Experiment(3)

Experiment name: TRIAL ON VAPOUR COMPRESSION

Objective: Trial on vapour compression test rig to find out actual and theoretical COP.

Name of device: **VAPOUR COMPRESSION**

Theory:

VAPOUR COMPRESSION REFRIGERATION SYSTEM

A vapour compression system is improved type of air refrigeration system in which suitable working substance termed as refrigerant is used, it condensates and evaporates at temperature and pressure close to atmospheric conditions. The refrigerants used for this purpose are ammonia, carbon dioxide, and sulphur dioxide. The refrigerant used does not leave the system, alternatively condensing and evaporating. In evaporation, the refrigerant absorbs it's latent heat from which it is used for circulating it around the cold chamber while cost during it gives latent heat to the circulating water of the cooler. The VCS is thus latent heat pump as it pumps its latent heat from brine end and delivers it to the cooler. It is generally used for all individual purposes from small domestic refrigerator to a big air conditioning plant.

ADVANTAGES:

1. It has similar size for given capacity of refrigerator.
2. It has less running cost.
3. It is employed for large range of temperature.
4. The COP is quite higher.

DISADVANTAGES:

1. The initial cost is higher.
2. The leakage of refrigerant is difficult to avoid.

ESSENTIAL PARTS OF THE SYSTEM:

1. Compressor:

The low pressure and temperature of the vapour refrigerant from evaporator is drawn into the compressor through IV or suction valve where it is compressed to high pressure and temperature. Refrigerant is discharged into the condenser through delivery or discharge valve.

2. Condenser

It consists of coils of pipe in which high pressure and temperature vapour refrigerant gets cooled and condensed. The refrigerant while running through the condenser gives up its latent heat to the surrounding condensing medium which is normally air or water.

3. Receiver

The condensed liquid refrigerant from the condenser is stored in vessel known as receiver from where it is supplied to the evaporator through the expansion valve.

4. Expansion Valve:

It allows the liquid refrigerant under high pressure and temperature to pass at a controlled rate after reducing its pressure and temperature. Some of the refrigerants evaporate and pass through expansion valve but their greater portion is vapourised in the evaporator at low pressures and temperatures.

5. Evaporator:

It consists of coils of pipe in which the liquid refrigerant at low pressure and temperature. In evaporation, the liquid vapour refrigerant absorbs its latent heat of vapourisation from the medium which is to be cooled.

ANALYSIS OF VAPOUR COMPRESSION SYSTEM:

It depends upon:

1. Load on refrigerant plant in Tonnes.
2. Temperature of refrigerant.
3. Atmospheric temperature.

The temperature of refrigerant required and atmospheric conditions decide the temperature of the refrigerant entering into the condenser and automatically it decides the pressure ratio.

Similarly, the working cycle is represented on T-S and P-h diagram, where the process 3-2 represents superheating and 4-5 represents undercooling. The COP of this cycle increases as it approaches near to the Carnot cycle. This is explained as follows: The absorption of heat in evaporation and rejection of heat in the condenser are in

the form of the latent heat. This heat transfer is carried out by maintaining the temperatures differences as low as possible in evaporator and condenser. By comparing with the refrigerant cycle where high temperature cycle is necessary to carry out into compressor isolating it from the atmosphere. Irreversibility only exists in the throttling process. The VCS approaches Carnot cycle as compared with air refrigeration system and COP of VCS is higher than air refrigeration system.

SPECIFICATIONS:

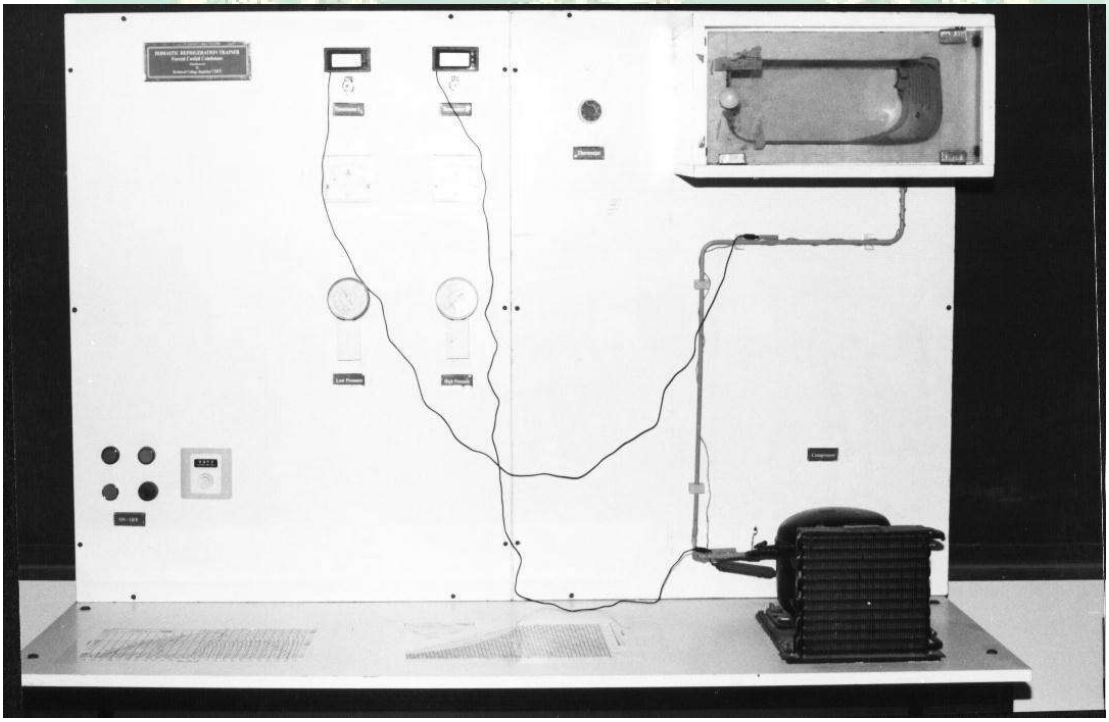
1. Cooling capacity: 30 kg of ice in 24 hours.
2. Insulation: PUF Insulation
3. Number of ice cans: 12
4. Size of tank: (0.83*0.345*0.345) m3.
5. Height of the tank: 0.27 m
6. Size of the ice can: (0.325*0.116*0.078) m3.

PROCEDURE:

1. Fill the tank in vapour compression test rig with the brine solution.
2. Switch ON the main supply.
3. Start the compressor and stirrer supply button.
4. Take initial energy meter reading of both compressor and stirrer.
5. Wait for about 50 minutes so that the system gets stabilized.
6. After stabilization take all readings at required temperature.
7. Measure evaporator (L.P) and condenser (H.P) pressures.

OBSERVATIONS:

1. Inlet temperature of brine at the start = 30°C.
2. Total weight of brine solution = 110.9 kg
3. Specific heat of brine = 23.32 kJ/kg°C
4. Final temperature of the brine at time of loading ice plant = -6°C
5. Final temperature of brine = 0°C



Photograph Forced cooled condenser refrigerator unit

Observation Table:

Sr.No.	TIME	T1	T2	T3	T4	T5	T6	Energy Meter Reading kW	LP (bar)	HP (bar)

CALCULATIONS:

1. Refrigeration Effect = m*Cp*(dT/dt)
   - Size of can = 0.325*0.116*0.078 = 0.0294 m3
   - Total size of the can = 12*0.00294 = 0.3528 m3
   - Size of the tank = 0.83*0.395*0.395 = 0.1295 m3
   - Volume occupied by the brine solution =
   - Weight of water =
   - Weight of salt water =
   - Refrigeration Effect =
2. Compressor work =
3. COP (actual)
4. COP (from p-h chart)
   - ❖ absolute suction pressure = LP =
   - ❖ absolute delivery pressure = HP =

W=
h2=
h3=h4=
h1=

$$COP_{th} = \frac{h_1 - h_4}{h_2 - h_1}$$

RESULT:

1. Theoretical COP =
2. Actual COP =