Department of Mechanical Engineering
Vapour Compression Refrigeration System

Refrigeration is a process by which heat is removed from a space or substance to reduce and maintain temperature lower than its surroundings.

PRINCIPLE OF REFRIGERATION:

Refrigeration is defined as the process of production of temperature lower than the temperature of the surroundings and maintaining the lower temperature within the boundary of given space.

Generally, refrigeration effect is produced by transferring heat from a low temperature source to a high temperature source by expanding mechanical work. To produce this effect, it requires certain machinery. Hence this process is called mechanical refrigeration. The machines employed for this purpose are called refrigerating machines or Refrigerators.

CLASSIFICATION OF REFRIGERATION SYSTEM:

1.Natural method 2. Artificial method or Mechanical method.

Mechanical refrigerators are further classified as

1.Air Refrigeration system a) Reversed Carnot cycle
b) Bell Colemann cycle

2.Vapour Refrigeration system a) Vapour Compression refrigerator
b) Vapour Absorption refrigerator

TERMINOLOGY:

1.**Refrigeration:** Refrigeration is defined as the method of reducing the temperature of a system below that of the surroundings and maintain it at the lower temperature extracting heat continuously from it.

2.Refrigerator: Refrigerator is a device used for producing and maintaining the temperature in a space below the atmospheric temperature.

3.Refrigerant: In a refrigerator, a medium called refrigerant continuously extracts the heat from the space within the refrigerator which is to be kept cool at temperature less than the atmosphere. Some of the commonly used refrigerants are Ammonia, Freon, Methyl chloride, Carbon dioxide.

4.Capacity of Refrigeration: Generally the capacity of refrigerating machines are expressed by their cooling capacity. The standard unit used for expressing the

capacity of refrigerating machine is “tone of refrigeration”. One tone of refrigeration is equal to 12,600 KJ/hr or 210 KJ/min.

5.Co-efficient of performance: Co-efficient of performance is defined as the ratio of heat extracted in a given time (refrigerating effect) to the work input.

This is expressed as COP.

6.Power required: The power required to produce a refrigerating effect is equivalent to one tone of refrigeration may be calculated as follows.

Refrigeration effect = 12600 KJ/hr = 3.5 KJ/sec

1 KW = 1 KJ / sec

KW per ton of refrigeration = 3.5 / COP

7.Refrigeration effect: Refrigeration effect is the amount of heat absorbed in the evaporator, which is the same as the amount of heat removed in a given time from the space to be cooled. In other words *It is the cooling effect produced in a given time. It is expressed in KJ/sec.*

PARTS OF A REFRIGERATOR:

Refrigerator must consist the following parts. 1. Evaporator 2.Condenser 3.Circulating system 4. Expansion device.

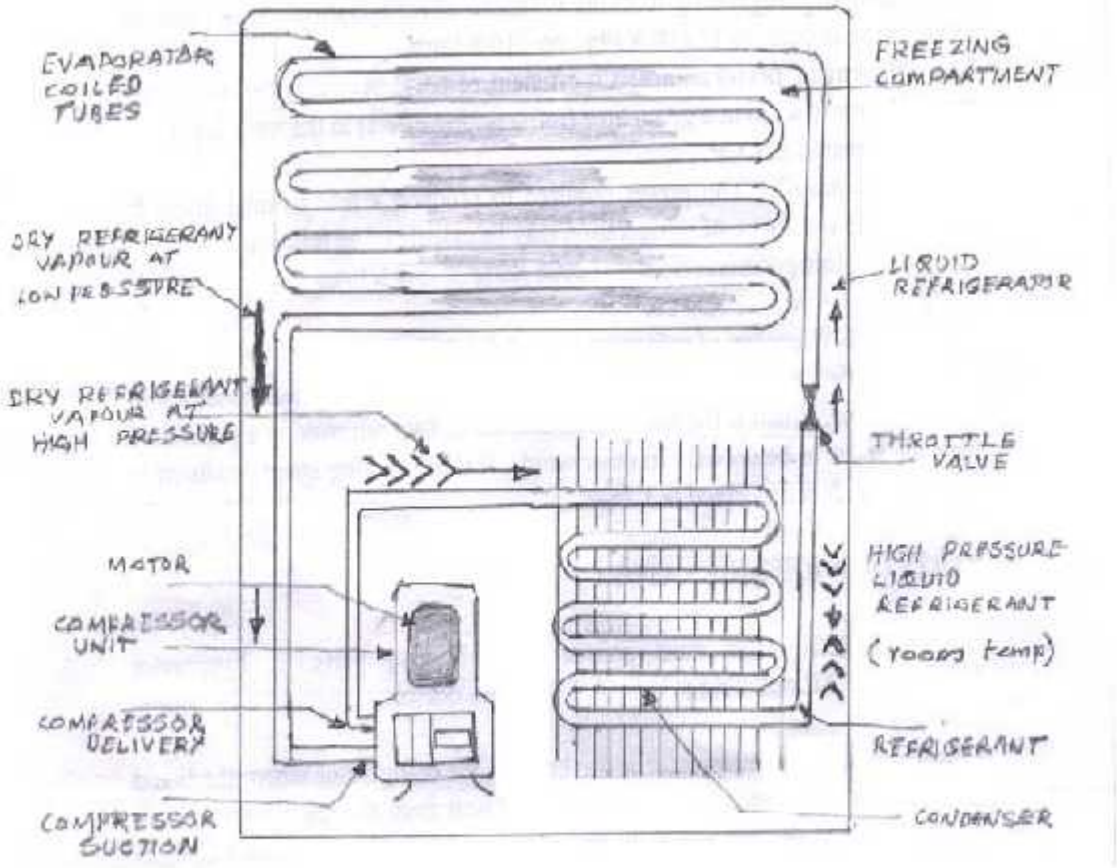
1.Evaporator: The evaporator is the heart of the refrigerator where the liquid refrigerant is evaporated by the absorption of heat from the refrigerator cabinet in which carries the substances to be cooled are kept. The evaporator consists of a simple meta tubing which is formed around the freezing and cooling compartments to product the cooling effect. In turn this cooling effect is used for freezing ice or lowering the temperature of perishables placed in the cooling department. Since it produces the cooling effect it is also sometimes called as cooling coil or freezer coil.

2.Circulating system: The circulating system consists of the mechanical devices such as compressors or pumps which are necessary to circulate the refrigerant to undergo the refrigeration cycle. They increase the pressure which results in the increase of refrigerant’s temperature. These devices are driven by the electric motors. The electrical energy input to the motor is the energy input to the refrigerators.

3.Condenser: A condenser is an appliance which rejects the heat from the refrigerant at higher temperature to the atmospheric air. In condenser, the refrigerant vapour gives off its latent heat of the refrigerant that is given off in the condenser. It comprises mainly of the heat absorbed in the refrigerator cabinet and the heat developed due to compression.

4.Expansion device: An expansion device serves to reduce the pressure and temperature of the refrigerant before it is sent to the evaporator. The liquid

refrigerant from the condenser is passed through an expansion valve where its pressure and temperature is reduced.



VAPOUR COMPRESSION REFRIGERATOR:

In a vapour compression refrigerator, vapour is used as a refrigerant. It is circulated through the system, where it alternatively evaporates and condenses, undergoing a change of phase from vapour to liquid and again liquid to vapour. During evaporation it absorbs the latent heat from the refrigerated space and subsequently the heat is given off while condensing. A vapour

compression system makes use of mechanical energy supplied to the compressor to run the refrigerator.

The figure shows the vapour compression refrigerator. It consists of an evaporator made of coiled tubes installed in the freezing compartment of the refrigerator. They are connected to the suction side of the compressor and a throttle valve (expansion valve) as shown. The delivery side of the compressor is connected to the throttle valve through the condenser.

The purpose of providing a compressor in this system is to withdraw the vapour from the evaporator and compress it to such a pressure which corresponds to the saturation temperature higher than that of the cooling medium flowing into the condenser, so that the high pressure vapour can reject heat into the condenser and be ready to expand to the evaporator pressure again. The compressor is usually oversized so that if it runs continuously it would produce progressively lower temperature. In order to maintain the desired temperature range, within the refrigerator, the motor driving the compressor is controlled by a thermostat switch.

The refrigerant at low pressure and temperature passing through the evaporator coil tubes absorbs the heat from the contents in the freezing compartment and gets evaporated. This lowers the temperature in the freezing compartment. The evaporated refrigerant at low pressure from the evaporator is drawn by the compressor which compresses it to high pressure.

The saturation temperature of the refrigerant corresponding to the increased pressure is higher than the temperature of the cooling medium in the condenser. Therefore the high pressure –high temperature vapours can inject heat in the condenser and they will be ready to expand in the throttle valve to the lower evaporator pressure again.

The high pressure-high temperature refrigerant vapour from the compressor flows to the condenser where its latent heat is given off to the atmospheric air. As a result of this, the refrigerant condenses. The high pressure condensed liquid refrigerant approximately at room temperature now flows to the throttle valve where it expands to partly evaporate. Hence the refrigerant coming out of the expansion valve will be a very wet vapour and at a very low temperature of around 10^0C.

The wet vapour then passes to the evaporator coils where it absorbs its latent heat and then recirculated to repeat the cycle continuously. Thus heat is continuously extracted from the contents of the refrigerator in the evaporator

and rejected from the condenser to the atmospheric air. This helps to keep the contents of the refrigerator at the required lower temperature.

The required low temperature is maintained in the refrigerator by a thermostat switch. The switch switches on and off the compressor motor by a relay as and when the temperature either falls below or rises above the required temperature. One of the most commonly used refrigerant in the vapour compression refrigerator is dichlorodifluromethane, popularly known as FREON 12 or R 12. This refrigerant vapourises at -6.7^0C in the evaporator under a pressure of 246.2 KPa and after compression to 909.2 K Pa it would condense at 37.8^0C in the condenser.