Refrigeration Capacity :-

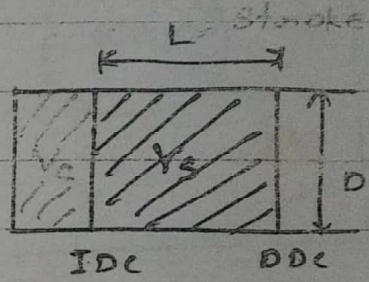
$$RC = \dot{m} \times RE$$

$$\{ RC = \dot{m}(h_1 - h_4) \}$$

$$\{ RC = \dot{m}(h_1 - h_3) \}$$

Volumetric efficiency of a reciprocating compressor :- It is the breathing capacity of a compressor & it is defined as the ratio of actual volume to the total volume of the refrigerant entering the compressor to the swept volume.

$$V_s = \frac{\pi}{4} D^2 L$$



Let $\dot{m}$ be the actual mass flow rate of refrigerant & v_s be specific volume of refrigerant at the inlet to the compressor. Therefore, actual volume entering the compressor is

$$V_{act} = \dot{m} \times v_s$$

$$\eta_v = \frac{\text{actual volume}}{\text{swept volume}} = \frac{\dot{m} v}{\frac{\pi}{4} D^2 L N K} \quad m^3/sec$$

$$\{ \eta_v = \frac{\dot{m} v_s}{\frac{\pi}{4} D^2 L \times N \times K} \}$$

where, K = no. of compressor
N = speed in rpm
L = stroke length
D = bore diameter

Problm 1:- In a V-C refrigeration cycle following data is obtained. Enthalpy at the inlet to the compressor is 180 kJ/kg & at the exit of compressor is 210 kJ/kg & the enthalpy at the exit of condenser is 80 kJ/kg then find the COP.

Solm -

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

$$= \frac{180 - 280}{210 - 180}$$

$$= 3.33 \text{ Ans.}$$

Problm 2: In a 5 kW capacity (cooling capacity) refrigeration system operating on simple V-C cycle the refrigerant enters the evaporator with an enthalpy of 75 kJ/kg & leaves with an enthalpy of 183 kJ/kg. Enthalpy of refrigerant after compression is 210 kJ/kg. Calculate

i) COP
ii) Power input to the compr. in kW
iii) Rate of heat transfer at the condenser in kJ/sec.

Soln- RC = 5 kW, h_4 = 75 kJ/kg, h_1 = 183 kJ/kg
h_2 = 210 kJ/kg

ii) $$COP = \frac{h_1 - h_3}{h_2 - h_1}$$

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

$$= \frac{183 - 75}{210 - 183}$$

$$= 4 \quad \text{Ans.}$$

iii) $$P_{in} = \dot{m}(h_2 - h_1)$$

$$= (210 - 183)$$

$$=$$

$$COP = \frac{RC}{P_{in}}$$

$$4 = \frac{5}{P_{in}}$$

$$P_{in} = \frac{5}{4}$$

$$P_{in} = 1.25 \text{ kW} \quad \text{Ans.}$$

iii) $$Q_R = (h_2 - h_3) \text{ kJ/kg}$$

$$Q_R = \dot{m}(h_2 - h_3) \text{ kJ/sec}$$

$$RC = \dot{m}(h_1 - h_4)$$

$$5 = \dot{m}(183 - 75)$$

$$\dot{m} = \frac{5}{183 - 75}$$

$$\dot{m} = 0.046 \text{ kg/sec}$$

$$Q_{R_{rate}} = .04629\,(210-75)$$

$$Q_{R_{rate}} = 6.25 \text{ kJ/sec Ans.}$$

IInd method :-

$$1.25 + 5 = Q_1$$

$$Q_1 = 6.25 \text{ kJ/sec Ans.}$$