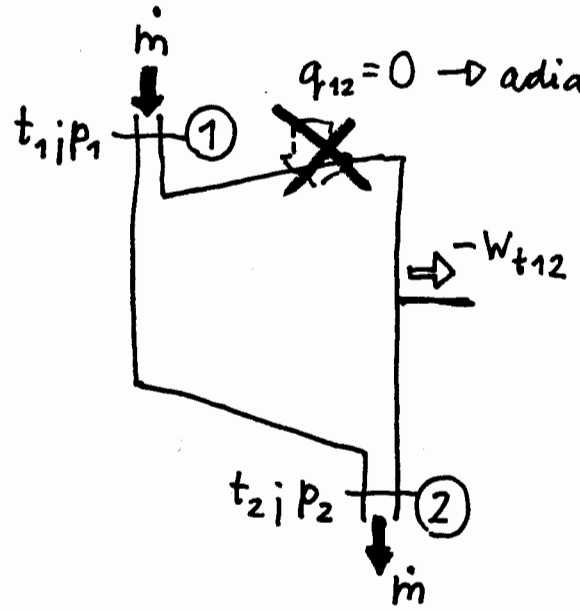
Gépészmérnöki (BSc) alapszak
levelező tagozat

MH / HFS 1

Műszaki hőtan
GEAHT101BL

Segédlet a házi feladat megoldásához

1.



Izentrópikus eset:

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\kappa-1}{\kappa}}$$

$$T_1[K] = t_1[°C] + 273{,}15$$

$$T_2[K] = t_2[°C] + 273{,}15$$

A valóságos esetben:

$$t_{2v} = t_2 + \Delta t \quad \rightarrow \quad T_{2v} = t_{2v} + 273{,}15$$

— · —

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

$$w_{t12} = h_2 - h_1 \quad ;$$

$$-w_{t12} = h_1 - h_2 = c_{po}(T_1 - T_2) = c_{po}(t_1 - t_2) \quad ;$$

$$-P = \dot{m}\cdot(-w_{t12}) \quad ;$$

$$(-w_{t12})_v = c_{po}\,(t_1 - t_{2v}) \quad ;$$

$$(-P)_v = \dot{m}\cdot(-w_{t12})_v \quad .$$

$$\Delta s_{irr} = s_{2v} - s_1 = c_{po}\,\ln\frac{T_{2v}}{T_1} - R\ln\frac{p_2}{p_1} \quad ;$$

$$R = c_{po}\,\frac{\kappa-1}{\kappa} \quad ;$$

$$\dot{S}_{irr} = \dot{m}\,\Delta s_{irr} \quad .$$

(2.) A Karaffa-példatárból (373. és 391. oldal):

$$p_o = 0{,}035\ \text{bar} \longrightarrow t_o = 26{,}69\,^\circ\text{C}$$

$$v_o' = 0{,}0010033\ \frac{m^3}{kg} \longrightarrow \varrho_o' = 996{,}71\ \frac{kg}{m^3}$$

$$v_o'' = 39{,}480\ \frac{m^3}{kg} \longrightarrow \varrho_o'' = 0{,}02533\ \frac{kg}{m^3}$$

$$h_o' = 111{,}84\ \frac{kJ}{kg} \qquad h_o'' = 2549{,}9\ \frac{kJ}{kg}$$

$$r_o = 2438{,}1\ \frac{kJ}{kg}$$

$$s_o' = 0{,}3907\ \frac{kJ}{kgK} \qquad s_o'' = 8{,}5224\ \frac{kJ}{kgK} \quad ;$$

— · —

$p_2 = p_3 = p_4 = p_5 = 150$ bar

$t_5 = 500\,^\circ C$

$v_5 = 0{,}02079 \frac{m^3}{kg} \rightarrow \rho_5 = 48{,}10 \frac{kg}{m^3}$

$h_5 = 3309{,}7 \frac{kJ}{kg}$ i $s_5 = 6{,}3471 \frac{kJ}{kg\,K}$.

$$q_{be} = h_5 - h_2 \approx h_5 - h_o'$$

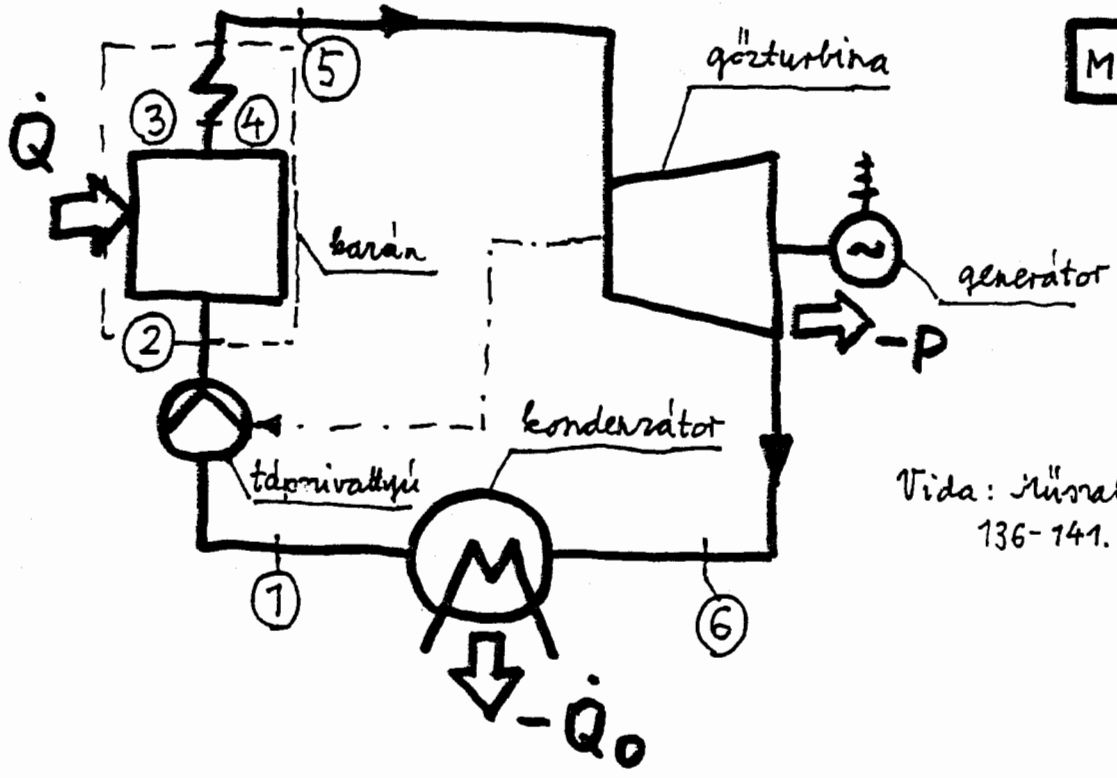
$$\dot{Q} = \dot{m} q_{be}$$

$$\left.\begin{aligned} s_6 = s_5 &= s_o' + x_6 (s_o'' - s_o') \\ x_6 &= \frac{s_5 - s_o'}{s_o'' - s_o'} \\ h_6 &= h_o' + x_6 (h_o'' - h_o') \end{aligned}\right\}$$

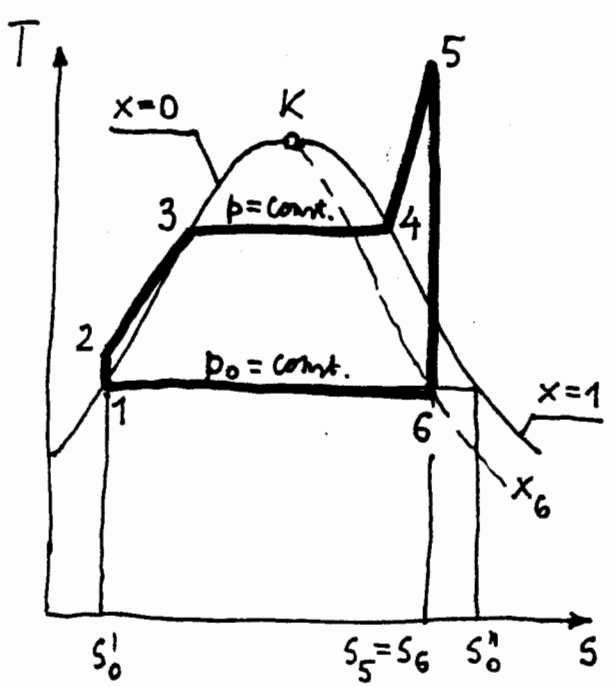
$$w_t = w_{56} = h_6 - h_5$$

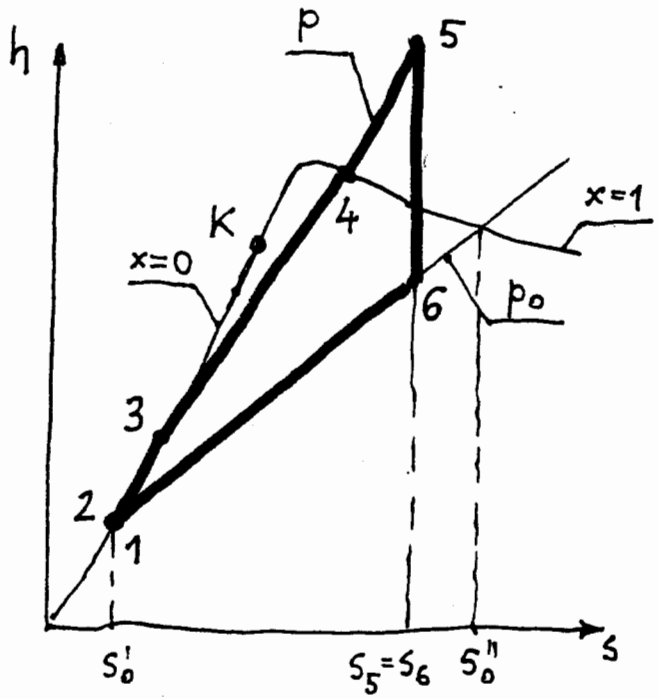
$$-w_t = h_5 - h_6$$

$$-P = \dot{m}(-w_t)$$



Vida: Műszaki hőtan
136-141. old.





1-2 izentropikus nyomásnövekedés (tápszivattyú)

2-3-4-5 izobár hőközlés → 2-3 vízmelegítés
3-4 elpárologtatás
4-5 túlhevítés

5-6 izentropikus expanzió

6-1 izobár hőelvonás (kondenzáció)

Rankine, William John Macquorn (1820-1872)
skót mérnök és fizikus

|| Clausius, Rudolf (Julius Emanuel) (1822-1888)
német fizikus

$$P + \dot{Q} + \dot{Q}_o = 0$$

$$-\dot{Q}_o = \dot{Q} - (-P)$$

$$\eta_t = \frac{-P}{\dot{Q}}$$

(3.) $p_{t1} = p_t[2\,^\circ C]$

$p_{t2} = p_t[27{,}5\,^\circ C]$ } számítása a közelítő képletből

$$x_1 = 0{,}622 \cdot \frac{p_{t1}}{\frac{101300}{0{,}9} - p_{t1}} \quad \text{i}$$

$$(h_{1+x})_1 = c_{pl}\, t_1 + x_1 (r_o + c_{pg}\, t_1)$$

$$c_{pl} = 1004{,}6 \frac{J}{kg\,K}$$

$$c_{pg} = 1863 \frac{J}{kg\,K}$$

$$r_o = 2500{,}9 \cdot 10^3 \frac{J}{kg}$$

$\boxed{x_1 = x_2}$

$$(h_{1+x})_2 = c_{pl}\, t_2 + x_2 (r_o + c_{pg}\, t_2) .$$

$$p_q = \varphi p_{t1}$$

$$\varrho = \frac{p}{R_l T}\left(1 - 0{,}378\,\frac{p_q}{p}\right)$$

$$R_l = 287{,}05\,\frac{J}{kg\,K} \quad ;$$

$$p = 101300\ Pa \quad ;$$

$$T = 2 + 273{,}15 = 275{,}15\ K \ .$$

$$\dot{m} = \varrho \dot{V} \quad ;$$

$$\dot{m} = \dot{m}_l + \dot{m}_q \quad ;$$

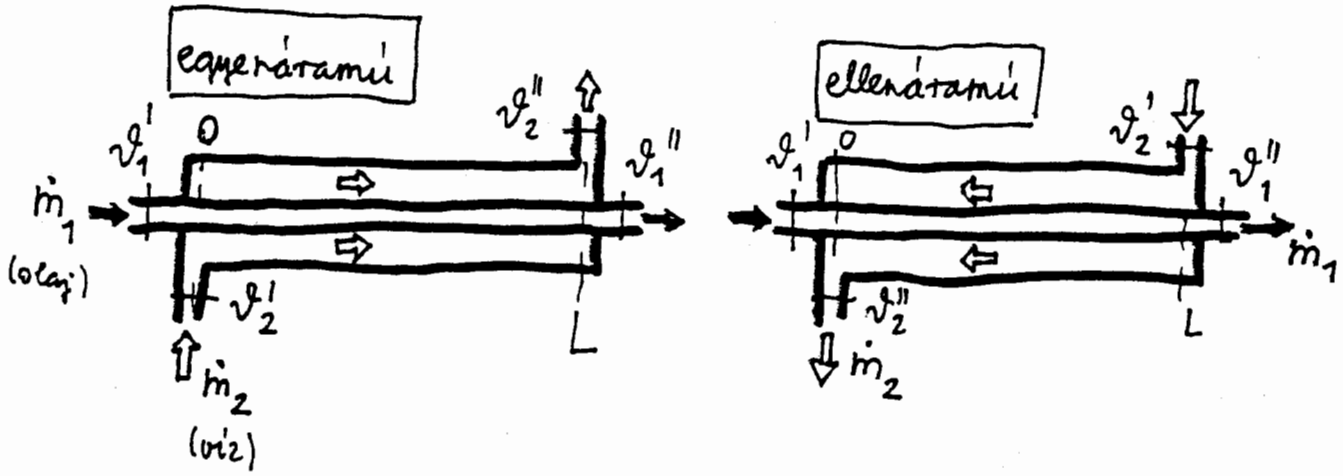
$$\dot{m}_l = \frac{\dot{m}}{1+x} \quad ;$$

$$\dot{Q} = \dot{m}_l \left[(h_{1+x})_2 - (h_{1+x})_1\right] \quad ;$$

$$\varphi_2 = \frac{p}{p_{t2}} \cdot \frac{x_2}{0{,}622 + x_2} \ .$$

4. A hőkapacitás-áramok:

$$\dot{W}_1 = \dot{m}_1 c_1 \qquad \text{i} \qquad \dot{W}_2 = \dot{m}_2 c_2$$



$$\dot{W}_1 \left(\vartheta_1' - \vartheta_1''\right) = \dot{W}_2 \left(\vartheta_2'' - \vartheta_2'\right)$$

$$\vartheta_2'' = \vartheta_2' + \frac{\dot{W}_1}{\dot{W}_2} \left(\vartheta_1' - \vartheta_1''\right)$$

$$\dot{Q} = \dot{W}_1 \left(\vartheta_1' - \vartheta_1''\right)$$

$$\dot{Q} = k A \, \frac{(\Delta\vartheta)_0 - (\Delta\vartheta)_L}{\ln \dfrac{(\Delta\vartheta)_0}{(\Delta\vartheta)_L}}$$

Egyenáramú:

$$(\Delta\vartheta_m)_{egy} = \frac{(\vartheta_1' - \vartheta_2') - (\vartheta_1'' - \vartheta_2'')}{\ln \frac{\vartheta_1' - \vartheta_2'}{\vartheta_1'' - \vartheta_2''}} \quad ;$$

Ellenáramú:

$$(\Delta\vartheta_m)_{ell} = \frac{(\vartheta_1' - \vartheta_2'') - (\vartheta_1'' - \vartheta_2')}{\ln \frac{\vartheta_1' - \vartheta_2''}{\vartheta_1'' - \vartheta_2'}}$$

$$\boxed{A = \frac{\dot{Q}}{k\,\Delta\vartheta_m}}$$

Egyenáramú: $$A_{egy} = \frac{\dot{Q}}{k \cdot (\Delta\vartheta_m)_{egy}} \quad ;$$

Ellenáramú: $$A_{ell} = \frac{\dot{Q}}{k \cdot (\Delta\vartheta_m)_{ell}} \quad .$$