

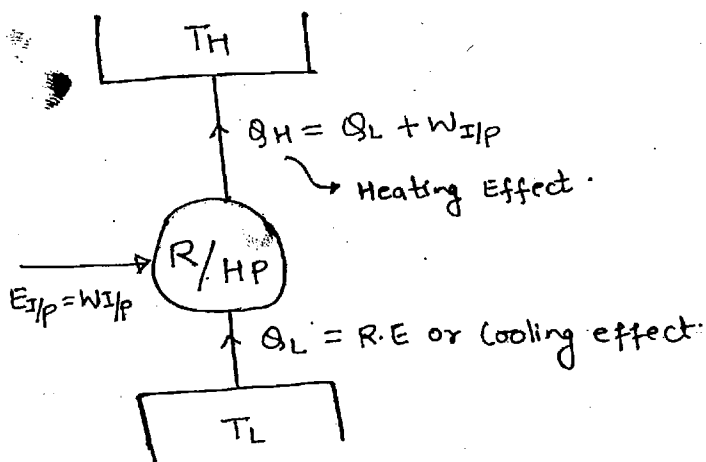
REFRIGERATION

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AIR - CONDITIONING.....

* REFRIGERATION :-

- * Refrigeration is the process of maintaining the place at a lower temp. compare to the surroundings.
- * Refrigerant is the working fluid which helps in providing refrigeration.
- * The heat absorbed from lower temp is called refrigeration effect or cooling effect. Heat Rejected at higher temp is called Heating effect.
- * Refrigeration effect and heating effect per unit time is called refrigeration Capacity & heating Capacity resp.



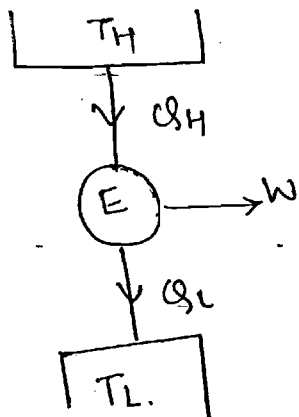
$$COP_{Ref.} = \frac{D.E}{E_{I/P}}$$

$$COP_{Ref} = \frac{R.E}{W_{I/P}}$$

$$COP_{HP} = \frac{H.E}{W_{I/P}}$$

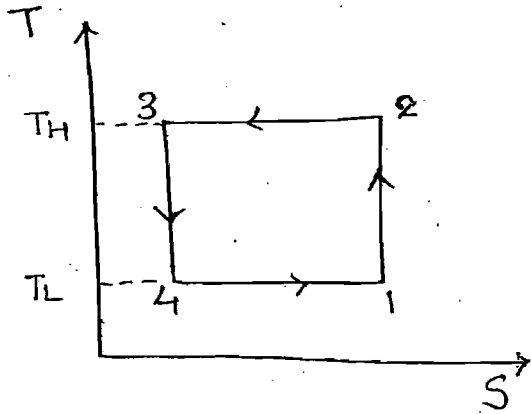
$$COP_{HP} - COP_{Ref} = \frac{H.E - R.E}{W_{I/P}}$$

$$COP_{HP} - COP_{REF} = 1$$



$$\eta = \frac{D.E}{E_{I/P}} = \frac{W}{Q_H}$$

* The ideal cycle for Refrigeration is "Reversed Carnot Cycle".



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

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

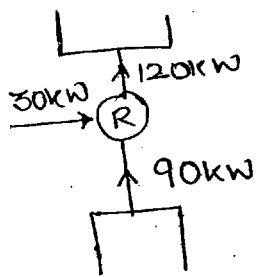
Process 1-2 :- Isentropic Compression

Process 2-3 :- Isothermal Heat Rejection.

Process 3-4 :- Isentropic expansion

Process 4-1 :- Isothermal Heat addition.

Q-6 (W.B)

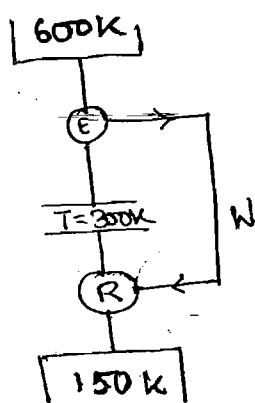


$$COP = \frac{R \cdot E}{W}$$

$$= \frac{90}{30}$$

$$COP = 3$$

Q-2 (W.B)



$$\eta = 1 - \frac{T_L}{T_H}$$

$$= 1 - \frac{300}{600}$$

$$= 0.5$$

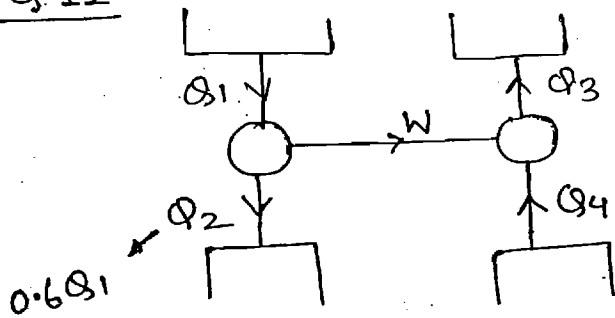
$$\eta = \frac{1}{COP}$$

$$COP = 2$$

$$COP_{HP} = \frac{300}{300 - 150}$$

$$COP_{HP} = 2$$

Q.11



$0.6Q_1$

$$Q_2 + Q_4 = 3Q_1$$



$0.6Q_1$

$$Q_4 = 2.4Q_1$$

$$\begin{aligned} \text{COP}_{\text{ref}} &= \frac{Q_4}{W} \\ &= \frac{2.4Q_1}{0.4Q_1} \end{aligned}$$

$$\text{COP}_{\text{ref}} = 6$$

$$\eta_{\text{HP}} = 0.4$$

$$\eta_E = \frac{W}{Q_1}$$

$$0.4 = \frac{W}{Q_1}$$

$$W = 0.4Q_1$$

TON OF REFRIGERATION :-

ONE TON OF REFRIGERATION REPRESENTS THE RATE OF HEAT TRANSFER REQUIRED TO CONVERT ONE U.S TON [907kg] OF WATER AT 0°C INTO ICE AT 0°C IN 24 hrs.

1 US TON ($\approx 907 \text{ kg}$)

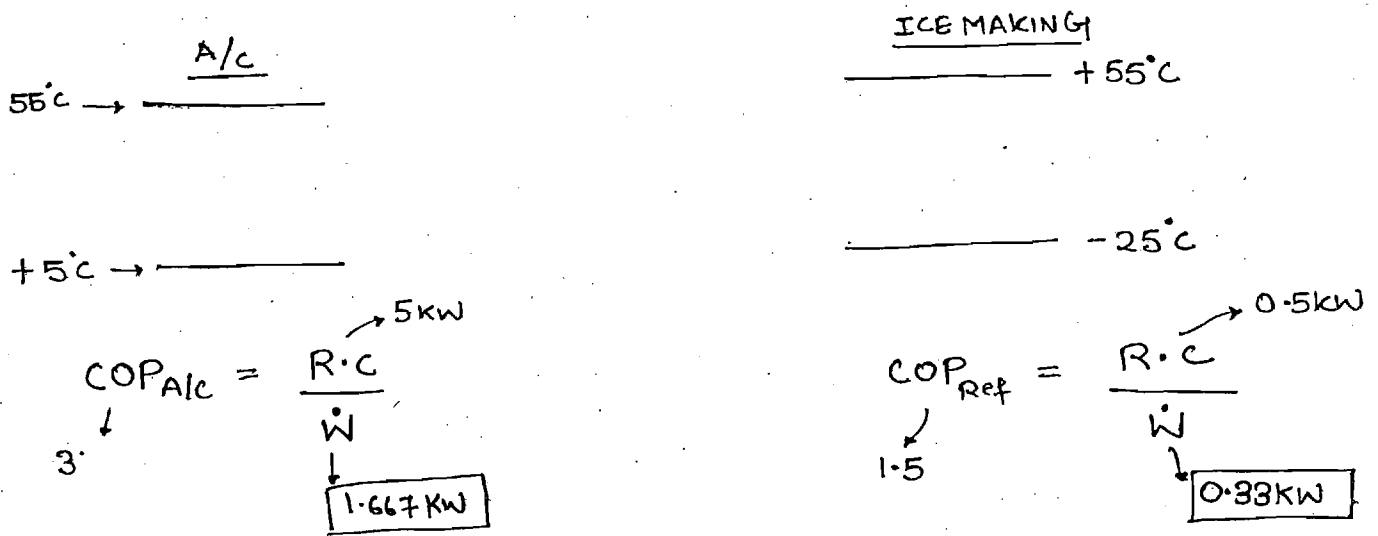
1 TR = 3.5167 kW

$\approx 211 \text{ kJ/min}$

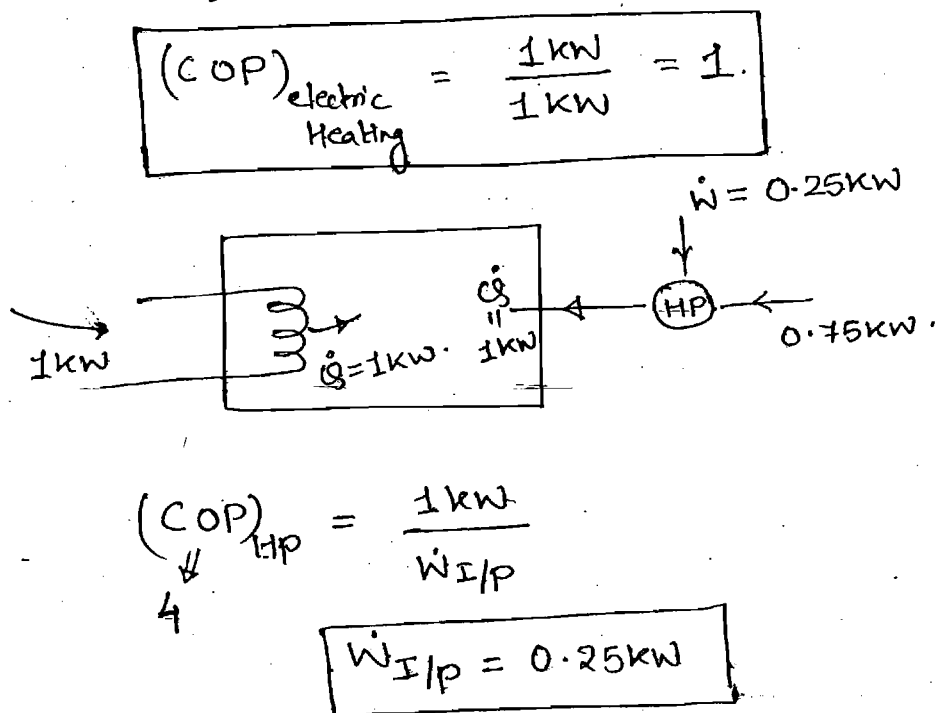
$\approx 50.4 \text{ kcal/min.}$

NOTE:- * The COP for Ice making Comes out be Lower than that for Comfort Colling, because the Lower temp for ice making is much Lower than that for Comfort Cooling.

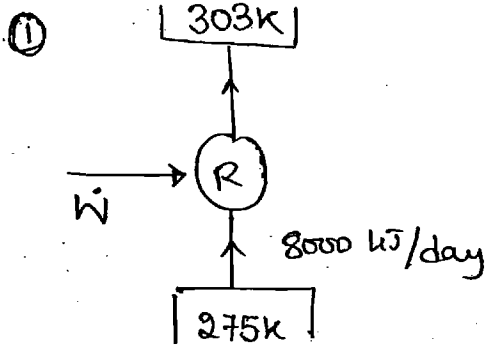
* The electricity bill for Air Conditioner is much higher compared to domestic refrigerator because the Refrigeration Capacity for air-conditioner is 10 times more than the domestic Refrigerator.



* Electric Heating is very less efficient compared to the use of H.P.



CH-1



$$COP = 0.15 \left[\frac{275}{303 - 275} \right]$$

$$(COP)_R = 1.47$$

$$COP = \frac{R.C}{W_{I/P}}$$

$$1.47 = \frac{8000}{W_{I/P}}$$

$$W_{I/P} = 5430.3 \text{ kJ/day}$$

$$W_{I/P} = \frac{5430.3}{3600} = \underline{\underline{1.51 \text{ kWh/day}}}$$

$$1 \text{ kWh} = 3600 \text{ kJ}$$

$$\frac{1 \text{ kJ}}{\text{sec}} \times 3600 \text{ sec.}$$

$$\underbrace{(2 \times 40 \text{ W} + 150 \text{ W})}_{\text{kW}} \times 10^{-3} \times \underbrace{12 \times 30}_{\text{Hrs.}}$$

$$\underline{\underline{82.8 \text{ kWh}}}$$

⑧

$$R.C = \dot{m} c (T_H - T_L)$$

$$3.5167 = \dot{m} \times 4.18 (35 - 20)$$

$$\dot{m} = 200 \text{ kg/hr} \approx \underline{\underline{200 \text{ l/hr}}}$$

$$\rho_w = 1 \text{ kg/ltr} = 1000 \text{ kg/m}^3$$

⑩

$$Q = \overset{3600}{\uparrow} \overset{c}{\uparrow} \left[\overset{2}{\uparrow} \times \overset{(30)}{\uparrow} + \overset{LH}{\uparrow} + 0.5 \times \overset{(230)}{\uparrow} \right] \overset{dT}{\uparrow}$$

27°C → -3°C → -3°C → -23°C

$$Q = \underline{\underline{10,80,000}}$$

$$\text{Ref. Capa.} = \frac{Q}{10 \times 3600} = \underline{\underline{30 \text{ kW}}}$$