BMEGEENMWEP

Sub-cooling

Refrigeration-4

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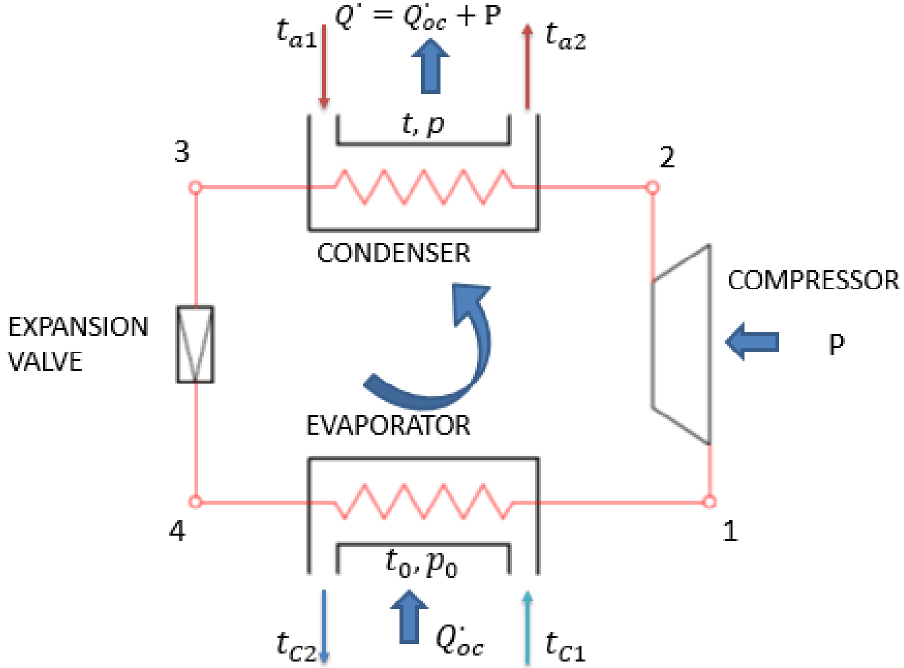
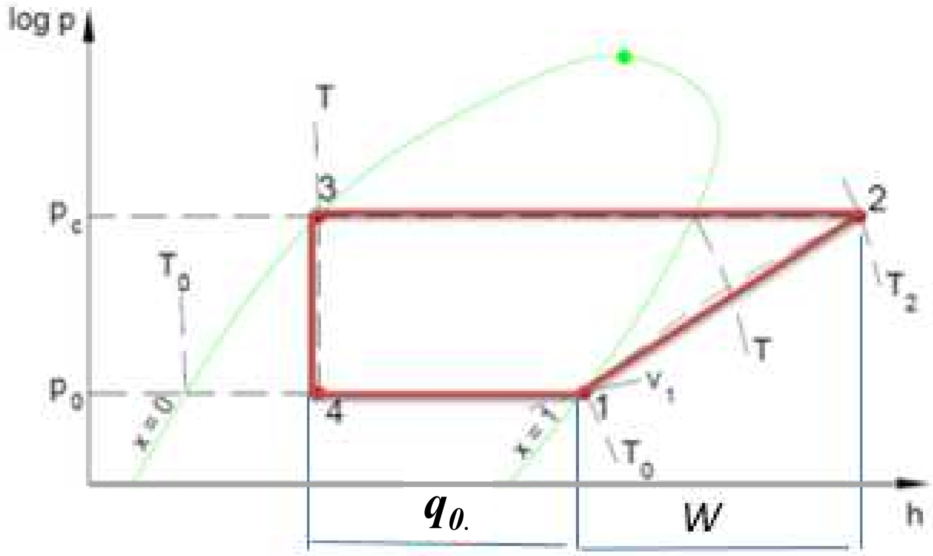
ENERGETIKAI GÉPEK ÉS RENDSZEREK TANSZÉK

STANDARD VAPOR-COMPRESSOR CYCLE
THE EFFECT OF SUB-COOLING ON *COP:*

- The COP of Standard Vapor-Compressor Cycle $COP_{Stand.} = \frac{q_0}{W}$
- How can We got higher $COP_{Stand.}$ at the same external conditions (th1, th2, ta1)?

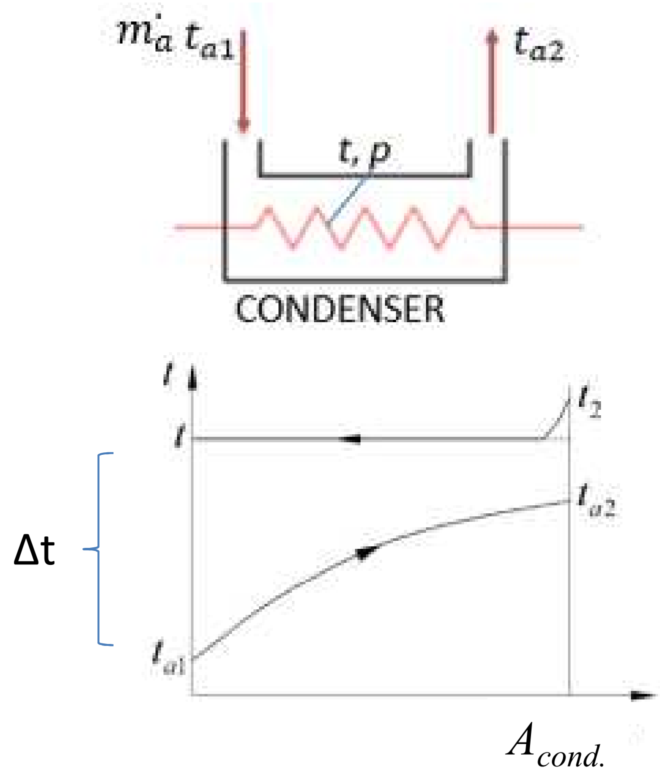




Standard Vapor-Compressor Cycle

THE EFFECT OF SUB-COOLING ON COP

- In the Standard-Vapor Compression cycle we can see the condensing temperature ($t > t_{a,1}$) higher than natural coolant,
- We have possibility to cool down the refrigerant by natural coolant,
- We can build another counter-flow heat exchanger after the condenser to cool down the refrigerant by natural coolant,
- The refrigerant is saturated liquid and after that heat exchanger its temperature deceases (t_3*) but the pressure remains constant p; the refrigerant becomes ***subcooled liquid*** it's temperature *(t_3* < t).* The natural coolant temperature increases to (t_a*) .



THE EFFECT OF SUB-COOLING ON COP

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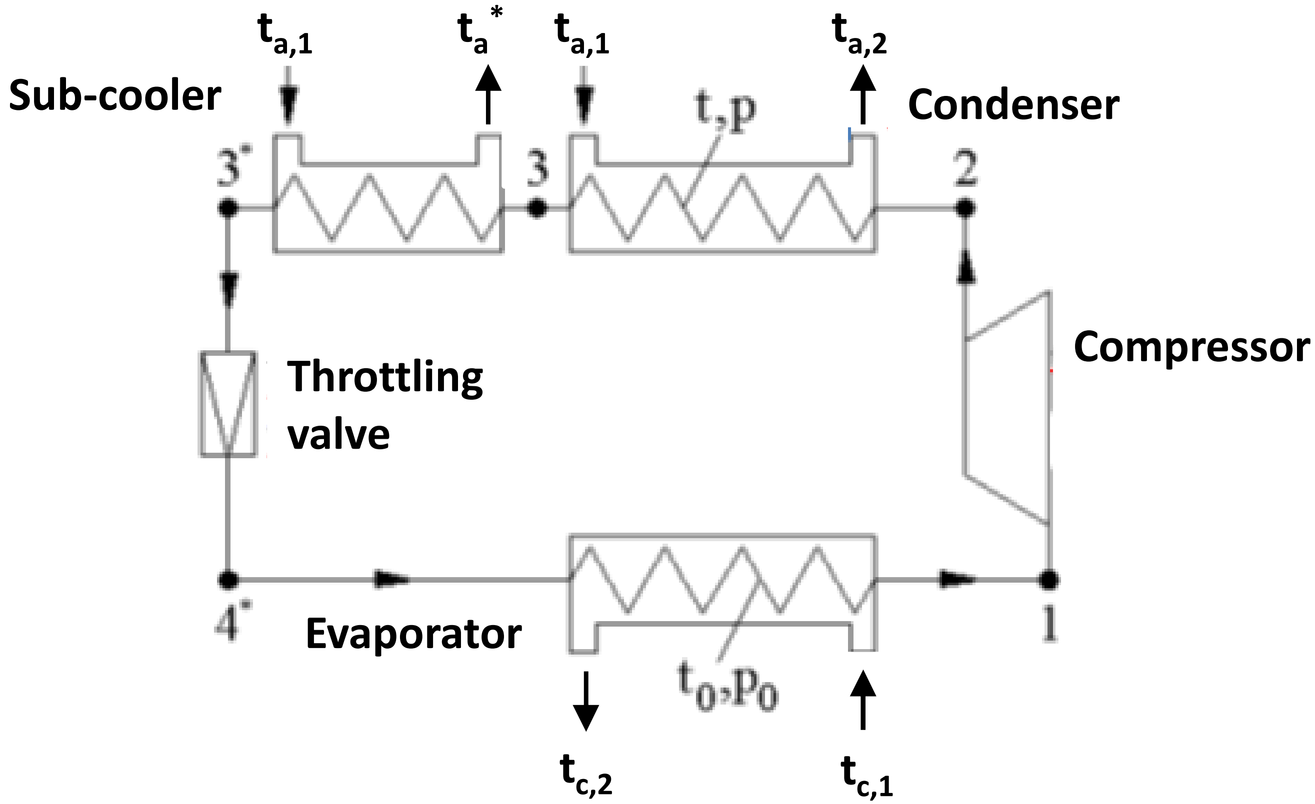
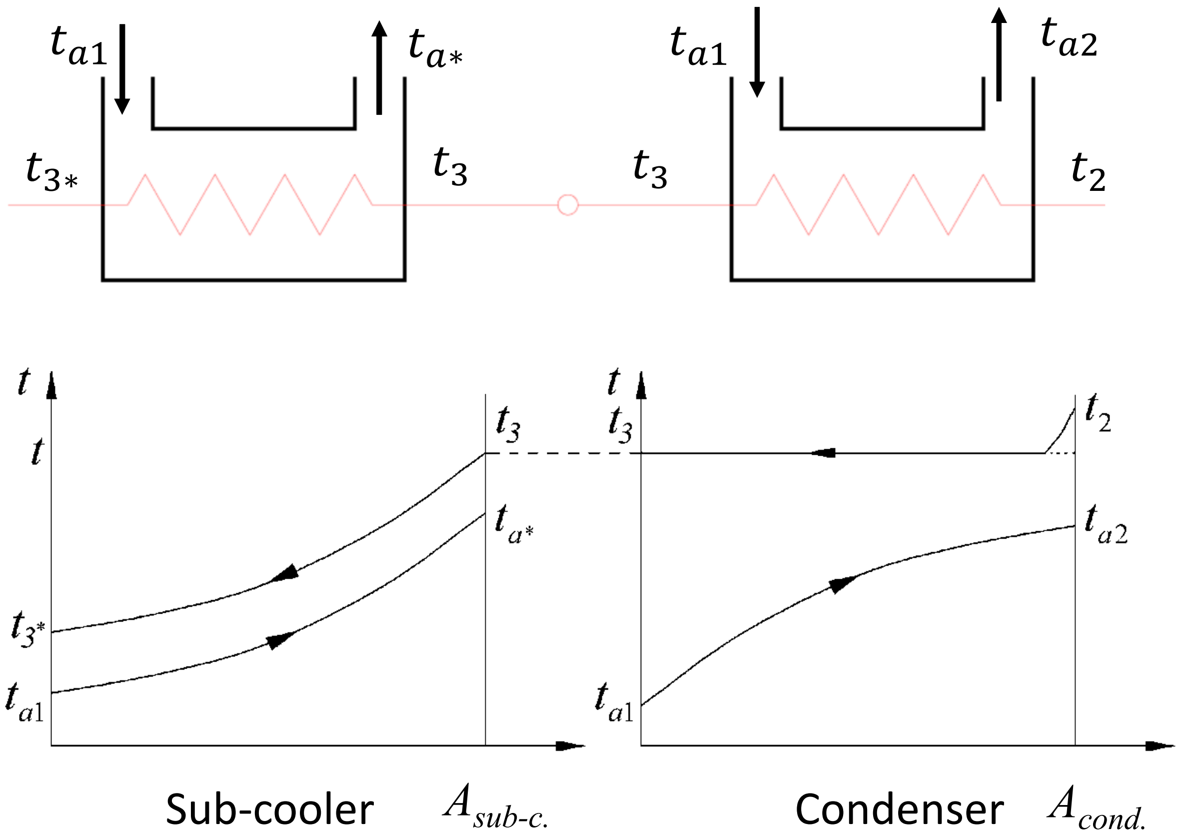
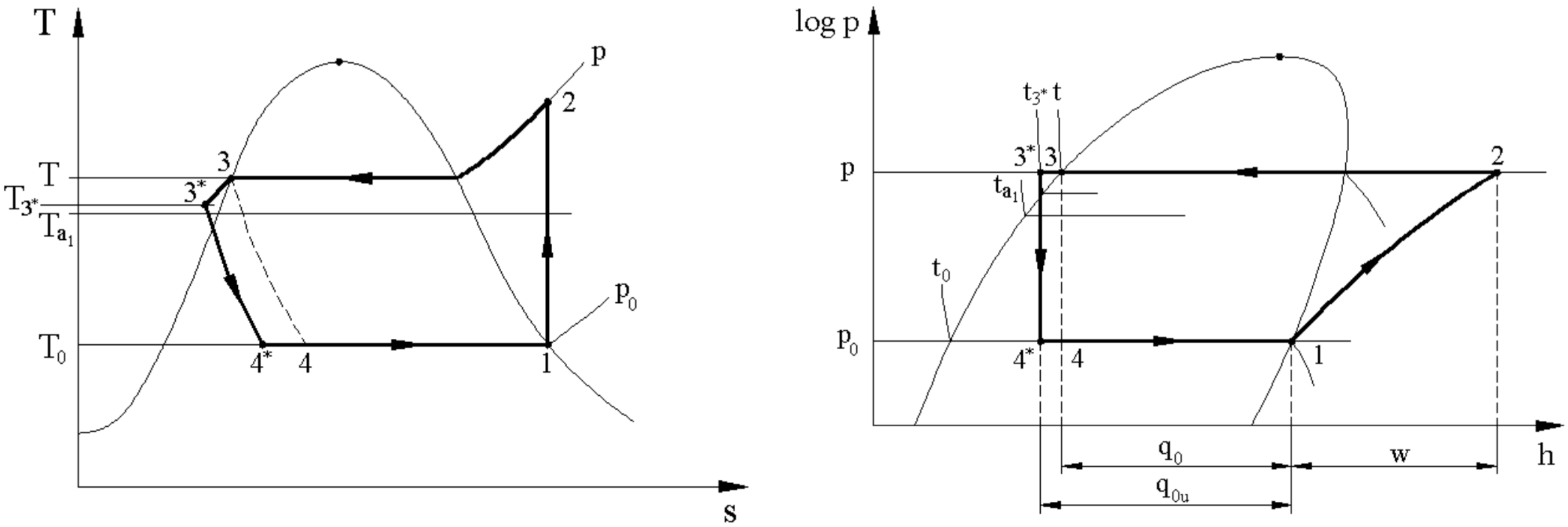


THE EFFECT OF SUB-COOLING ON COP



THE EFFECT OF SUB-COOLING ON COP



The sub-cooling in T-s and log p-h diagrams

THE EFFECT OF SUB-COOLING ON COP

- The result when We use sub-cooling:
- $q_0 \rightarrow q_{0sub.} = q_0 + \Delta q_0$ $\quad q_{0sub.} > q_0$
- $w = w_{sub.} = const.$ Because the compression process starts from 1 point (saturated vapor)
- $COP_{sub.} = \frac{q_{0u}}{w} > COP = \frac{q_0}{w}$
- We got higher COP

THE EFFECT OF SUB-COOLING ON COP

- For the cycle for the same cooling capacity $\dot{Q}_{0c}$:
- The mass flow rate of refrigerant $\dot{m} = \frac{\dot{Q}_{0c}}{q_0} > \dot{m}_{sub.} = \frac{\dot{Q}_{0c}}{q_{0sub.}}$ with sub-cooler because $q_0 < q_{0sub.}$
- $w = w_{sub.}$
- The power input deceases $P = \dot{m} \cdot w > P_{sub.} = \dot{m}_{sub.} \cdot w_{sub.}$
- The rejected heat decreases
- $\dot{Q}_{cond.} = \dot{m} \cdot q > \dot{Q}_{cond_{sub.}} = \dot{m}_{sub.} \cdot q$
- The volumetric flow rate decrease:
- $\dot{V}_c = \dot{m} \cdot v_1 > \dot{V}_{c_{sub.}} = \dot{m}_{sub.} \cdot v_1$

COP INCREASE

- The specific rejected heat in sub-cooler:
- $q_{sub.} = h_4 - h_{4^*}$
- The rejected heat capacity in sub-cooler $\dot{Q}_{sub.} = \dot{m}_{sub.} \cdot q_{sub.}$
- The energy balance:
- $\dot{Q}_{0c} + P_{sub.} = \dot{Q}_{cond_{sub.}} + \dot{Q}_{sub.}$

END

- Thanks for your attention