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Section 4

Question No. 3

Cascade refrigeration system:

→ The cascade refrigeration system consist of two or more vapour compression refrigeration system in series which used refrigerant with progressively lower boiling temps.

→ A two stage cascade system using two refrigerants as shown in fig. 4 its corresponding p-h & T-s digram are shown in fig.

→ In cascade refrigeration system a cascade condenser server as an evaporator for the high temp cascade system and as a condenser for the low temp cascade system.

→ ~~They~~ The only useful refrigeration effect is produced in the evaporator of the ~~too~~ low temp cascade system.

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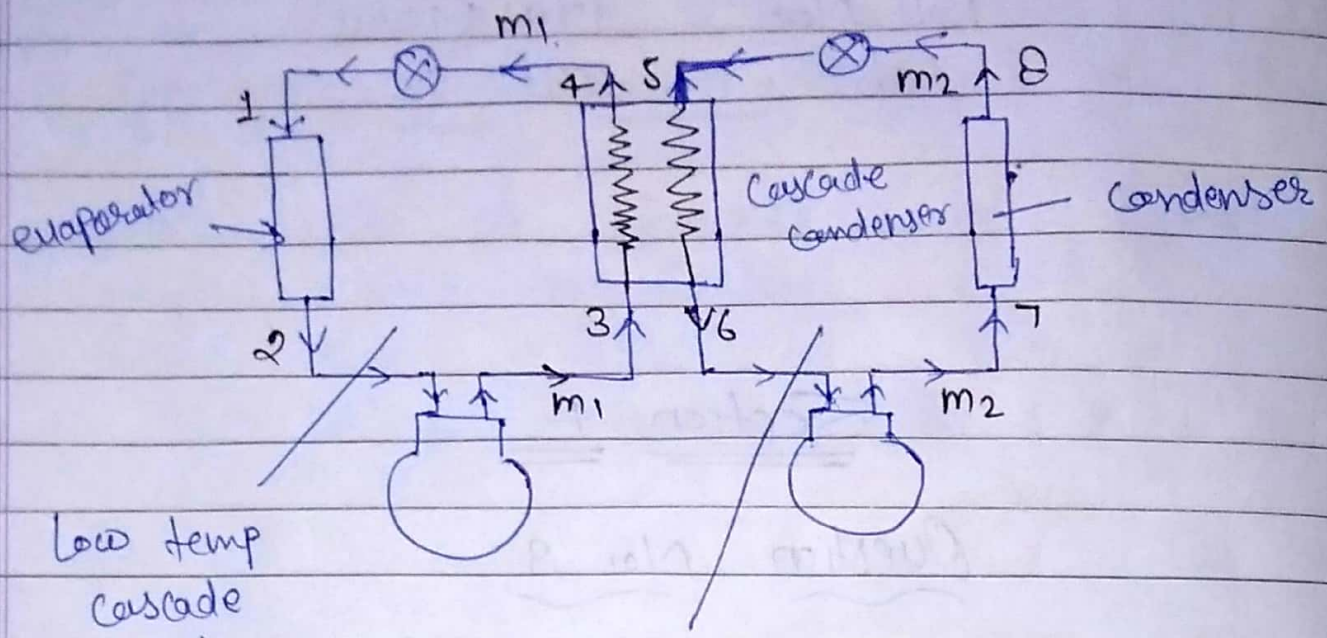

· low temp Cascade compressor

High temp cascade compressor.

Schematic arrangement of a two stage cascade system.

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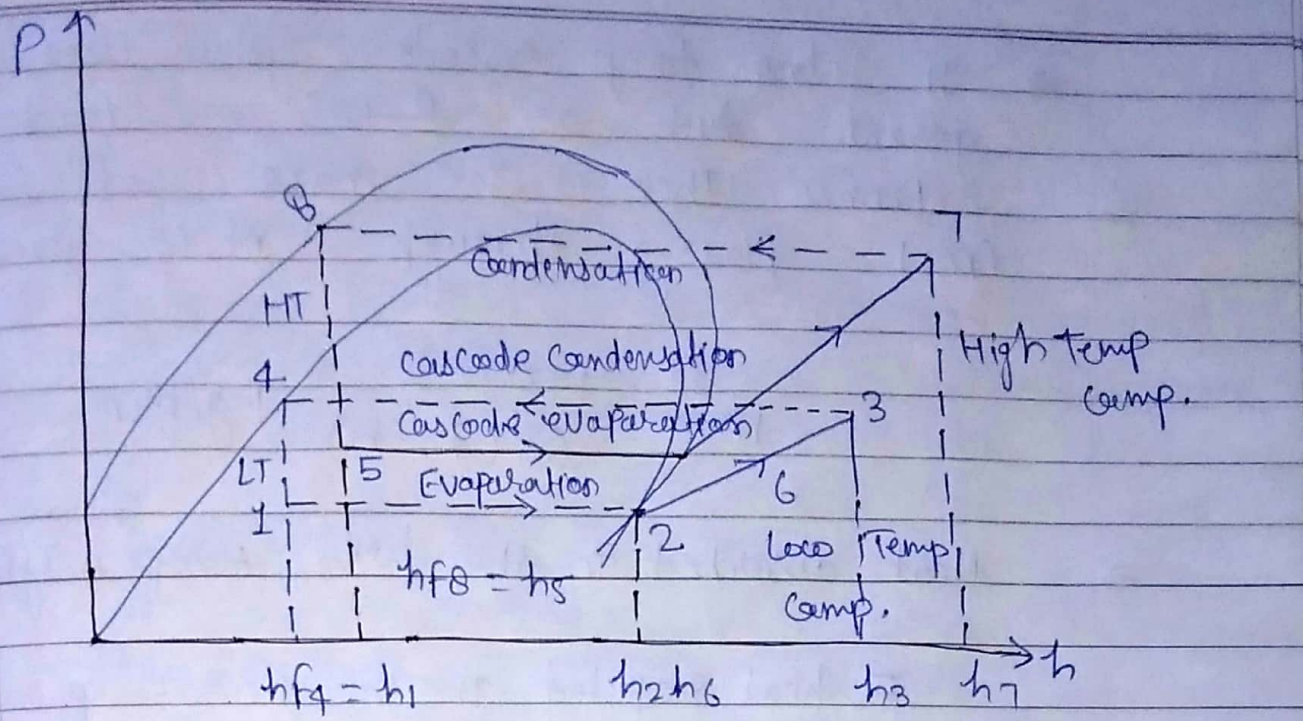
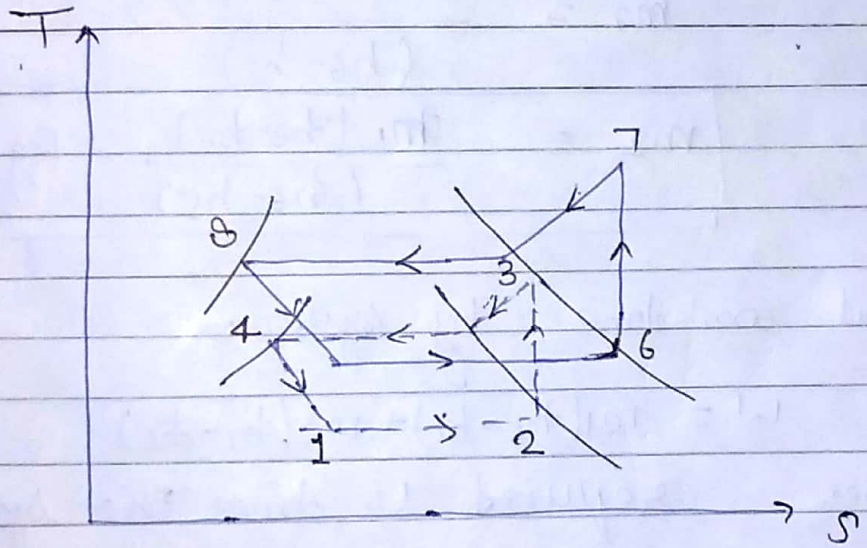


p-h diagram.



T- S diagram

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→ If low temp cascade system uses a refrigerant ~~such as R-13~~ load of Q tonnes then the mass of refrigerant (m_1) flowing through it is given by

$$m_1 = \frac{14000\,Q}{60(h_2 - h_1)} \text{ kg/min}$$

Heat absorbed in the high temp cascade system.

= heat rejected in the low temp cascade syste

i.e.

$$m_2(h_6 - h_5) = m_1(h_3 - h_{f4})$$

$$m_2 = \frac{m_1(h_3 - h_{f4})}{(h_6 - h_5)}$$

$$\boxed{m_2 = \frac{m_1(h_3 - h_1)}{(h_6 - h_5)} \text{ kg/min}}$$

Total workdone by system.

$$W = m_1(h_3 - h_2) + m_2(h_7 - h_6)$$

Power required to drive the system

$$P = \frac{m_1(h_3 - h_2) + m_2(h_7 - h_6)}{60} \text{ KW}$$

Refrigeration effect = $\frac{14000\,Q}{60}$ KJ/min

$$COP = \frac{\text{Refrigerating effect}}{\text{Work done}} = \frac{14000\,Q}{60[m_1(h_2 - h_2) + m_2(h_7 - h_6)]}$$