

# جامعة تكريت

قسم الميكانيك

كلية الهندسة

## محاضرة دورة التبريد الامتصاصية مع مبادلين حرارية ( Absorption Refrigerator Cycle )

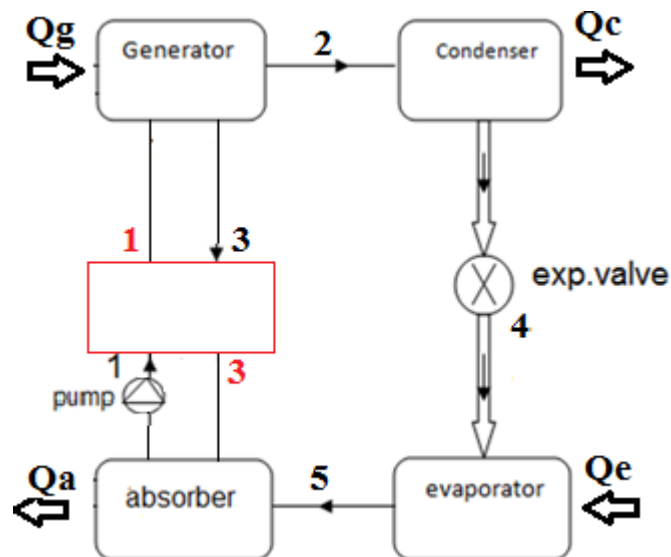
المادة: تكييف التاريخ ١٢ تموز 2021

$$(COP)_{act} = \frac{\text{usefual effective heat}}{\text{heat added}} = \frac{q_e}{q_g}$$

$$(COP)_{tho} = \frac{T_e(T_g - T_c)}{T_g(T_c - T_e)}$$

$$(COP)_{act} = \frac{\text{usefual effective heat}}{\text{heat added}} = \frac{Q_e}{Q_g}$$

$$(COP)_{relative} = \frac{(COP)_{act}}{(COP)_{tho}}$$



Generator

$$Q_g + \dot{m}_1 h_1 = \dot{m}_2 h_2 + \dot{m}_3 h_3$$

Condenser

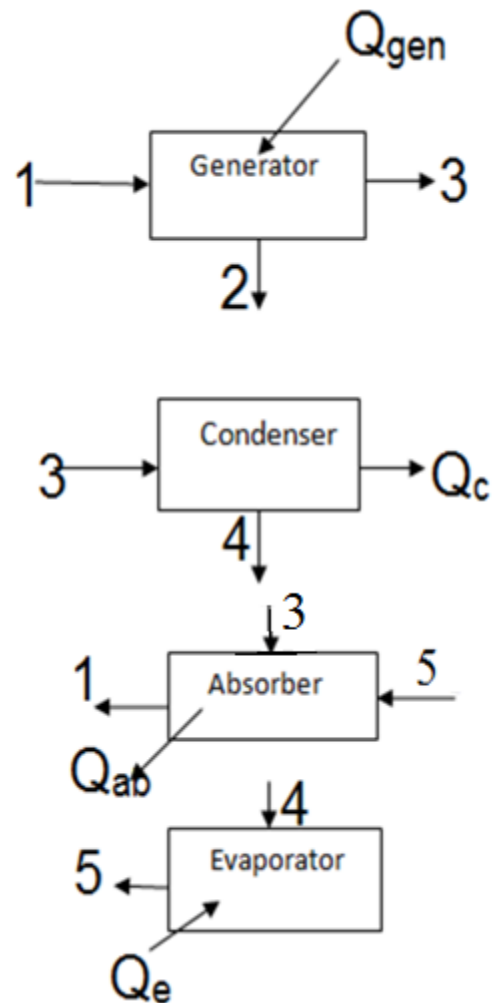
$$Q_c + \dot{m}_4 h_4 = \dot{m}_3 h_3$$

Absorber

$$Q_a + \dot{m}_1 h_1 = \dot{m}_5 h_5 + \dot{m}_3 h_3$$

Evaporator

$$Q_e + \dot{m}_4 h_4 = \dot{m}_5 h_5$$



معامل أداء المنظومة الامتصاصية الفعلية  $(COP)_{act}$

$$(COP)_{act} = \frac{Q_e}{Q_g}$$

معامل أداء المنظومة الامتصاصية النظرية  $(COP)_{tho}$

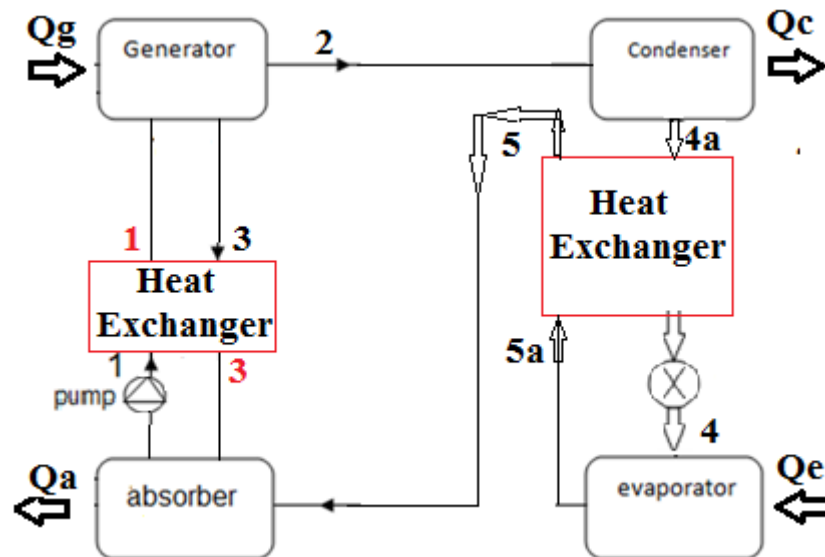
$$(COP)_{tho} = \frac{T_e(T_g - T_c)}{T_g(T_c - T_e)}$$

**Example:** -The following data are known for LiBr-H<sub>2</sub>O absorption system. The cooling capacity is 1 kW, generation temp. is 76°C, condenser temp. 38°C, evaporator temp. 4°C. Temp. of absorber is 32°C. Assumed saturation condition for strong solution entering generation, weak solution leaving generation and water vapor Leaving evaporator.

Find: -

- a- Properties of solution or water at each point (p, t, h, x).
- b- Mass flow rate each point.
- c-  $(COP)_{act}$  &  $(COP)_{tho}$
- d- Relative COP
- e- Heat rejected or added for the cycle components.
- f- The COP when heat exchanger added between high and low solution leave the absorber then enter the generator at 40°C.
- g- The COP when heat exchanger added between the condenser and evaporator, which drop the temperature of working fluid leave the condenser by 4°C & 8°C.

## Solution



$$P_g = P_c = \text{high pressure at } T_{sat} = 38^\circ\text{C}$$

$$P_{ab} = P_e = \text{low pressure at } T_{sat} = 4^\circ\text{C}$$

Absorber

$$P_1 = P_5 = 0.813 \text{ kPa}$$

$$X_1 = 53.1\% \quad h_1 = 72 \frac{\text{kJ}}{\text{kg}}$$

Generator -3-

$$P_2 = P_3 = 6.624 \text{ kPa}$$

$$X_3 = 57.2\% \quad h_3 \cong 172 \frac{\text{kJ}}{\text{kg}}$$

$$h_4 = 159.1 \frac{\text{kJ}}{\text{kg}} = h_f \text{ at } P_c$$

$$h_5 = 2508 \frac{\text{kJ}}{\text{kg}} = h_g \text{ at } P_e$$

$$h_2 = h_{\text{Super heated at } P_c \text{ \& } 76^\circ\text{C}} = 2640.8 \frac{\text{kJ}}{\text{kg}}$$

Or

$$\begin{aligned} h_2 &= h_{\text{Super heated at } P_c \text{ \& } 76^\circ\text{C}} = 2501 + 1.84 \times T_2 \\ &= 2501 + 1.84 \times 76 = 2642.8 \frac{\text{kJ}}{\text{kg}} \end{aligned}$$

$$\begin{aligned} \dot{m}_2 = \dot{m}_4 = \dot{m}_5 &= \frac{1}{h_5 - h_4} = \frac{1}{2508.9 - 159.1} \\ &= 0.000426 \text{ kg/s} = 0.426 \text{ l/s} \end{aligned}$$

$$\dot{m}_3 X_3 = \dot{m}_1 X_1$$

$$\dot{m}_1 = \dot{m}_2 + \dot{m}_3$$

$$\dot{m}_1 = 0.426 + \dot{m}_3$$

$$\dot{m}_1 = 0.0005941 \frac{\text{kg}}{\text{s}} \text{ \& } \dot{m}_3 = 0.0005515 \frac{\text{kg}}{\text{s}}$$

### Heat Exchanger 1

$$\dot{m}_1 h_1 + \dot{m}_3 h_3 = \dot{m}_1 \dot{h}_1 + \dot{m}_3 \dot{h}_3$$

$$\dot{h}_3 = 161.2 \frac{\text{kJ}}{\text{kg}} \text{ When } T_1 = 40^\circ\text{C} \text{ \& } \dot{h}_1 = 82 \frac{\text{kJ}}{\text{kg}}$$

$$Q_c + \dot{m}_4 h_4 = \dot{m}_2 h_2$$

$$Q_c = 1.057 \text{ kW}$$

$$Q_g + \dot{m}_1 h_1 = \dot{m}_2 h_2 + \dot{m}_3 h_3$$

$$Q_g = 1.5896 \text{ kW}$$

### Heat Exchanger 1

$$Q_g + \dot{m}_1 \dot{h}_1 = \dot{m}_2 h_2 + \dot{m}_3 \dot{h}_3$$

$$Q_g = 1.166 \text{ kW}$$

Total energy balance

Supplied energies = Rejected energies

$$\text{Supplied energies} = q_g + q_e$$

$$= 1 + 1.6458 = 2.6458 \text{ kW}$$

$$\text{Rejected energies} = q_a + q_c$$

$$= 1.5896 + 1.057 = 2.6466 \text{ kW}$$

$$(COP)_{act} = \frac{Q_e}{Q_g} = \frac{1}{1.5896} = 0.629$$

### Heat Exchanger

$$(COP)_{act} = \frac{Q_e}{Q_g} = \frac{1}{1.166} = 0.857$$

$$(COP)_{tho} = \frac{T_e(T_g - T_c)}{T_g(T_c - T_e)} = \frac{277(349 - 311)}{349(311 - 277)} = 1.103$$

$$(COP)_{relative} = \frac{(COP)_{act}}{(COP)_{tho}} = \frac{0.629}{1.103} = 0.74$$

Heat Exchanger 2 at Temp. difference =4°C

$$\dot{m}_5 h_{5a} + \dot{m}_4 h_{4a} = \dot{m}_4 \dot{h}_4 + \dot{m}_5 \dot{h}_5$$

$$\dot{h}_5 = 2526 \frac{\text{kJ}}{\text{kg}}$$

Evaporator

$$\dot{m}_4 h_4 + Q_e = \dot{m}_4 \dot{h}_{5a}$$

$$Q_e = 1.007 \text{ kW}$$

Heat Exchanger 2 at Temp. difference =8°C

$$\dot{m}_5 h_{5a} + \dot{m}_4 h_{4a} = \dot{m}_4 \dot{h}_4 + \dot{m}_5 \dot{h}_5$$

$$\dot{h}_5 = 2541 \frac{\text{kJ}}{\text{kg}}$$

Evaporator

$$\dot{m}_4 h_4 + Q_e = \dot{m}_4 \dot{h}_{5a}$$

$$Q_e = 1.014 \text{ kW}$$

$$(COP)_{act} = \frac{Q_e}{Q_g} = \frac{1.014}{1.166} = 0.869$$