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.

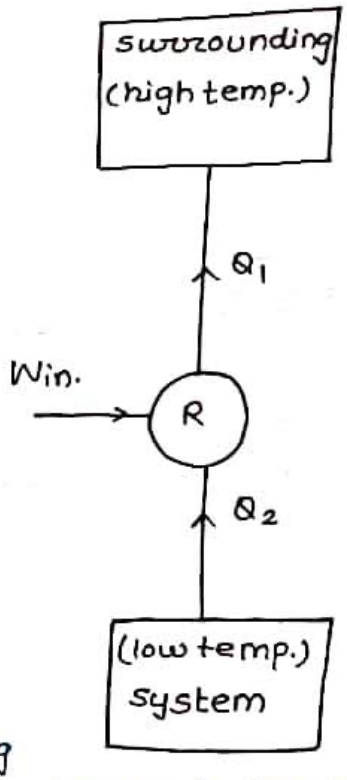
Examples: CO_2, air, water, R-11, R-22, R-134 etc.

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.

$$c.o.p. = \frac{Q_2}{W_{in}}$$

Refrigeration effect (RE) $= Q_2$

$$c.o.p_R = \frac{RE}{W_{in}}$$



Significance of cop:
cop represents the running cost of the system. Greater the cop lessar 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 $\simeq 3$

Domestic Refrigerator, cop $\simeq 1$

Vapour absorption System, cop is generally < 1.

1 British tonne = 2220 lbs = 1000 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 is 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.

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

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

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

1 kcal = 4.18 KJ

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

Ideal Refrigeration cycle:

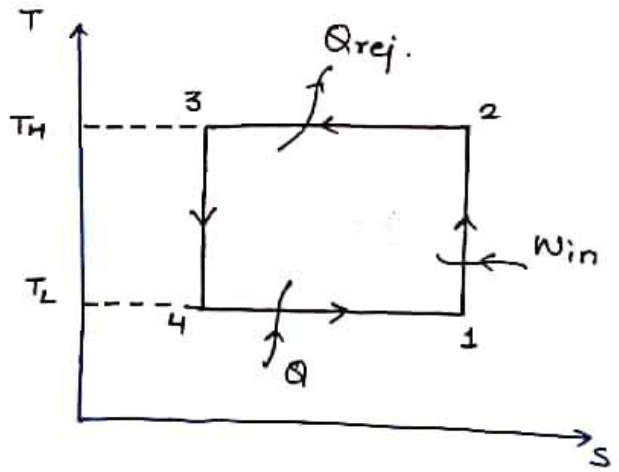
Reverse carnot cycle is an ideal ref. cycle.

$$C.O.P_{rev} = \frac{T_L}{T_H - T_L}$$

$$COP_{max} = \frac{T_L}{T_H - T_L}$$

↓

ideal COP.



Refrigeration capacity (R.C):

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

$$\downarrow$$

$$Kg/s \times \frac{KJ}{Kg} \Rightarrow \frac{KJ}{Sec} = kW$$

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 refrigrant (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:

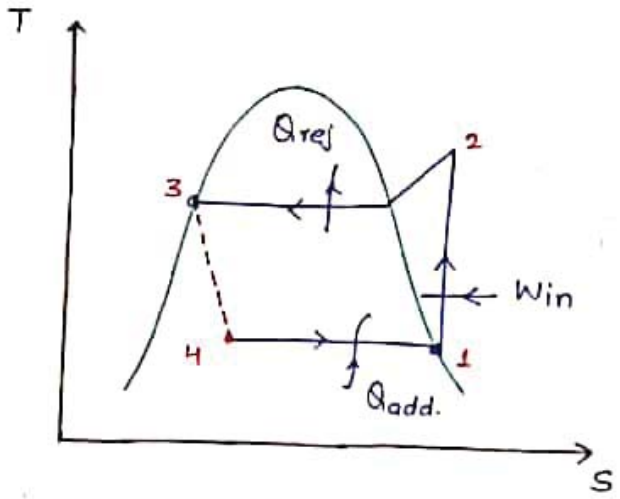
Simple / Standard / Saturated V-C cycle:-

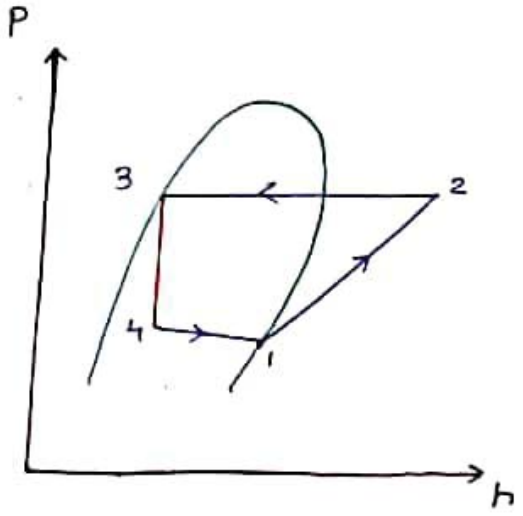
1-2:- rev. adiabatic compression

2-3- constant pressure Heat Rejection

3-4- isenthalpic expansion (throttling)

4-1- constant pressure Heat addition.





3-4 isenthalpic

$\delta Q \to 0$

$ds \geq 0$ (irrev.)

$dS_{univ} > 0$

$\delta (ds)_{sys} + (ds)_{surr} > 0$ (0 / $\delta Q = 0$)

$ds > 0$

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

So-----line.

3-4. → complete line.

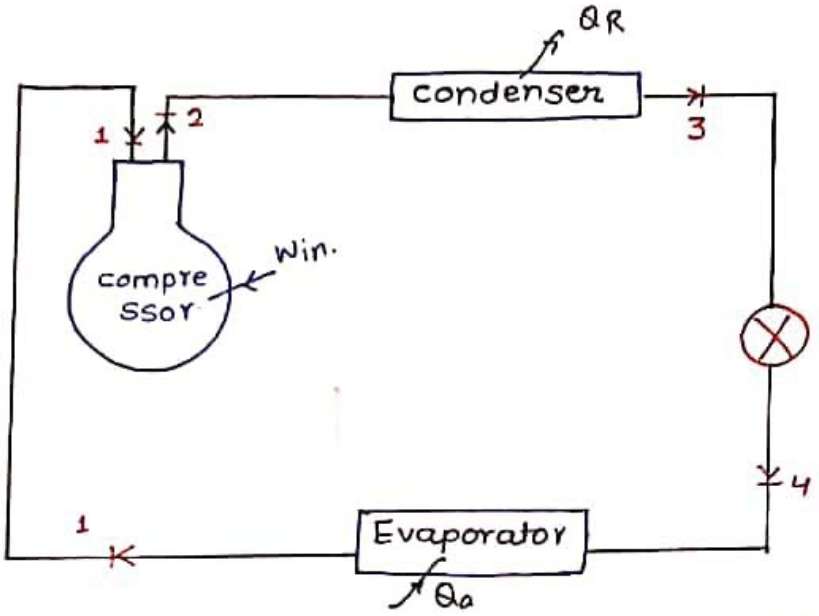
b/c we know each & every point $h_3 = h_4$

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 reg.

Q=0 in throttling valve bcoz temp. drop.



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

The flow of refrigerant

↓

compressor

↓

condenser

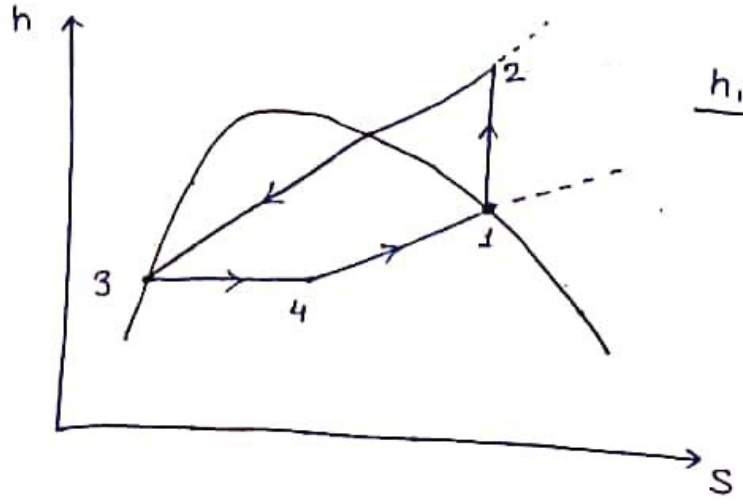
↓

Expansion valve

↓

Evaporator.

~~Analysis~~ Plot v-c cycle on h-s diagram.



$h_1 > h_3$.