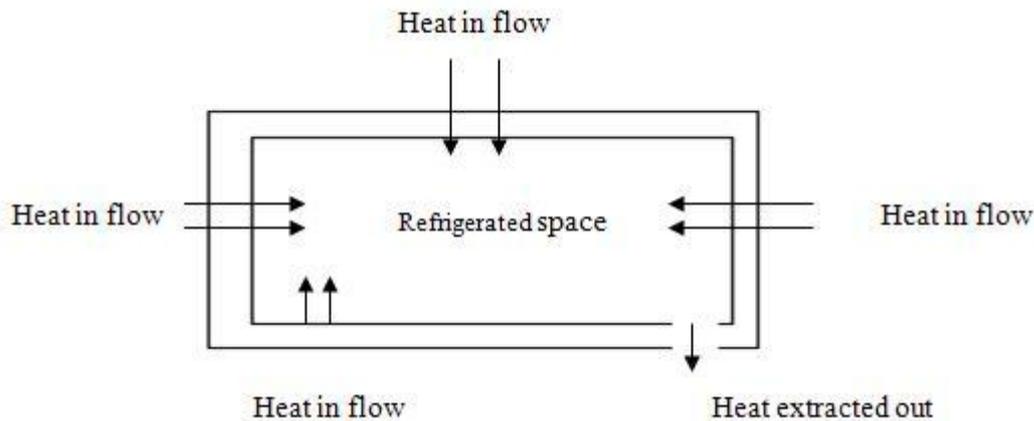
#### **B) Mechanical**

- Direct cooling by the evaporation of liquids
  - Vapour compression system
  - Vapour absorption system
  - Vapour adsorption system
- Indirect cooling by gases
  - Compressed air.
  - Expansion turbine
  - Forced air
  - Vortex tube
- Indirect cooling by liquids
  - Brine circulation
  - Water circulation
- Electrical or Magnetic
  - Thermo electric cooling
  - Magnetic cooling (Adiabatic demagnetization)

### **2.4. Principle of Refrigeration**

It is a process by which the temperature of a given space or a substance is lowered below than that of the atmosphere or surroundings. Thus in order to maintain a temperature below the surrounding atmosphere, it is essential that the amount of heat that gets into the refrigerated

space must be extracted out to maintain the desired temperature differential.



## 2.5.Vapour compression refrigeration system

Vapour compression refrigeration system is also called mechanical refrigeration system. In this system compressor is used for producing mechanical energy by which system work is completed.

### Working of vapour compression refrigeration system

The refrigerant stored in the receiver at high pressure is released through controlling valves to the evaporator coils. The controlling valves reduces high pressure of the liquid refrigerant to low pressure and releases inside the evaporator coils. The low pressure liquid refrigerant under expansion form is passes through the entire evaporator coils. When the refrigerant liquid passing through the evaporator coils inside the cold storage it absorbs heat from the surroundings. Once the liquid absorbs heat it becomes vapour and passes through the evaporator coils and enters the suction side of the compressor. In the compressor, when vacuum is created inside the cylinder of the compressor it draws vapour from the suction side and compresses it to higher pressure and temperature. The increased pressure and temperature of the vapour refrigerant passes through the discharges line and enters the condenser coils. The condenser coils condenses the hot refrigerant vapour by air or water or both to refrigerant liquid. The refrigerant liquid from the end of the condenser coils enters the receiver.Thus the refrigerant after undergoing various phase changes comes back to its original state and thus completes the vapour compression refrigeration cycle.

### 2.5.1.Parts of the vapour compression refrigeration system

#### 1.Receiver:

This is a storage tank for the refrigerant which is fixed below the condenser, and is filled with refrigerant. The refrigerant inside the receiver is under high pressure. The receiver has inlet valve, outlet valve, safety valve etc. The receiver is fitted in the evaporation type condenser or water cooled condenser. There is no receiver in domestic refrigerators. The refrigerants are to be accumulated in the condenser of the domestic refrigerator.

#### 2. Refrigerant flow controls or throttling devices:

The function of the controlling devices is to reduce high pressure liquid refrigerant from the receiver to low pressure in the correct quantities and to feed the liquid refrigerant to the

evaporator coils,so as to operate a system at maximum efficiency without overloading the compressor.

**3. Evaporator:**

Evaporator is that part in a refrigeration system where the refrigerant boils and changes to vapour, when liquid refrigerant inside the evaporator absorbs heat from warm place /material placed in it.

**4. Suction line:**

The line through which refrigerant flows from evaporator to the compressor is called suction line. These suction lines are made of pure steel material. In case of domestic these are made of copper material. F

**5. Compressor:**

The compressor is referred to as the heart of mechanical refrigeration system. The compressor pumps the refrigerant through the system.

**6. Discharge line:**

The line between compressor and the condenser is called discharge line, this is towards high pressure side of the system. This is made of steel material in case of domestic this is made of copper material.

**7. Condenser:**

When high superheated refrigerant vapor comes in condenser from compressor, its temperature is brought down by air or water or both. The heat goes from vapor to condensing medium and gets transformed into liquid.

**2.5.2.Vapour compression refrigeration system**

**Advantages**

- It has smaller size for the given capacity of refrigeration.
- It has less running cost.
- It can be employed over a large range of temperatures.
- The coefficient of performance is high.

**Disadvantages**

- The initial cost is high.
- The prevention of leakages of the refrigerant is the major problem in this system.

**2.6.Refrigeration effect and coefficient of performance**

**Refrigeration effect**

A refrigeration machine can be called efficient only if it can create maximum refrigerating effect for the work allotted to it. Refrigeration effect means that cooling action should be done at the rate of heat absorption from any place in a cycle.

coefficient of performance

The rate of refrigerating effect to the heat equal to the supplied work is called coefficient of performance.

$$\text{C.O.P.} = \frac{\text{Refrigerating effect}}{\text{In put work}}$$