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UNIT-3

INTRODUCTION TO RAC

Ques:-

Define Refrigeration and refrigerant. Define '1 tonn of refrigeration'. Also write down the applications of refrigeration.

Ans:-

Refrigeration :- It is the process of manipulating the temperature at a place lower than that of the surrounding.

In order to maintain temperature continuously, refrigeration system must run on a cycle.

Refrigerant :- It is a substance which is used to produce lower temperature.

1 tonne of Refrigeration :- It is the amount of heat that is to be removed from one tonne of water at zero (0°C) in order to convert it into ice at (0°C) in one day (24 hours).

Tonne of refrigeration represents heat transfer rate.

$$1 \text{ T.R.} = 3.5 \text{ KJ/sec} = 3.5 \text{ KW} = 210 \text{ KJ/min}$$

Applications of Refrigeration

1. Domestic Refrigeration
2. Industrial Refrigeration
3. Transport Refrigeration
4. Chemical Refrigeration
5. Air Conditioning

Ques 2:- What are different types of refrigeration methods. Explain VCRS methods by T-S diagram with related block diagram.

Ans:- Different types of Refrigeration —

1. Natural Refrigeration Methods :-

(i) Natural Ice - Refrigeration

(ii) Evaporative cooling.

2. Artificial Refrigeration Methods :-

(i) Vapour compression Refrigeration.

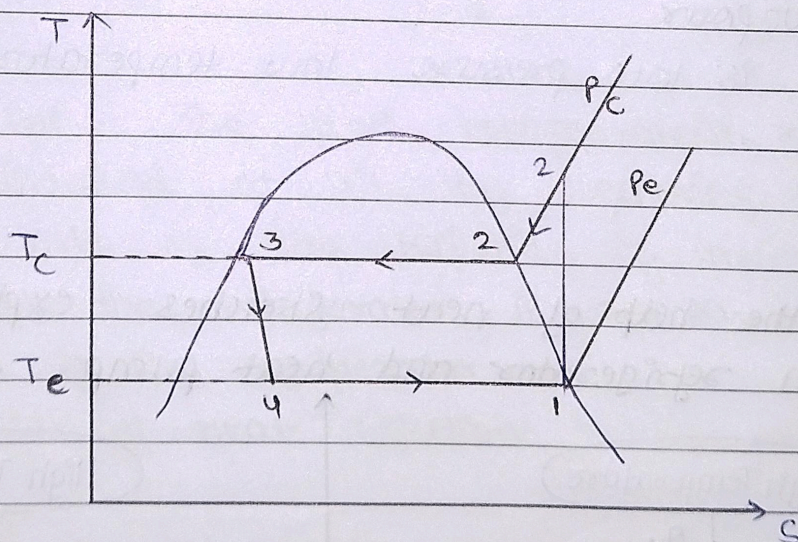
(ii) Vapour absorption system.

(iii) Gas refrigeration system.

(iv) Steam jet refrigeration system.

(v) Vortex tube refrigeration system.

T-S Diagram -



* In compression process (1-2) :- (Isentropic compression)

- Inlet is low pressure, low temperature, saturated vapour.
- Outlet is high pressure, High temperature, saturated / superheated vapour.

* In Condenser Process (2-3) : Isobaric Heat Rejection

- Inlet is high pressure, high temperature, saturated vapour
- Outlet is high pressure, low temperature, saturated liquid.

* In Expansion Process (3-4) : Isenthalpic expansion.

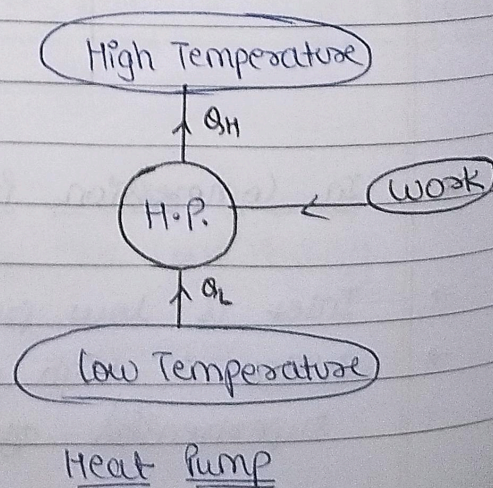
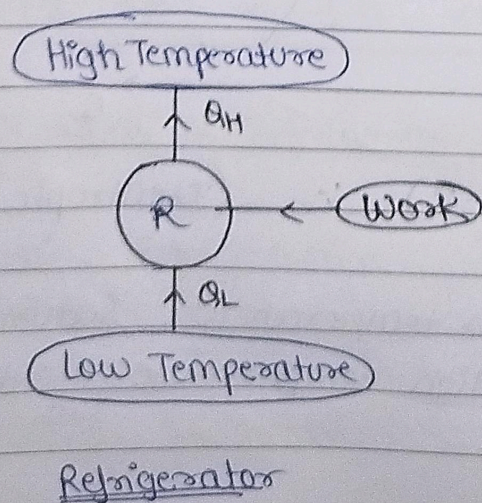
- Heat is high temperature
- Inlet is high pressure, low temperature, saturated liquid
- Outlet is low pressure, low temperature, saturated liquid and vapour mixture.

* In Evaporator Process (4-1) : Isobaric & Isothermal heat extraction.

- Inlet is low pressure, low temperature, saturated liquid and vapour
- Outlet is low pressure, low temperature saturated vapour.

Ques 3:- With the help of neat sketches explain differences between refrigerator and heat pump.

Ans :-



REFRIGERATOR

1. It is a device used to maintain temperature at a place lower than that of its surrounding.

2. The desired effect of refrigerator is cooling.

3. Coefficient of performance (COP) of refrigerator is defined as the ratio of Heat removed (taken) from the low temperature reservoir to the work input.

$$(COP)_R = \frac{Q_L}{W}$$

HEAT PUMP

It is a device which is used to maintain temperature at a place higher than that of its surrounding.

Desired effect of heat pump is Heating.

(COP) is defined as the ratio of Heat given to the high temperature reservoir to the work input.

$$(COP)_{HP} = \frac{Q_H}{W} = 1 + (COP)_R$$

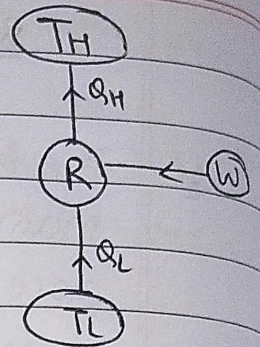
- Ques 4:- Define COP. The food compartment of a refrigerator is maintained at 2°C by removing heat from it at a rate of 370 KJ/min . If the required power input to the refrigerator is 2.5 KW , determine (a) the COP of the refrigerator. (b) the rate of heat rejection to the room.

Ans:- Coefficient of performance of a device is defined as the ratio of desired effect and work input.

$$(COP) = \frac{\text{Desired effect}}{\text{work input}}$$

Numerical :-

Given $\rightarrow$ $Q_L = 370 \text{ KJ/min}$
 $= \frac{370}{60} (\text{KJ/sec})$
 $= 6.166 \text{ KJ/sec}$

or

$$Q_L = 6.166 \text{ KW}$$

$$W = 2.5 \text{ KW}$$

$$(a) \quad (COP)_R = \frac{Q_L}{W} = \frac{6.166}{2.5} = 2.46$$

$$(COP)_R = 2.46$$

$$(b) \quad Q_H = W + Q_L$$

$$Q_H = 2.5 + 6.166$$

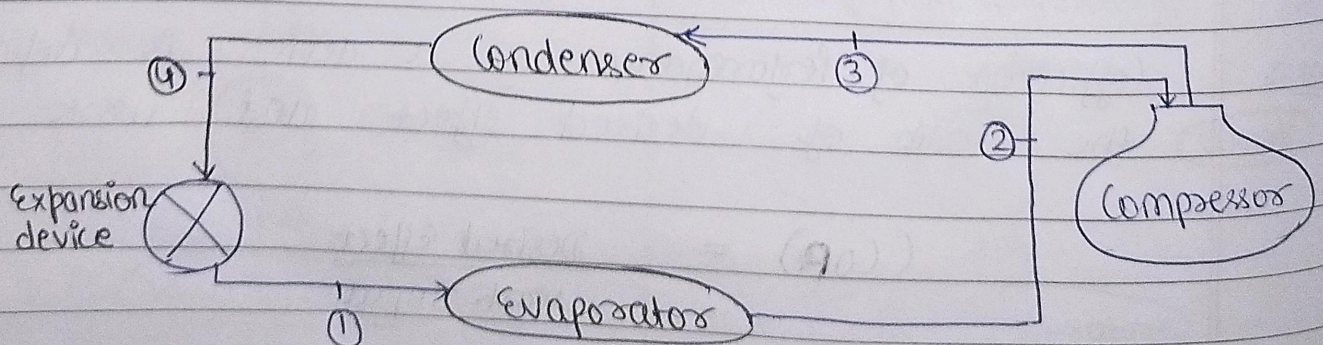
$$Q_H = 8.666$$

Ans

Ques 5:- With the help of neat sketches explain working of Domestic 'Refrigerator'.

Ans :- These are following main parts of a Refrigerator

1. Compressor
2. Condenser
3. Throttling / Expansion device
4. Evaporator.



1. Evaporation (1-2) :- From point (1-2), low pressure liquid refrigerant enters the evaporator and absorbs heat from its surrounding. After evaporation, the refrigerant slightly super heated (after being converted into gas).
2. Compression (2-3) :- From point (2-3) the super heated vapour from evaporator enters the compressor where its pressure is increased due to compression, the temperature also increases.
3. Condensation (3-4) :- From point (3-4) the pressurized & super heated refrigerant from compressor enters the condenser & gets cooled, usually by using air or water.
4. Expansion (4-1) :- From point (4-1) the pressure of the refrigerant drops by the throttling process.

Ques:- What is air conditioning? Explain the factors which affects human comfort. What are the conditions for comfort air conditioning?

Ans:- Air-conditioning is a process of controlling air temperature, humidity, ventilation, filtration and air circulation in a space (building or vehicle).

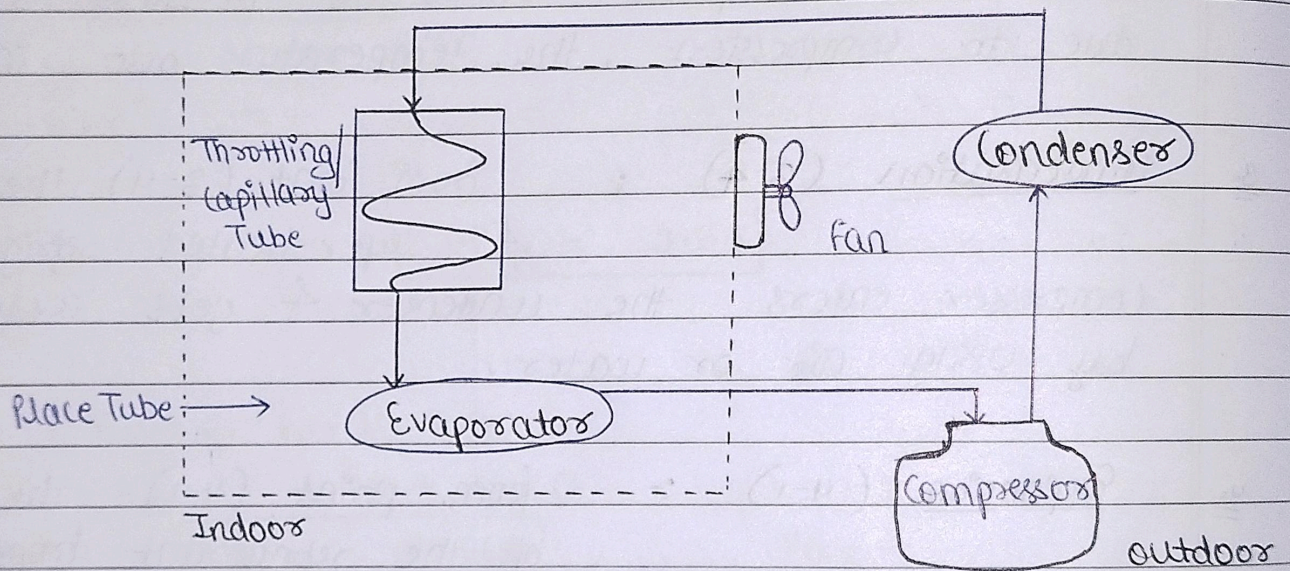
Human comfort refers to the control of temperature and humidity of air & its circulation.

So, that resulting environment becomes human friendly.

- Temperature : 22°C to 27°C
- Relative Humidity : 40% to 60%
- Air velocity : 5 m/min to 8 m/min

Ques 7:- With the help of neat sketch explain working of window type 'air-conditioner'.

Ans :-



Window AC

* Compressor :-

- The refrigerant enters the compressor at low temperature and pressure in a gaseous state.
- In compressor, temp & pressure of refrigerant increases.
- The refrigerant leaves the compressor in gaseous state. An electric motor may be used to compress the refrigerant.

* Condenser :-

- It is a kind of heat exchanger in which refrigerant

enters at High temp. & pressure in gaseous form.

→ The refrigerant rejects heat in condenser and gets converted into high pressure liquid.

* Capillary Tube (Throttling device) :-

→ High pressure refrigerant coming from the condenser enters the throttling device where the pressure & temperature of the refrigerant drops down.

→ Throttling device also controls the flow of refrigerant in the cycle.

* Evaporator :-

→ It is also a kind of heat exchanger where refrigerant enters at low pressure & temperature in liquid form.

→ The refrigerant gets evaporated by absorbing heat from the space to be cooled.

→ By absorbing heat, the refrigerant gets converted into gaseous state.

* Propeller fan :- It is used in condenser to help in moving the air over the surface of the cooling coil (condensing coil).

* Filter Drier :- It is used to remove the moisture from the refrigerant.

* Drain Pan :- It is used to contain the water that condenses from the cooling coil and its discharge out to the outdoor.

Ques 8:- Explain following :-

(i) Specific Humidity :- It is defined as the mass of water vapour present in a unit mass of air, denoted by w .
It is unit less.

$$w = \frac{M_{wv}}{M_{da}}$$

(ii) Relative Humidity :- It is often expressed as a percentage, it indicates a present state of absolute humidity relative to a maximum humidity at same temperature.
(or)

It is a measure of how much water vapour is in a water-air mixture compared to the maximum amount possible, denoted by (ϕ) .

$$\phi = \frac{\text{Actual mass of water vapour in a given volume}}{\text{Maximum mass of water vapour in a given volume}}$$

(iii) Dry Bulb Temperature :- The dry bulb temperature is the ambient air temperature measured by regular thermometer.
Denoted by ' T_{db} ' or ' T '.

(iv) Wet Bulb Temperature :- The temperature measured by thermometer that is wrapped in wet wicks, denoted by ' T_{wb} '.
It is always less than dry bulb temperature.

- (v) Dew Point Temperature :- The temperature at which 1st drop of dew is formed when the air is cooled at constant pressure is known as dew point temperature (T_{dp}).
The formation of dew is also known as condensation.

Ques 9:- Explain following :-

- (i) Atmospheric Air :- Air in the atmosphere normally contains some water vapour (moisture), no. of pollutants and this air is referred as atmospheric air.
- (ii) Dry Air :- It is a mixture of Nitrogen, oxygen and some small amounts of other gases.
- (iii) Wet Air :- It is the air that contains high levels of water vapour, wet air is also known as saturated air.
- (iv) Saturated air :- It is same as wet air.
- (v) Humidity :- It is defined as the amount of water vapour present in the air.
Higher the humidity, the wetter it feels outside.