Műszaki hőtan 2007.04.14.

összefoglalás Műszaki hőtan

I. főtétel – zárt $q_{12} + w_{12} = u_2 - u_1 \quad \left[\frac{kJ}{kg}\right]$

$$w_{12} = -\int_1^2 p\,dV + w_{12\,\text{súrl}}$$

nyitott

$$q_{12} + w_{t12} = h_2 - h_1 + \frac{c_2^2 - c_1^2}{2} + g(z_2 - z_1)$$

$$w_{t12} = \int_1^2 v\,dp + \frac{c_2^2 - c_1^2}{2} + g(z_2 - z_1) + w_{12\,\text{súrl.}}$$

ideális gáz esetek

$$p \cdot V = RT$$

$$h_2 - h_1 = c_{p0}(T_2 - T_1) = c_{p0}(t_2 - t_1)$$

$$T[K] = t[C^\circ] + 273{,}15$$

$$u_2 - u_1 = c_{v0}(T_2 - T_1) = c_{v0}(t_2 - t_1)$$

$q_{12} = c_0(t_2 - t_1)$ | $-q_{12} = c_{p0}(t_1 - t_2)$ | $-\dot{Q}_{12} = \dot{m}\, c_{p0}(t_1 - t_2)$

II. főtétel

S, s

~~...~~ entrópia

entrópia változhat – hő / – súrl. / – irreverzibilitás

zárt. $dS = dS_Q + dS_{irr}$ $dS_{irr} \geq 0$

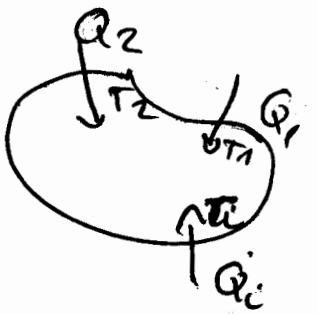
$$dS_Q = \dot{S}_Q \, d\tau$$

$$dS_{irr} = \dot{S}_{irr} \, d\tau$$

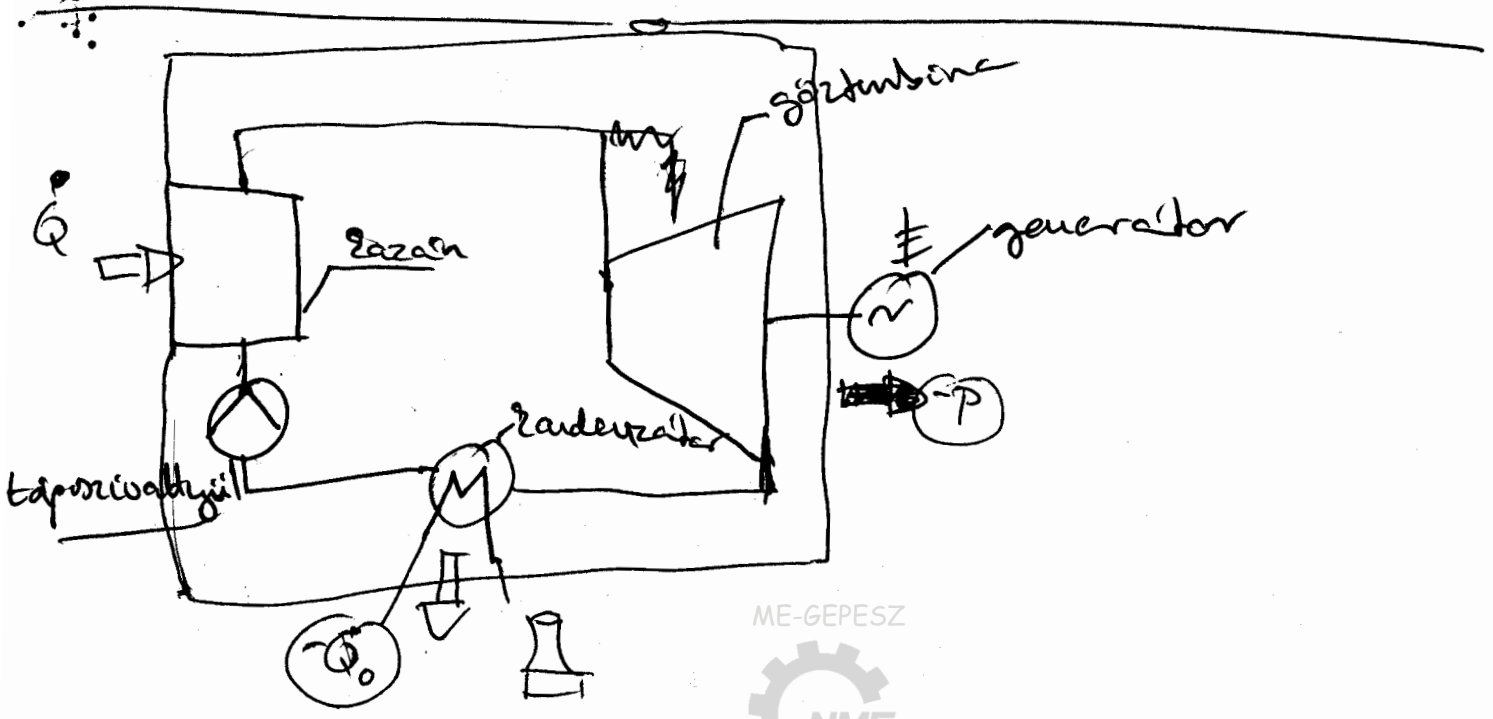
entropia produkció

$$dS_Q = \frac{dQ}{T}$$

$$\dot{S}_Q \, d\tau = \frac{\dot{Q} \, d\tau}{T} \qquad \dot{S}_Q = \frac{\dot{Q}}{T}$$



$$\frac{dS}{d\tau} = \sum_i \frac{\dot{Q}_i}{T_i} + \dot{S}_{irr}$$



2007.04.14.

Műszaki hőtan

$$\frac{dU}{d\tau} = \dot{Q} + \dot{Q}_0 + P \overset{\text{stac}}{=} 0$$

$$-P = \dot{Q} - f(\dot{Q}_0)$$

$$\frac{dS}{d\tau} = \frac{\dot{Q}}{T} + \frac{\dot{Q}_0}{T_0} + \dot{S}_{irr} =$$

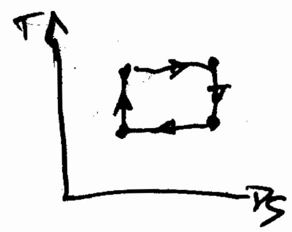
$$-\dot{Q}_0 = \frac{T_0}{T}\dot{Q} + T_0 \dot{S}_{irr}$$

$$(-P)_{rev} = \left(1 - \frac{T_0}{T}\right)\dot{Q}$$

$$-P = \left(1 - \frac{T_0}{T}\right)\dot{Q} - T_0 \cdot \dot{S}_{irr}$$

$T_0 \rightarrow T_{Ekv}$

energia = exergia + anergia (E, A)



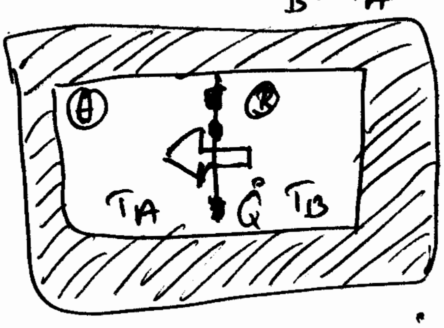
$$\dot{E}_Q = \left(1 - \frac{T_{Ekv}}{T}\right)\dot{Q}$$

η_c – Carnot tényező

$$\dot{A}_Q = \frac{T_{Ekv}}{T}\dot{Q}$$

$$\dot{E}_v = T_{Ekv} \cdot \dot{S}_{irr}$$

$T_B > T_A$



$$\frac{dS}{d\tau} = \dot{S}_{irr} = \left(\frac{dS}{d\tau}\right)_A + \left(\frac{dS}{d\tau}\right)_B$$

$$\left(\frac{dS}{d\tau}\right)_A = \frac{\dot{Q}_A}{T_A} \qquad \left(\frac{dS}{d\tau}\right)_B = \frac{\dot{Q}_B}{T_B}$$

$$\dot{Q} = \dot{Q}_A = -\dot{Q}_B$$

$$\dot{S}_{irr} = \frac{\dot{Q}}{T_A} - \frac{\dot{Q}}{T_B} = \frac{T_B - T_A}{T_A \cdot T_B} \dot{Q}$$

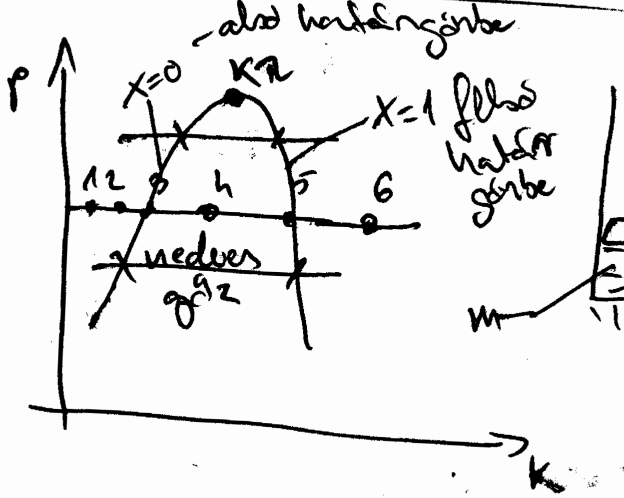
$$\dot{S}_{irr} = \frac{T_B - T_A}{T_A \cdot T_B} \dot{Q}$$

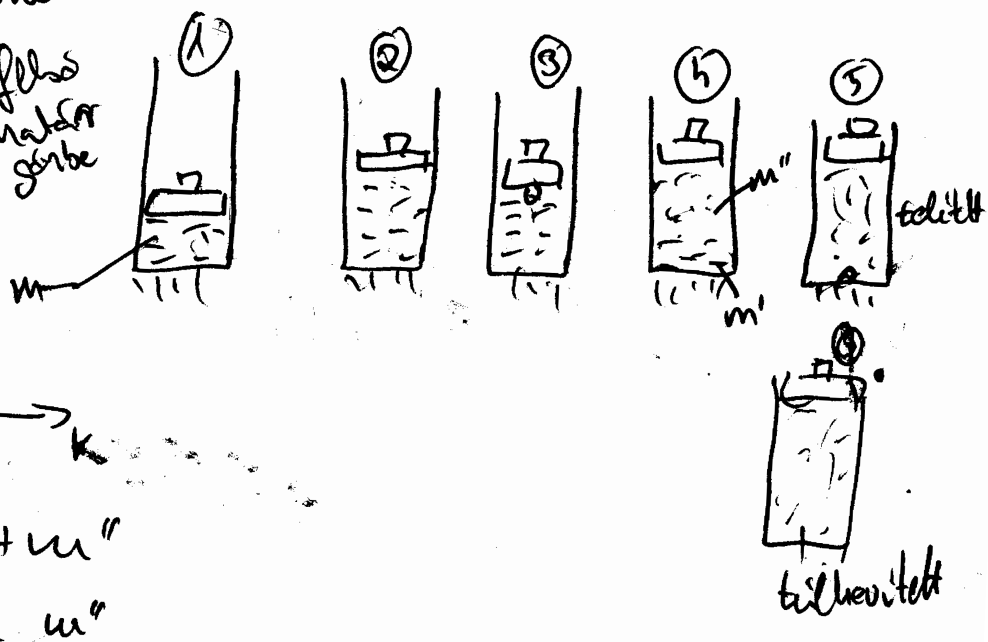
$$\dot{E}_V = T_{kör} \cdot \dot{S}_{irr}$$

$$\dot{Q} = \lambda \cdot A (T_B - T_A)$$

Mollier

Nedves gőz mező





$$m = m' + m''$$

$$x = \frac{m''}{m' + m''}$$

Elsner - Vízgőztáblázatok

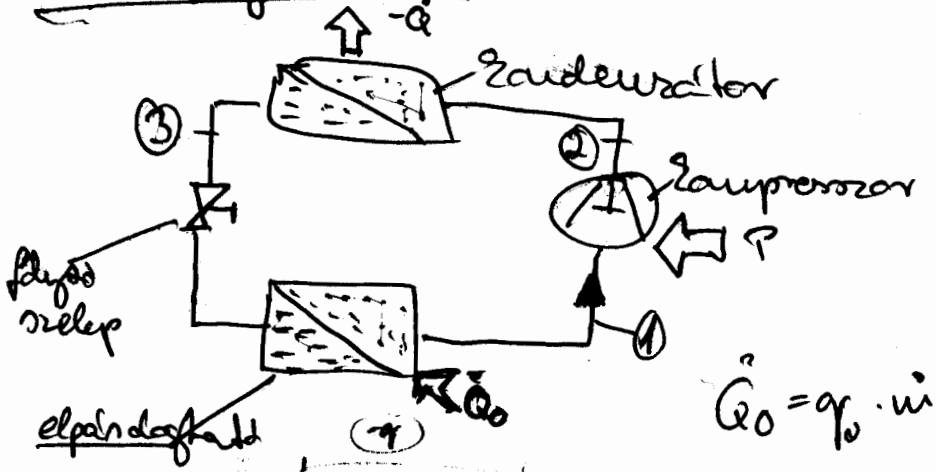
$$v = v' + x(v'' - v')$$

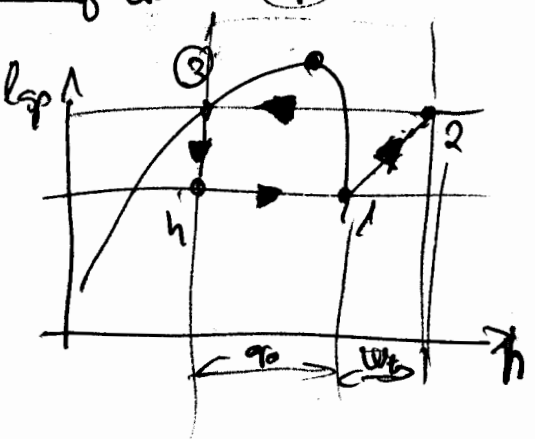
$$h = h' + x(h'' - h')$$

$$s = s' + x(s'' - s')$$

Körfolyamatok

Hűtőkörfolyamat





$$\dot{Q}_0 = q_0 \cdot \dot{m} \qquad P = w_t \cdot \dot{m}$$

$$(-\dot{Q}) = (-q) \cdot \dot{m}$$

$$\varepsilon = \frac{q_0}{w_t} = \frac{Q_0}{P}$$