

Hindbookcenter



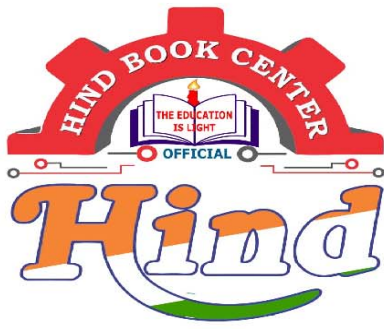
Hind Book Center & Photostat

KULKARNI ACADEMY
Mechanical Engineering
Toppers Handwritten Notes
Refrigeration Air Condition
By-Praveen Kulkarni Sir

- Colour Print Out
- Blackinwhite Print Out
- Spiral Binding,& Hard Binding
- Test Paper For IES GATE PSUs IAS, CAT
- All Notes Available & All Book Availabile
- Best Quaity Handwritten Classroom Notes & Study Materials
- IES GATE PSUs IAS CAT Other Competitive/Entrence Exams

Visit us:-www.hindbookcenter.com

Courier Facility All Over India
(DTDC & INDIA POST)
Mob-9711475393



Hindbookcenter



ALL NOTES BOOKS AVAILABLE ALL STUDY MATERIAL AVAILABLE
COURIERS SERVICE AVAILABLE

MADE EASY, IES MASTER, ACE ACADEMY, KREATRYX

ESE, GATE, PSUs BEST QUALITY TOPPER HAND WRITTEN NOTES
MINIMUM PRICE AVAILABLE @ OUR WEBSITE

- | | |
|--------------------------------|---------------------------|
| 1. ELECTRONICS ENGINEERING | 2. ELECTRICAL ENGINEERING |
| 3. MECHANICAL ENGINEERING | 4. CIVIL ENGINEERING |
| 5. INSTRUMENTATION ENGINEERING | 6. COMPUTER SCIENCE |

IES, GATE, PSU TEST SERIES AVAILABLE @ OUR WEBSITE

- ❖ IES –PRELIMS & MAINS
- ❖ GATE

➤ NOTE;- ALL ENGINEERING BRANCHS

➤ ALL PSUs PREVIOUS YEAR QUESTION PAPER @ OUR WEBSITE

PUBLICATIONS BOOKS -

MADE EASY, IES MASTER, ACE ACADEMY, KREATRYX, GATE ACADEMY, ARIHANT, GK
RAKESH YADAV, KD CAMPUS, FOUNDATION, MC –GRAW HILL (TMH), PEARSON...OTHERS

HEAVY DISCOUNTS BOOKS AVAILABLE @ OUR WEBSITE

Shop No.7/8 Saidulajab Market Neb Sarai More, Saket, New Delhi-30	Shop No: 46 100 Futa M.G. Rd Near Made Easy Ghitorni, New Delhi-30	F518 Near Kali Maa Mandir Lado Sarai New Delhi-110030	
--	---	--	--

Website: www.hindbookcenter.com

Contact Us: 9711475393

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: CO₂, air, water, R-11, R-22, R-134 etc.

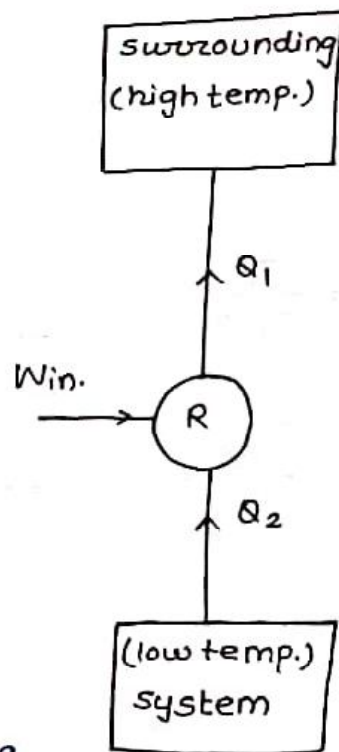
Refrigeration Effect (RE):

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) = Q₂

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



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 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 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:

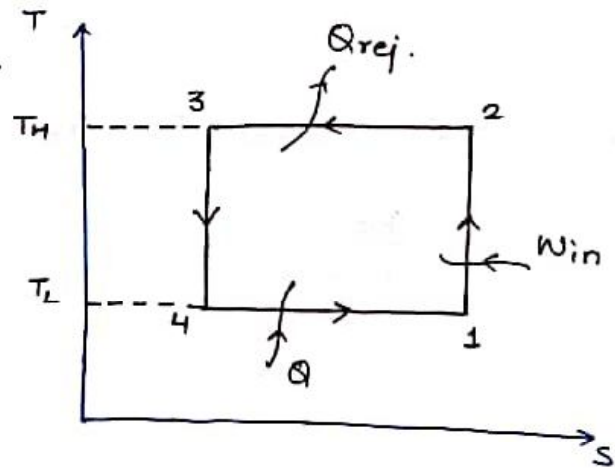
Reverse Carnot cycle is an ideal ref.

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):

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

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

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

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

Energy Efficiency Ratio (EER):

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

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

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

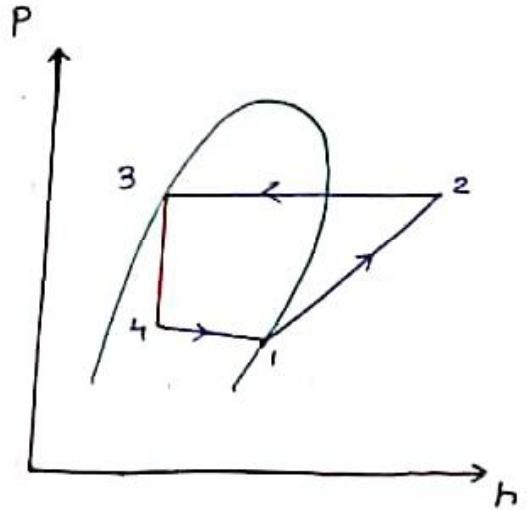
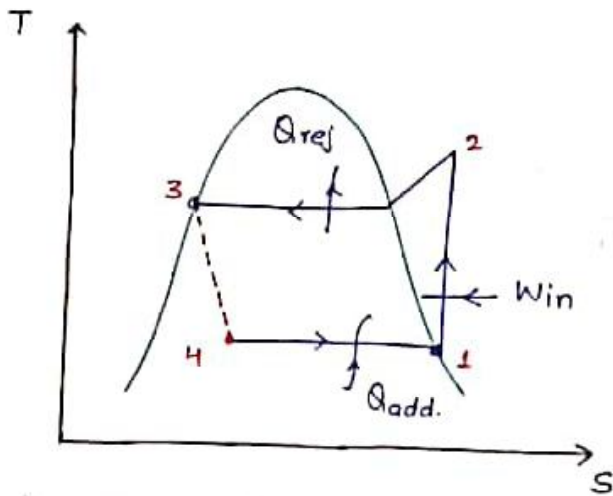
If efficiency of the compressor is 100% then COP & EER are same.

Note: In refrigeration systems lower temp. are generally known as evaporator temp. and higher temp. are generally known as condenser 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

$$\delta Q \rightarrow 0$$

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

$$dS_{univ} > 0$$

$$\delta (ds)_{sys} + \frac{(ds)_{sur}}{\delta Q} > 0$$

$$\delta Q = 0$$

$$\underline{ds > 0}$$

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

3-4. → complete line.

b/c we know each &

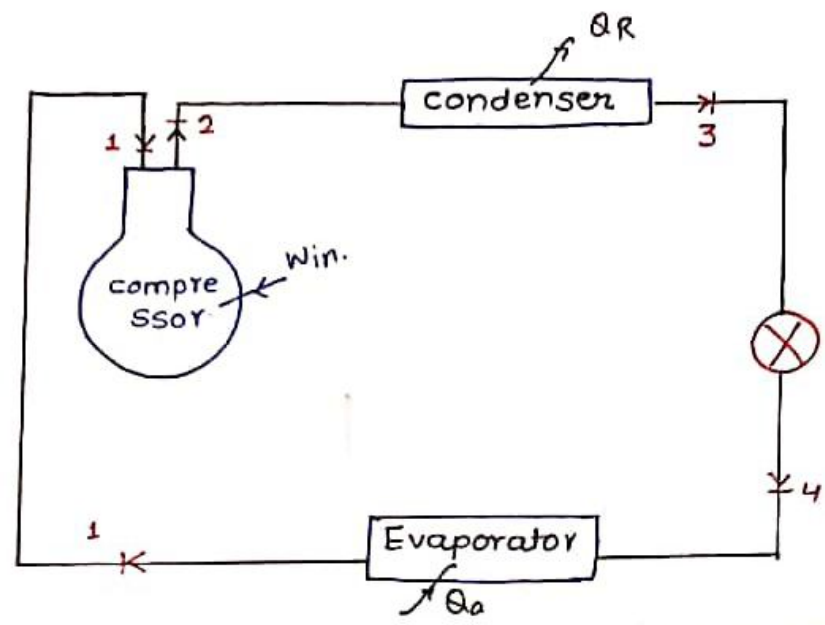
every point $h_3 = h_4$

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 ref.

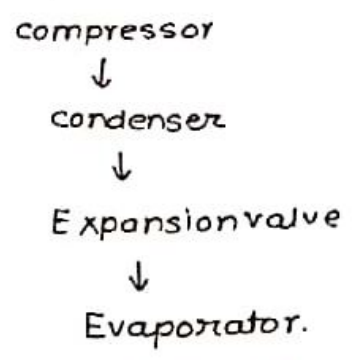
$Q=0$ in throttling then why temp. drop.



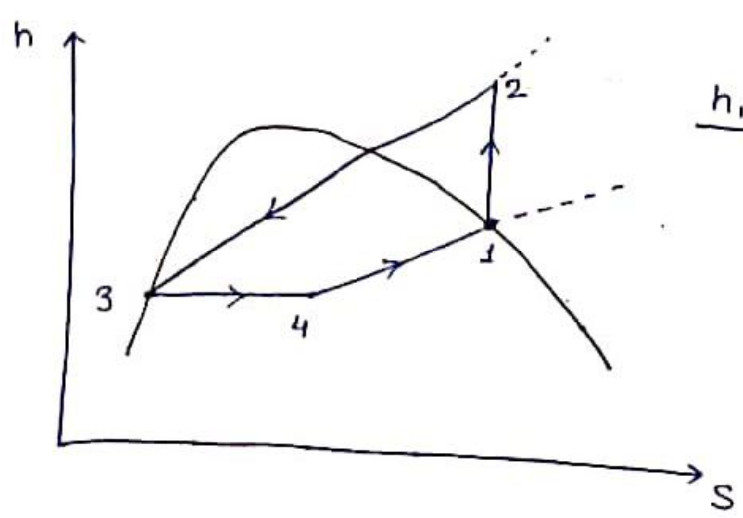
Expansion valve or Throttling valve

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

The flow of refrigerant



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



$h_1 > h_3$

Analysis of the cycle:

Assumptions:

- 1] Each device is treated as a steady flow device.
- 2] K.E & P.E. changes are neglected.
- 3] Compression is assumed to be rev. adiabatic.

(1-2) Rev. adiabatic device (compressor)

From SFEE

$$h_1 + \frac{c_1^2}{2} + g z_1 + q = h_2 + \frac{c_2^2}{2} + g z_2 + w$$

$$h_1 = h_2 + w$$

$$\Rightarrow w = h_1 - h_2 \Rightarrow w = -(h_2 - h_1)$$
$$\boxed{w_{\text{comp.}} = h_2 - h_1} = w_{\text{input}}$$

2-3. constant pressure heat rejection (condenser)

$$h_2 + \frac{c_2^2}{2} + g z_2 + q = h_3 + \frac{c_3^2}{2} + g z_3 + w$$

$$\Rightarrow h_2 + q = h_3$$

$$q = h_3 - h_2 \Rightarrow -(h_2 - h_3)$$

$$\boxed{q_{\text{rej.}} = h_2 - h_3}$$

3-4. Isenthalpic expansion (throttling)

$$h_3 + \frac{c_3^2}{2} + g z_3 + q = h_4 + \frac{c_4^2}{2} + g z_4 + w$$

$$\boxed{h_3 = h_4}$$

4-1. constant pressure heat ^{Absorption} Rejection (Evaporator)

$$h_4 + \frac{c_4^2}{2} + g z_4 + q = h_1 + \frac{c_1^2}{2} + g z_1 + w$$

$$\boxed{q_a = h_1 - h_4} = (\text{Refrigeration effect})$$

$$\text{COP} = \frac{R.E \rightarrow (\text{Q}_{\text{ab. from storage in evaporator}})}{W_{\text{in}} \rightarrow W_{\text{comp. or Net work}}}$$

$$\text{COP} = \frac{h_1 - h_4}{h_2 - h_1}$$

$$h_4 = h_3$$

$$\boxed{\text{COP} = \frac{h_1 - h_3}{h_2 - h_1}}$$

⇒ In v-c cycle work transfer occurs only in one device that is compressor where as in all other devices work transfer is zero.

Reason for using throttling instead of isentropic expansion in v-c cycle:

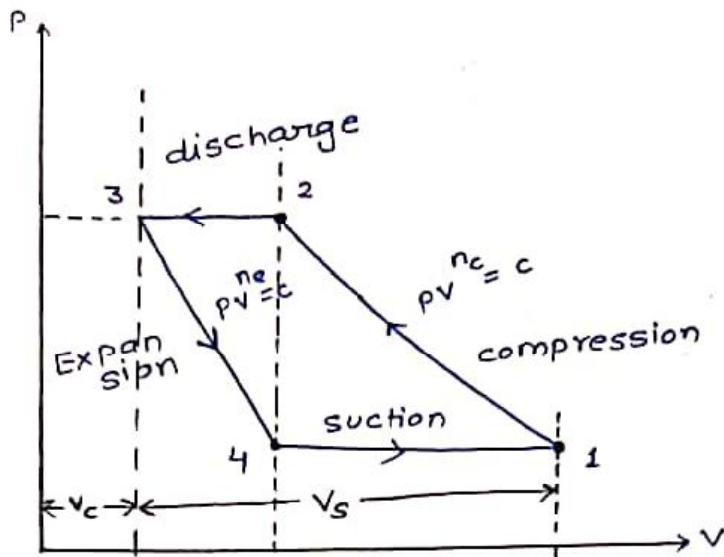
If isentropic expander is used instead of throttling there is some work output during expansion. It is the liquid refrigerant that expands as the specific volume of liquid is very small and hence expansion work is small. Therefore cost of the expander does not justify its uses. usages. therefore throttling is used in v-c cycle, instead of isentropic expansion.

* Volumetric efficiency of a reciprocating compressor:

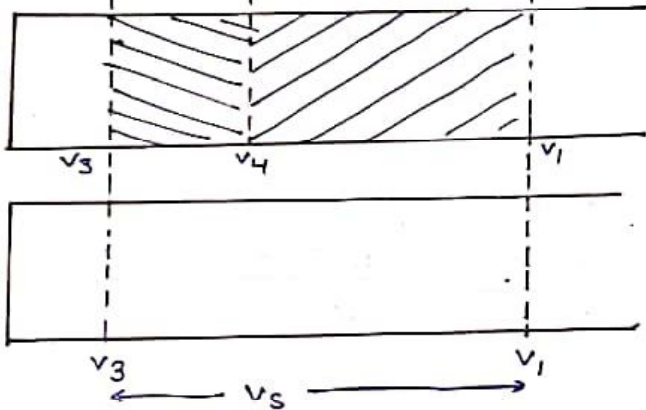
$$\eta_{\text{vol}} = \frac{V_{\text{act}}}{V_s} = \frac{V_1 - V_4}{V_1 - V_3}$$

clearance ratio or clearance Factor (c)

$$c = \frac{V_c}{V_s} = \frac{V_3}{V_1 - V_3}$$



more compression ratio
more expansion so
suction vol. $(v_1 - v_4)$
is less.



$$\eta_{vol} = \frac{v_1 - v_4}{v_1 - v_3} = \frac{v_1 - v_3 + v_3 - v_4}{v_1 - v_3}$$

$$= 1 - \frac{(v_4 - v_3)}{v_1 - v_3}$$

$$\Rightarrow 1 - \frac{v_3}{v_1 - v_3} \left[\frac{v_4}{v_3} - 1 \right]$$

$$\Rightarrow 1 - c \left[\frac{v_4}{v_3} - 1 \right] \Rightarrow 1 + c - c \left(\frac{v_4}{v_3} \right)$$

$$\boxed{\eta_{vol.} = 1 + c - c \left(\frac{P_2}{P_1} \right)^{1/n_e}}$$

$$\left| \begin{aligned} \frac{v_4}{v_3} &= \left(\frac{P_3}{P_4} \right)^{1/n_e} \\ &= \left(\frac{P_2}{P_1} \right)^{1/n_e} \end{aligned} \right.$$

n_e = index of expansion.

Note:- if nothing is mention then the index of compression and expansion are taken to be same.