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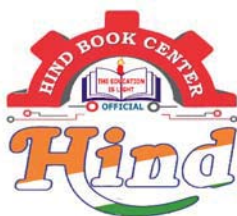
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By-Praveen Kulkarni Sir

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Refrigeration & air conditioning.

Refrigeration:

It is the process of maintaining lower temperatures compare to surroundings, in order to maintain lower temp. continuously the system should operate on a cycle.

Refrigerants:

These are the substances which are used for producing lower temperatures.

Examples: CO_2 , air, water, R-11, R-22, R-134 etc.

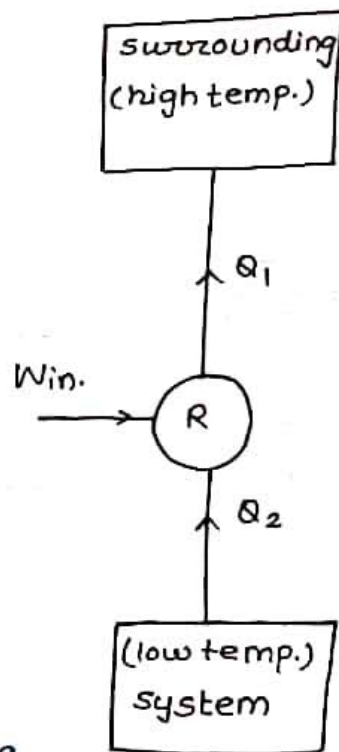
Refrigeration Effect (RE):

The amount of heat that is to be removed from the storage space in order to maintain lower temp. is known as refrigeration Effect.

$$\text{C.O.P.} = \frac{Q_2}{W_{\text{in}}}$$

Refrigeration effect (RE) = Q_2

$$\text{C.O.P.R} = \frac{\text{RE}}{W_{\text{in}}}$$



Significance of COP:

COP represents the running cost of the system. Greater the COP lesser is the running cost therefore systems with higher COP are desired. •

Note: COP can be greater than 1, equal to one or less than one.

Window air conditioner ≈ 3

Domestic Refrigerator, COP ≈ 1

Vapour absorption System, COP is generally < 1 .

$$1 \text{ British tonne} = 2220 \text{ lbs} = 1000 \text{ kg}$$

Unit of Refrigeration: [TR]

1 Ton of refrigeration means the amount of heat that is to be removed from 1 American tonne (2000 lbs = 907 kg) of water at 0°C in order to convert it into ice at 0°C in 1 day (24 hours).

Therefore ton of refrigeration represents heat transfer rate but not mass.

$$1 \text{ TR} = \frac{907 \times 334}{24 \times 3600}$$

$$1 \text{ TR} = 3.5 \text{ KJ/Sec.}$$

$$1 \text{ TR} = 210 \text{ KJ/min}$$

$$1 \text{ kcal} = 4.18 \text{ KJ}$$

$$1 \text{ TR} = 50 \text{ K-cal/min.}$$

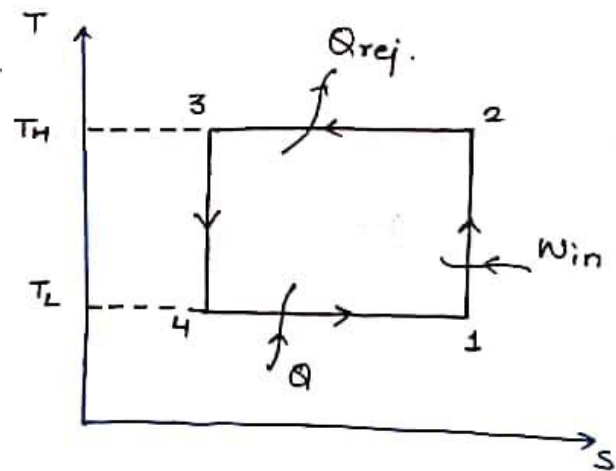
Ideal Refrigeration cycle:

Reverse Carnot cycle is an ideal ref. cycle.

$$\text{C.O.P.}_{\text{rev}} = \frac{T_L}{T_H - T_L}$$

$$\text{COP}_{\text{max}} = \frac{T_L}{T_H - T_L}$$

↓
ideal cop.



Refrigeration capacity (R.C):

$$\text{RC} = \dot{m} \times \text{RE}$$

$$\downarrow \quad \text{kg/s} \times \frac{\text{KJ}}{\text{kg}} \Rightarrow \frac{\text{KJ}}{\text{Sec}} = \text{KW}$$

Generally RE is expressed in KJ/kg and RC is expressed in KJ/sec.

Power Input to the compressor (P_{in}):

$$P_{in} = \dot{m} \times W_{in}$$

\dot{m} = mass flow rate of refrigerant (kg/sec)

$$COP_R = \frac{RE}{W_{in}} = \frac{RE \times \dot{m}}{W_{in} \times \dot{m}} = \frac{RC}{P_{input}}$$

While calculating cop work input to the compressor is taken into account therefore cop is equal to

$$COP = \frac{RE}{W_{in} (comp.)}$$

Energy Efficiency Ratio (EER):

It is the ratio of RE (or Desired effect) to the work input to the Motor.

$$EER = \frac{RE}{W_{in} (motor)}$$

$$\eta_{comp.} = \frac{P_{comp.}}{P_{motor}} = \frac{W_{in comp.}}{W_{in motor.}}$$

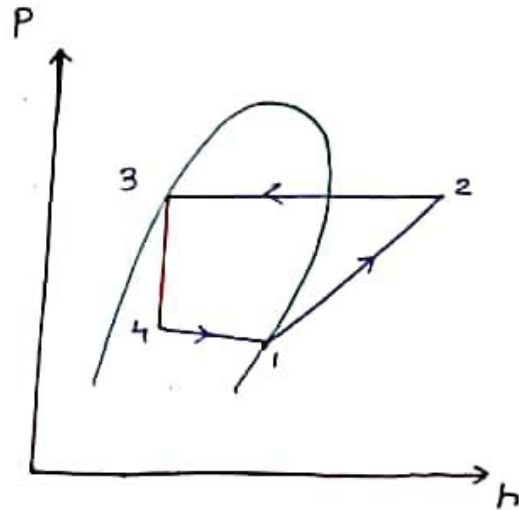
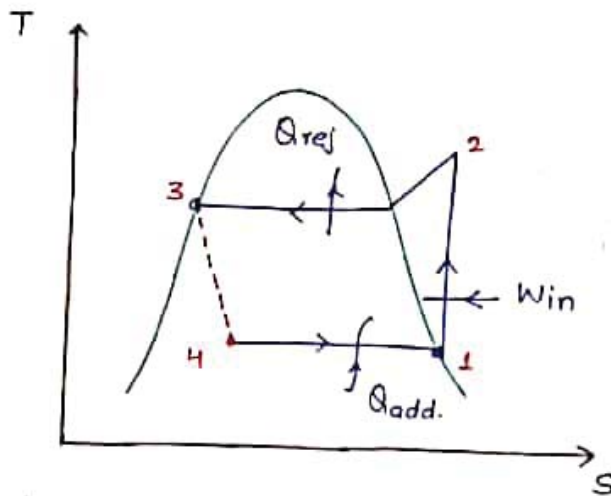
If efficiency of the compressor is 100% then COP & EER are same.

Note: In refrigeration systems lower temp. are generally known as evaporators temp. and higher temp. are generally known as condensor temp.

Vapour Compression Refrigeration System:

Simple / Standard / Saturated v-c cycle:-

- 1-2: rev. adiabatic compression
- 2-3: constant pressure Heat Rejection
- 3-4: isenthalpic expansion (throttling)
- 4-1: constant pressure Heat addition.



3-4 isenthalpic

$$\delta Q \rightarrow 0$$

$$ds \geq 0 \text{ (irrev.)}$$

$$dS_{univ} > 0$$

$$8(ds)_{sys} + (ds)_{sur} > 0$$

$$\delta Q = 0$$

$$ds > 0$$

3-4. each & every point we don't know what is happening.
So-----line.

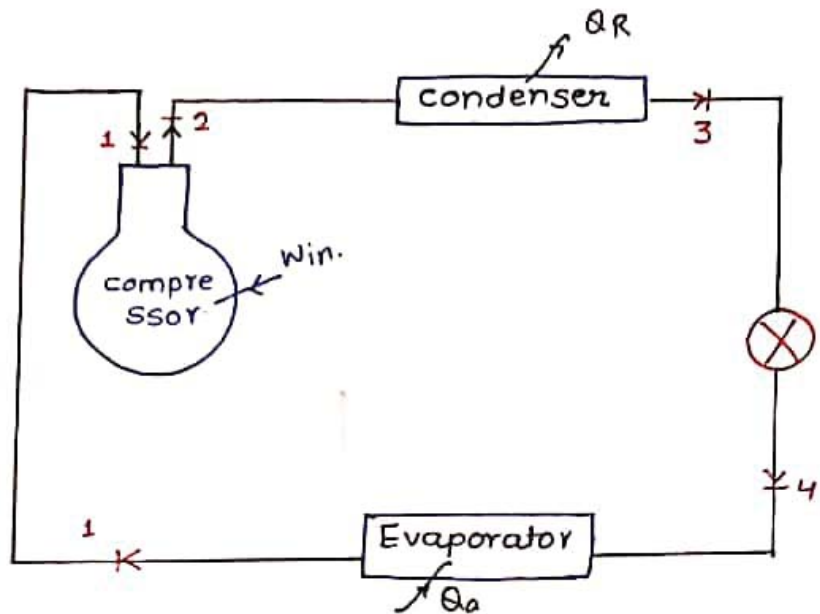
3-4. \rightarrow complete line.

b/c we know each &

every point $h_3 = h_4$

or 3-4 may be represented by----- (dash line) b/c throttling is an irreversible process.

v-c cycle is an irreversible cycle because This cycle consist of throttling which is an irrev. process.



which device is help in flow ref.

$Q=0$ in throttling then why temp. drop.

Expansion valve
or
Throttling valve

The basic components of v-c cycle are compressor, condenser, expansion valve, Evaporator.

The flow of refrigerant

compressor
↓
condenser
↓
Expansion valve
↓
Evaporator.

Analysis plot v-c cycle on h-s diagram.

