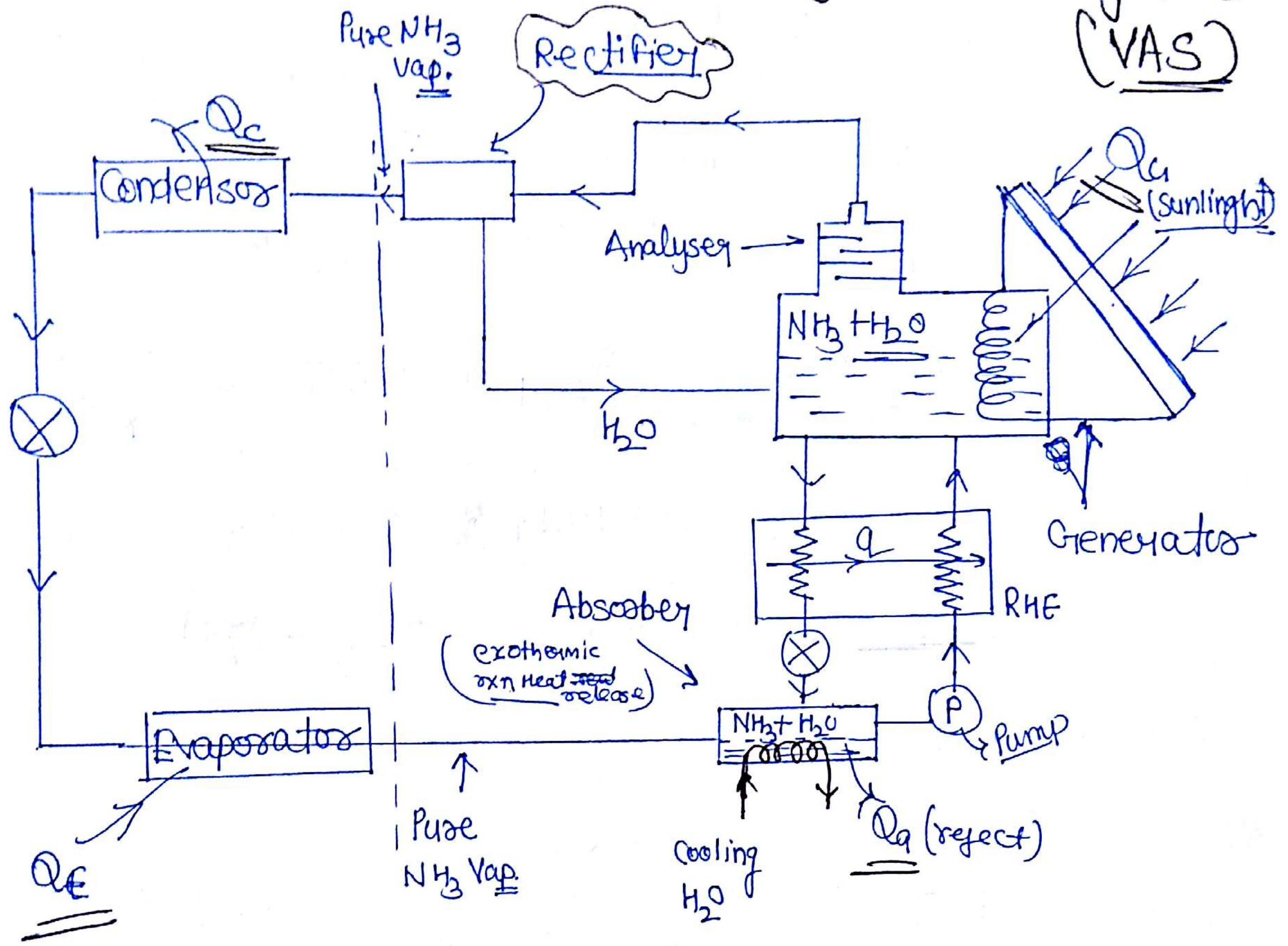
Imp

* Vapour Absorption Refrigeration System (VAS)



→ Pure NH_3 vapour enters the absorber where it is absorbed in water(H_2O). The reaction is exothermic and tho solibility of NH_3 is inversaly perportional to temp. of solution. Cooling water is continuosly circulated to maintain a low temp of solution to facilitate absorption of NH_3. Solution rich in NH_3 is pumped to Generator via Regerative heat exchanger in Generator this solution absorbs heat and NH_3 seperate forming high pressure of NH_3 vapour.

→ In RHE solution absorbs some heat from the water moving towards absorber. This reduceses the need for heat absorption in generator.

→ High pressure NH_3 vapour is passed through analyser where water vapour condenses. for complete removal of water vapour present with NH_3 vapour ractifier is installed.

* Water vapour is presence is undesirable because it may freeze at the exit of the throatling ~~va~~ valve because of low temp. thus chocking the system.

* Important Points.

① VAS works on low grade energy (Heat) whereas VCRS works on high grade energy (work). hence COP of VAS is very less (0.3 to 0.5).

② Most popular VAS is $NH_3 - H_2O$ system. In this H_2O water is absorbent and NH_3 is refrigerant. Other popular system are H_2O - LiCl & H_2O - LiBr. in these two water is the refrigerant hence used for Air Conditioning purpose.

③ VAS are used where large waste heat is available or the cost of electricity is very high. Solar refrigeration system and Geothermal refrigeration system are based on VAS.

④ Heat is absorbed in generator and evaporator and heat is rejected in Condensor & absorber.

⑤ Electrolux Refrigeration system is a VAS. It is three fluid system. ($NH_3 - H_2O - H_2$).

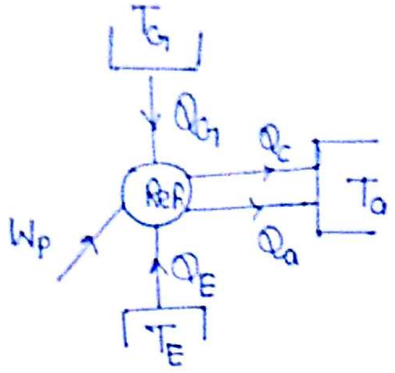
⑥ → Here NH_3 is the refrigerant, H_2O is absorbent and H_2 is used to create low partial pressure of NH_3.

⑦ → No pump is used in this system and the fluid flows under the action of gravity due to density difference.

$$COP = \frac{Q_{Evaporator}}{Q_G + W_p} \qquad Q_G >>> W_p$$

$$\boxed{COP = \frac{Q_E}{Q_G}}$$

For $(COP)_{max}$ Refrigerator — Reversible.



energy consv.

$$Q_G + Q_E + W_p = Q_c + Q_a$$

neglecting W_p

$$\Rightarrow Q_G + Q_E = Q_c + Q_a \quad -(1)$$

2nd law $\Rightarrow \oint_{rev.} \frac{dQ}{T} = 0$

$$\Rightarrow \frac{Q_G}{T_G} + \frac{Q_E}{T_E} - \frac{Q_a + Q_c}{T_o} = 0 \quad -(2)$$

from eq^n (1) & (2)

$$\frac{Q_G}{T_G} + \frac{Q_E}{T_E} - \frac{Q_G + Q_E}{T_o} = 0$$

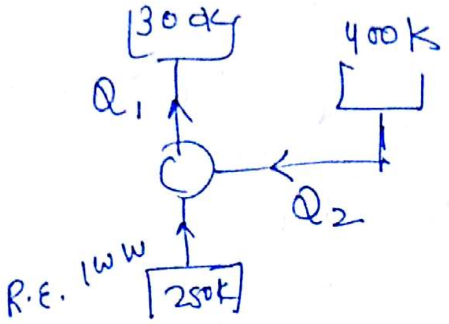
$$Q_E\left[\frac{1}{T_E} - \frac{1}{T_o}\right] = Q_G\left[\frac{1}{T_o} - \frac{1}{T_G}\right]$$

$$Q_E\left[\frac{T_o - T_E}{T_o T_E}\right] = Q_G\left[\frac{T_G - T_o}{T_o T_G}\right]$$

$$\frac{Q_E}{Q_G} = \frac{T_E(T_G - T_o)}{T_G(T_o - T_E)}$$

☆
$$\boxed{(COP)_{max} = \frac{T_E(T_G - T_o)}{T_G(T_o - T_E)}}$$

P.g. 49
Q. 13
WB



$$\frac{Q_1}{300} = \frac{Q_2}{400} + \frac{2}{5}$$

$$Q_1 = 100 + Q_2$$

$$\frac{100 + Q_2}{300} = \frac{Q_2}{400} + \frac{2}{5}$$

$$\frac{1}{3} + \frac{Q_2}{300} = \frac{Q_2}{400} + \frac{2}{5}$$

$$\frac{1}{3} - \frac{2}{5} = Q_2\left(\frac{400 - 300}{400 \times 300}\right)$$

$$\frac{5-6}{15} = Q_2 \frac{1}{8}$$

rej. $Q_2 = -80\,W$

(T1)

$T_G = 360\,K$

$T_0 = 310\,K$

$T_E = 260 \rightarrow 250\,K$

$$COP = \frac{T_E(T_G - T_0)}{T_G(T_0 - T_E)}$$

$$COP = \frac{260(50)}{360 \times 50} = \frac{250(T_G - 310)}{T_G(310 - 250)}$$

$$\frac{13}{18} = \frac{250\,T_G - 250 \times 310}{T_G \times 310 - T_G\, 250}$$

$$T_G = 374.9\,K$$

(12) $$COP = \frac{T_E(T_G - T_0)}{T_G(T_0 - T_E)} =$$

$$COP = \frac{258(383-328)}{383(328-258)} = 0.529$$

(11) $$COP = \frac{270(360-300)}{360(300-270)} = \frac{270 \times \overset{2}{\cancel{60}}}{360 \times \cancel{30}}$$

$$COP = 1.5$$

Ques In NH_3-H_2O absorption system heat is supplied to generator by condensing steam at 0.2 MPa. The initial state of steam is at a dryness fraction of 0.9 and the final state of the steam after condensing is saturated liquid. The temp. to be maintained in evaporator is $-10°C$ and the surrounding temp is $30°C$. (i) Find $(COP)_{max}$

(ii) if the actual COP is 40% of max COP and refrigeration load is 20 TR, what will be the required steam flow rate (kg/sec)

at 0.2MPa T_{sat} 120.2°C $h_{fg} = 2201.9$ kJ/kg.

Sol^n

$$(COP)_{max} = \frac{T_E(T_G - T_0)}{T_G(T_0 - T_E)}$$

$$= \frac{263(120.2 - 30)}{~~120~~ \cdot 393.2(30 + 10)}$$

$$(COP)_{max} = 1.508$$

$$R.E. = RE \times \dot{m}$$

~~$20 \times 3.51 = (h_1 - h_4) \times \dot{m}$~~

$$(COP)_{act} = 0.4\,(COP)_{max}$$

~~Q1~~ $\frac{RE}{W_{I/P}} = 0.4 \times 1.508 = 0.603$

~~$RE = 42.34 = \dot{m}(h_1 - h_4)$~~

~~$42.34 = \dot{m}(h_f + x\,h_{fg} - h_f)$~~

~~$\dot{m} =$~~

$$\frac{RC}{\dot{Q}_G} = 0.603 = \frac{20 \times 3.5167}{\dot{m} \times x \times h_{fg}}$$

$$\dot{m} = 0.058\ kg/s$$