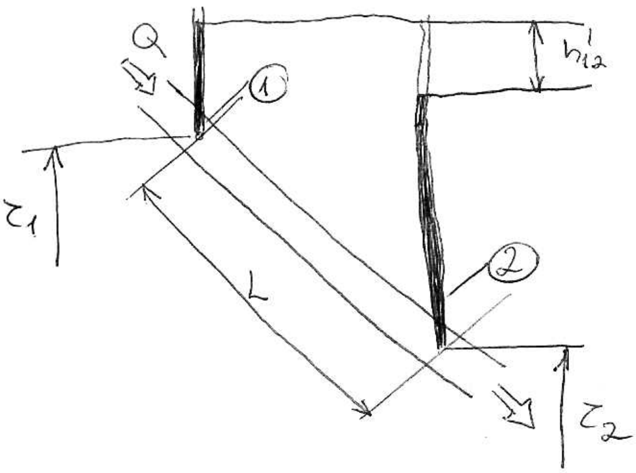
Műszaki áramlástan 10.27.

Nyitott felszínű (permanens, egyenletes)



$\dot{V} = Q \quad \left[\frac{m^3}{s}\right]$

$h'_{12} = \lambda \cdot \frac{L}{D} \frac{c^2}{2g}$

$r_H = \frac{A}{K} \qquad h'_{12} = \lambda \frac{L}{4 r_H} \frac{c^2}{2g}$

$$\frac{p_1}{\rho g} + \frac{c_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{c_2^2}{2g} + z_2 + h'_{12}$$

$c_1 = c_2 = c$

$$\frac{p_1}{\rho g} + z_1 = \frac{p_2}{\rho g} + z_2 + h'_{12} \qquad \underbrace{h'_{12} = \frac{p_1 - p_2}{\rho g} + z_1 - z_2}$$

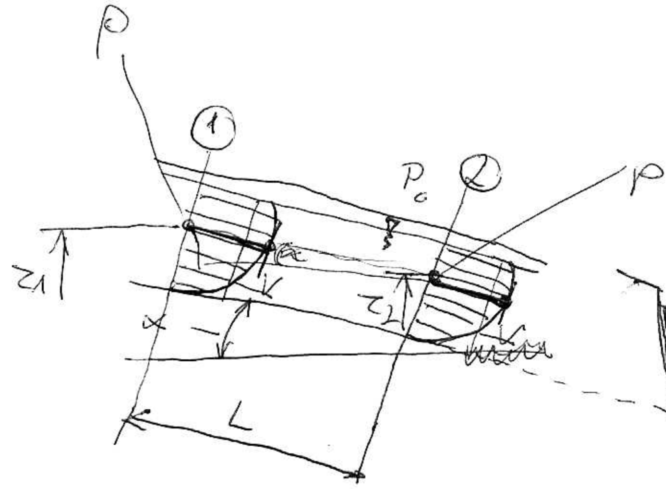
zárt csővezetékben

esés

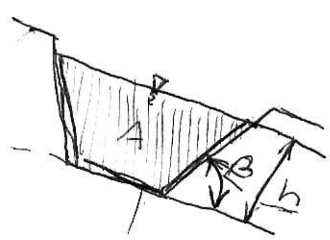
$$J = \frac{p_1 - p_2}{\rho g L} + \frac{z_1 - z_2}{L} \longrightarrow h'_{12} = J \cdot L$$

$c = \frac{Q}{A} \longrightarrow v$

fenyelmű



$$r_H = \frac{A}{K}$$



hedvesített terület $\equiv K$

$$\frac{p_1}{\rho g} + \frac{v^2}{2g} + z_1 = \frac{p}{\rho g} + \frac{v^2}{2g} + z_2 = h'_{12}$$

$$h'_{12} = z_1 - z_2 \longrightarrow h'_{12} = \lambda \frac{L}{4 r_H} \frac{v^2}{2g}$$

$$JL = \lambda \frac{L}{4 r_H} \frac{v^2}{2g}$$

neh. gy.

$$\boxed{v = \sqrt{\frac{8g}{\lambda}} \sqrt{r_H} \sqrt{J}}$$

cső hidraulikai sugara

csősurlódási tényező

$$\frac{z_1 - z_2}{L} = J = \sin\alpha$$

Chézy

Chézy képlet

$Q = A \cdot v$

$\lambda = 0{,}03$

$g = 9{,}81 \, m/s^2$

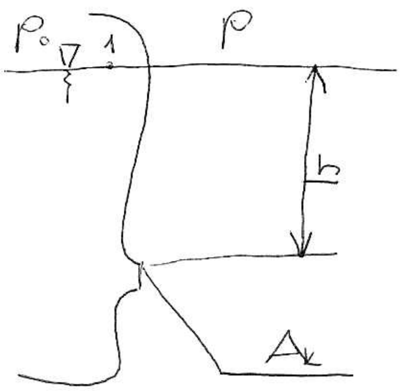
$v = 51 \cdot \sqrt{r_H} \sqrt{I}$

$\underline{v} = k_{CH} \cdot \underline{r_H^{1/2}} \, \underline{I^{1/2}}$

Manning-Strickler

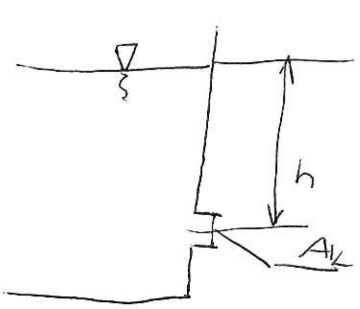
$v = \underline{k_{MS}} \cdot r_H^{2/3} \, I^{1/2}$

Kifolyás tartályból



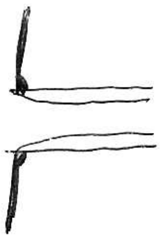
$$\frac{p_0}{\rho g} + h = \frac{p}{\rho g} + \frac{v^2}{2g}$$

$$v = \sqrt{\frac{2(p_0 - p)}{\rho} + 2gh}$$

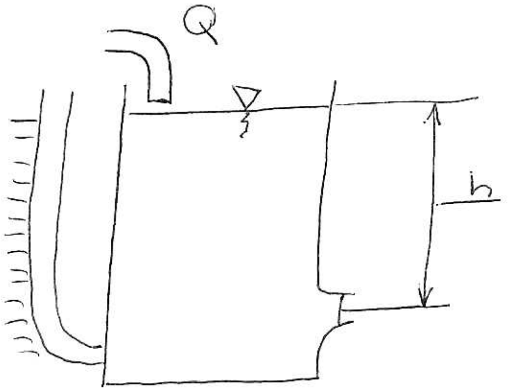


$v = \sqrt{2gh}$

$Q_e = v A_k$

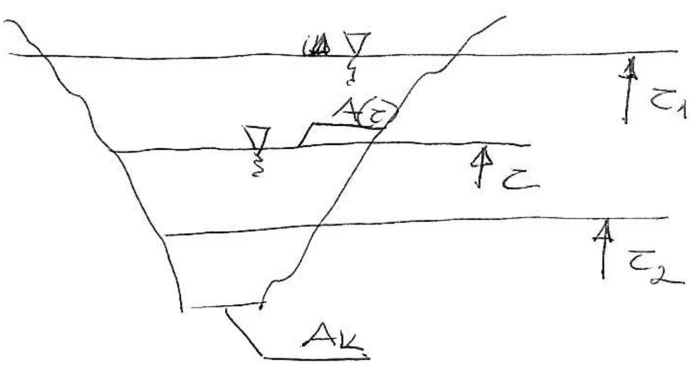


$$Q = \mu A_k \sqrt{2gh}$$



Danaida

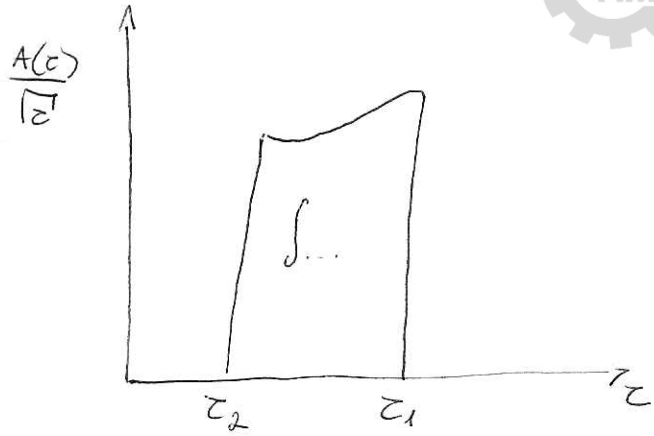
Kifolyási idő meghatározása

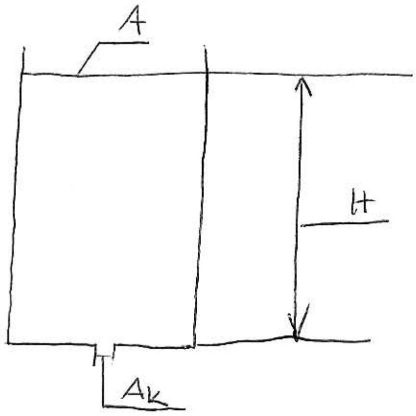


$$-\frac{dz}{dt} \cdot A(z) = \mu A_k \sqrt{2gz}$$

$$dt = -\frac{1}{\mu A_k \sqrt{2g}} \cdot \frac{A(z)}{\sqrt{z}}\, dz$$

$$t_{12} = \frac{1}{\mu A_k \sqrt{2g}} \int_{z_2}^{z_1} \frac{A(z)}{\sqrt{z}}\, dz$$



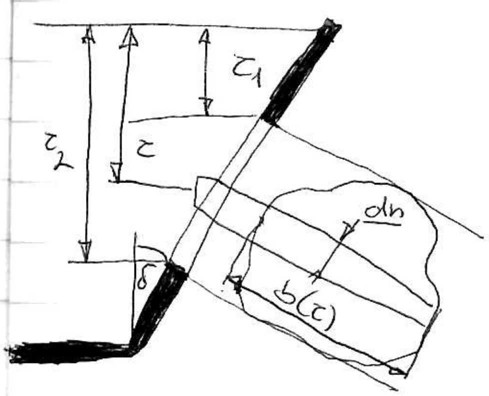


$$\underset{\text{kiürülési idő}}{t_{ü}} = \frac{A}{\mu A_k \sqrt{2g}} \int_0^H \frac{dz}{\sqrt{z}} =$$

$$= \frac{A\, 2\sqrt{H}}{\mu A_k \sqrt{2g}}$$

$$\boxed{t_{ü} = \frac{A}{\mu A_k} \cdot \sqrt{\frac{2H}{g}}}$$

Kifolyás tartályból nagy keresztmetszetű nyíláson

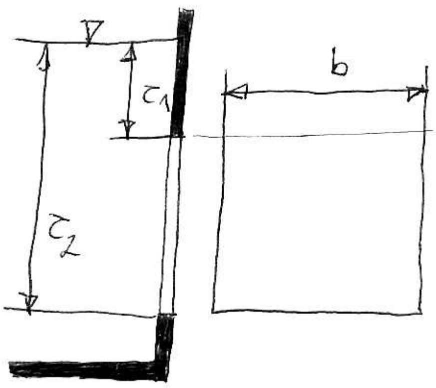


$$\frac{dz}{dn} = \cos\delta$$

$$dQ_e = \sqrt{2gz}\; b(z) \cdot \frac{dz}{\cos\delta}$$

$$Q_e = \frac{\sqrt{2g}}{\cos\delta} \int_{\tau_1}^{\tau_2} b(\tau)\sqrt{\tau}\, d\tau$$

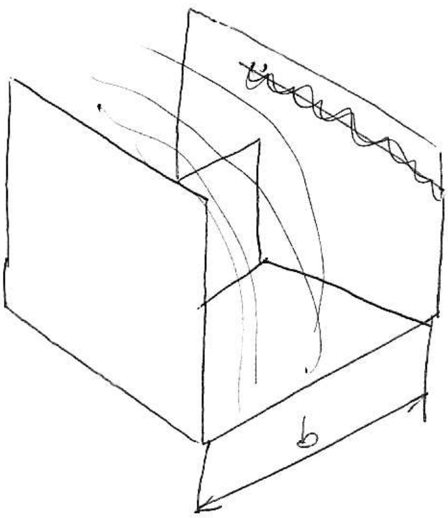
$$Q = \mu \frac{\sqrt{2g}}{\cos\delta} \int_{\tau_1}^{\tau_2} b(\tau)\sqrt{\tau}\, d\tau$$

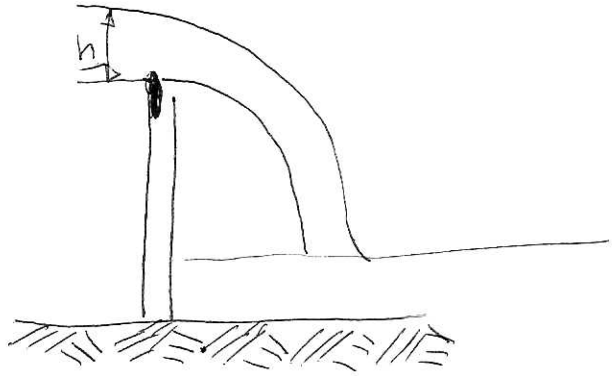


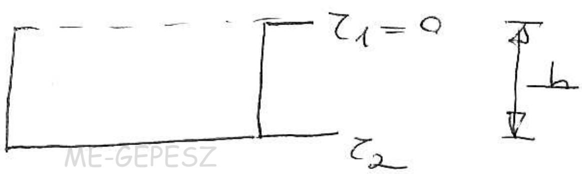
$$Q = \mu\sqrt{2g}\cdot b \int_{\tau_1}^{\tau_2} \sqrt{\tau}\, d\tau$$

$$Q = \mu\sqrt{2g}\cdot b\cdot \frac{2}{3}\left(\tau_2^{\frac{3}{2}} - \tau_1^{\frac{3}{2}}\right)$$

Bukógát (mérőbukó)

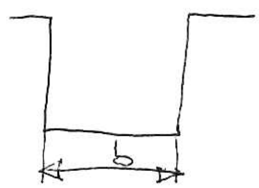


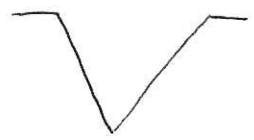




$$\boxed{Q = \frac{2}{3}\mu b\sqrt{2g}\,h^{\frac{3}{2}}}$$

$\mu \rightarrow$ adott szabályos érték



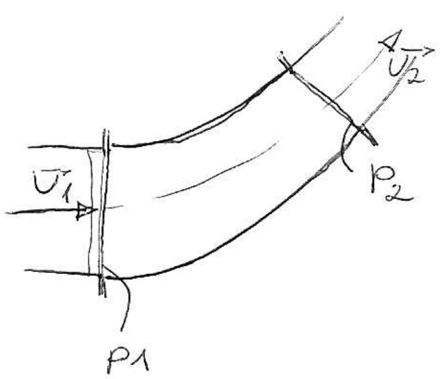


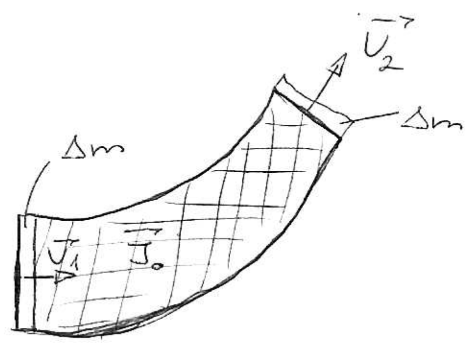
Thomson-bukó

Impulzus-tétel

$$\frac{d(m\vec{v})}{dt} = \vec{F}$$

áramcső
stacionárius áramlás
egydimenziós



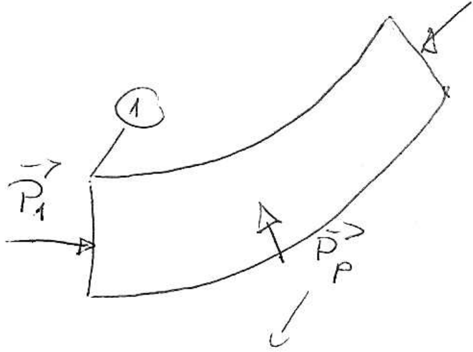


$t = 0$
$t = \Delta t$

$$\frac{(\vec{J}_0 + \Delta m\vec{v}_2) - (\vec{J}_0 + \Delta m\vec{v}_1)}{\Delta t} = \vec{F}$$

$$\frac{\Delta m}{\Delta \tau} = \dot{m}$$

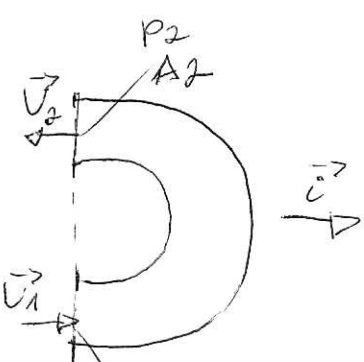
$$\boxed{\dot{m}(\vec{v}_2 - \vec{v}_1) = \vec{F}}$$



$$\dot{m}(\vec{v}_2 - \vec{v}_1) = \vec{P}_1 + \vec{P}_2 + \vec{P}_p + \vec{F}_g$$

$$\vec{R} = -\vec{P}_p - \vec{P}_1 + \vec{P}_2 + \vec{F}_g + \dot{m}\vec{v}_1 - \dot{m}\vec{v}_2$$

~~[illegible]~~



$$\vec{R} = \overset{p_1 - p_0}{p_1} \cdot A_1 \cdot \vec{i} + \overset{p_2 - p_0}{p_2} \cdot A_2 \cdot \vec{i} + \rho v_1^2 A_1 \cdot \vec{i} + \rho v_2^2 \cdot A_2 \cdot \vec{i} + G\vec{z}$$

(z vektor merőleges a talajra)

3. ábra: A szélturbina (szélkerék) elmélete.

$$\rho c_0 A_B = \rho c_m A_L \overset{\nearrow}{} = \rho c_k A_k$$

az a felület, amit a járókerék súrol

$$c_1 = c_2 = c_m$$

J: járókerék

$$\vec{0} = (p_1 - p_2) A_L \cdot \vec{i} + \vec{P}_J$$

$$\vec{F} = -\vec{P}_J = (p_1 - p_2) A_L \cdot \vec{i}$$

szél seb-e

$$\frac{p_0}{\rho} + \frac{c_0^2}{2} = \frac{p_1}{\rho} + \frac{c_m^2}{2}$$

$$\frac{p_0}{\rho} + \frac{c_k^2}{2} = \frac{p_2}{\rho} + \frac{c_m^2}{2}$$

$$p_1 - p_2 = \frac{\rho}{2}(c_0^2 - c_k^2)$$

$$\vec{F} = \frac{\rho}{2}(c_0^2 - c_k^2) A_L \cdot \vec{i}$$

$$\rho c_m A_L (c_k - c_0) \vec{i} = \vec{P}_J$$

$$\vec{F} = -\vec{P}_J = \rho c_m A_L (c_0 - c_k) \vec{i}$$

$$\cancel{\rho} c_m A_L (c_0 - c_k) = \frac{\cancel{\rho}}{2} A_L (c_0 - c_k)(c_0 + c_k)$$

$$\boxed{c_m = \frac{c_0 + c_k}{2}}$$

A szélturbina teljesítménye (elvehető telj.)

$$P_e = \dot{m}\,\frac{p_1 - p_2}{\rho} = \rho\, c_m A_L \cdot \frac{c_0^2 - c_k^2}{2} = \frac{\rho}{2} A_L \frac{c_0 + c_k}{2} \left(c_0^2 - c_k^2\right) =$$

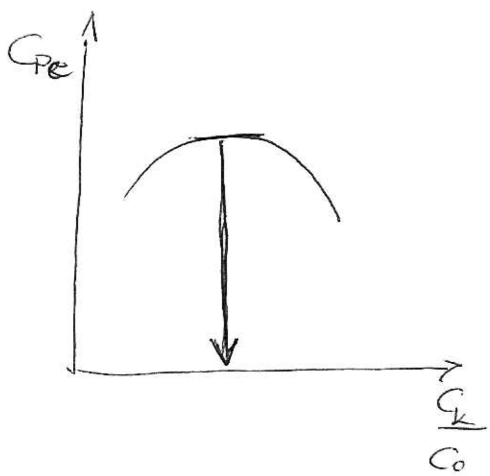
$$= \underbrace{\frac{\rho}{2} \cdot c_0^3 \cdot A_L}_{P_0} \underbrace{\frac{1}{2}\left(1 + \frac{c_k}{c_0}\right)\left(1 - \frac{c_k^2}{c_0^2}\right)}_{c_{Pe}}$$

$$P_0 = \frac{c_0^2}{2} \cdot \rho\, c_0\, A_L = \frac{\rho}{2} c_0^3 \cdot A_L \rightarrow \frac{P_0}{A_L}$$

$$c_{Pe} = \frac{P_e}{P_0}$$

$$c_P = \frac{P}{P_0}$$ → szélturbinából ténylegesen elvehető

$$y = \frac{1}{2}(1+x)(1-x^2)$$



$$\frac{c_k}{c_0} = \frac{1}{3}$$

$$(c_{Pe})_{max} = \frac{16}{27}$$

Betz