Drugi kolokvijum iz Mehanike fluida

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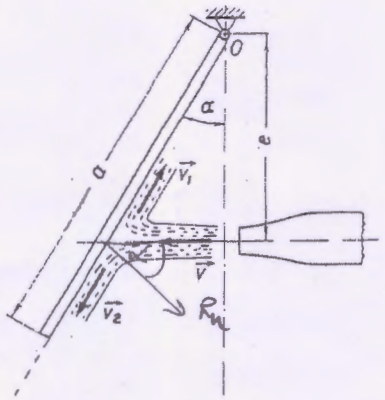
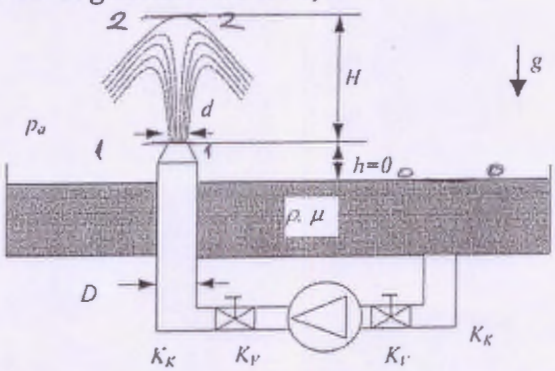
1. **(11p)** U kvadratnu ploču dužine a = 1 m i težine G = 294.19 N obješenu o oslonac O, udara mlaz vode brzinom v = 12 m/s na rastojanju l=0.6 m ispod oslonca. Odrediti:
   a) Protok vode koji je potreban da ploču održava u položaju nagnutom prema vertikali za ugao $\alpha = 30°$.
   b) Veličinu i pravac otpora oslonca u tom položaju.



2. **(9p)** Odrediti radnu tačku pumpe (protok i napor pumpe) da bi visina mlaza vode bila H = 3.4 m. Dužina cjevovoda je L = 7.2 m, D = 0.3 m, d =0.1 m, λ = 0.014. Lokalni gubici iznose 15 % gubitaka na trenje.



3. **(15p)** Prečnik d kapljice u spreju zavisi od prečnika D i brzine mlaza, takođe zavisi od gustine, koeficijenta dinamičke viskoznosti i koeficijenta površinskog napona. Koliki je odnos prečnika dvije slične kapljice u dvije slične pojave, jednom sa vodom gustine ρ_1 = 1000 kg/m^3, $\mu_1 = 10^3$ Pa·s, $\sigma_1 = 7.28 \cdot 10^{-2}$ N/m^2, a drugi put sa benzinom gustine ρ_2 = 881 kg/m^3, $\mu_2 = 6.51 \cdot 10^{-4}$ Pa·s, $\sigma_2 = 2.88 \cdot 10^{-2}$ N/m^2.

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①

$$\frac{\partial}{\partial t}\int_{V_K} \rho \vec{v}\, dV + \int_{A_K} \rho \vec{v}\,(\vec{v}\, d\vec{A}) = \Sigma F$$

$$-\rho \vec{v}_0 Q_0 + \rho \vec{v}_1 Q_1 + \rho \vec{v}_2 Q_2 = \vec{P}_0 + \vec{P}_1 + \vec{P}_2 + \vec{G} + \vec{F}_{KF}$$

$$\vec{F}_{KF} = -\vec{F}_{FK}$$

$$\vec{F}_R = \vec{F}_{FK} + \vec{F}_{sb}$$

a) $F_R = \rho \vec{v}_0 Q_0 - \rho \vec{v}_1 Q_1 - \rho \vec{v}_2 Q_2$ – не фигурирају, јер нема утицај сама а управо за њу

$$R_N = \rho \cdot v_0 \cdot Q_0 \cdot \cos\alpha$$

$$\Sigma M_0 = 0 \Rightarrow R_N \cdot \frac{l}{\cos\alpha} = G \cdot \frac{a}{2} \cdot \sin\alpha$$

$$\rho \cdot v_0 \cdot Q_0 \cdot \cos\alpha \cdot \frac{l}{\cos\alpha} = G \cdot \frac{a}{2} \cdot \sin\alpha$$

$$Q_0 = \frac{G \cdot a \cdot \sin\alpha}{2 \rho v_0 l} = 0{,}0102 \ m^3/s$$

б)

$$F_{Rx} = R_N \cdot \cos\alpha = \rho \cdot v_0 \cdot Q_0 \cdot \cos^2\alpha = 91{,}8 \ N$$

$$F_{Ry} = G - R_N \sin\alpha = 241{,}189 \ N$$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} = \underline{258{,}068 \ N}$$

② $Q = ?$ $H_p = ?$

$H = 3.4\,м$; $L = 7.2\,м$; $D = 0.3\,м$; $d = 0,1\,м$; $\lambda = 0,04$.

Б.Э. 0-0 1-1

$$\frac{p_0}{\rho} + \frac{v_0^2}{2} + gz_0 + gH_p = \frac{p_1}{\rho} + \frac{v_1^2}{2} + gz_1 + gh_w$$

$p_0 = p_1 = p_б$

$v_0 \approx 0$ $\Rightarrow$ $gH_p = \frac{v_1^2}{2} + gh_w$

$z_1 - z_0 = 0$

$$H_p = \frac{v_1^2}{2g} + h_w$$

g $gH_p = \frac{v_1^2}{2} + \left(1{,}15 \cdot \lambda \cdot \frac{L}{D} \cdot \frac{v^2}{2}\right)$

Б.С. 1-1 2-2.

$$\frac{p_1}{\rho} + \frac{v_1^2}{2} + gz_1 = \frac{p_2}{\rho} + \frac{v_2^2}{2} + gz_2$$

$v_1 = \sqrt{2 \cdot g \cdot H} = \underline{8,16\,м/с}$

Ур.К. $v_1 \cdot A_1 = v \cdot A$

$v = v_1 \cdot \frac{A_1}{A}$

$v = 8,16 \cdot \frac{d_1^2}{D^2} = 0,906\,м/с$

$H_p = \frac{v_1^2}{2g} + h_w = 3,416\,м$

$Q = v_1 \cdot \frac{d_1^2 \pi}{4} = 0,064\,м^3/с$.

③ $f(d, D, v, \rho, \mu, \sigma)$

$\frac{d_1}{d_2} = 0$ ($\rho_1 = 1000\ kg/m^3$, $\mu_1 = 10^3 Pa \cdot s$, $\sigma_1 = 7.28 \cdot 10^{-2}\ N/m^2$

$\rho_2 = 881\ kg/m^3$, $\mu_2 = 6.51 \cdot 10^{-4} Pa \cdot s$, $\sigma_2 = 2.88 \cdot 10^{-2}$

масса: ρ
время: v
длина: D

$d = \rho^x v^y D^z$

$L = M^x L^{-3x} L^y T^{-y} L^z$.

$d(m) = L$

$D(m) = L$

$v(m/s) = L \cdot T^{-1}$

$\rho(kg/m^3) = M \cdot L^{-3}$

$0 = x$

$1 = -3x + y + z \Rightarrow z = 1$

$0 = y$

$\mu = \rho v$

$\mu = \frac{kg}{m^3} \cdot \frac{m^2}{s} = \frac{kg}{ms} = M \cdot L^{-1} \cdot T^{-1}$

$d = D$

$\boxed{\Pi_1 = \frac{d}{D}}$

$\sigma(N/m^2)$ $\frac{kg \cdot m}{m^2 s^2} = \frac{kg}{ms^2} = M L^{-1} T^{-2}$

$\mu = \rho^x v^y D^z$

$M L^{-1} T^{-1} = M^x L^{-3x} L^y T^{-y} L^z$

$1 = x$

$-1 = -3x + y + z \Rightarrow z = 1$

$-1 = -y \Rightarrow y = 1$.

$\boxed{\Pi_2 = \frac{\mu}{\rho v D}}$

$\sigma = \rho^x v^y D^z$

$M \cdot L^{-1} T^{-2} = M^x L^{-3x} L^y T^{-y} L^z$

$1 = x$

$-1 = -3x + y + z \Rightarrow z = -1 + 3 - 2 = 0$

$-2 = -y \Rightarrow y = 2$.

$\sigma = \rho v^2 \Rightarrow \boxed{\Pi_3 = \frac{\sigma}{\rho v^2}}$

$f(\Pi_1, \Pi_2, \Pi_3) = 0$

$\Pi_1 = f(\Pi_2, \Pi_3)$

$\boxed{d = D \cdot f\left(\frac{\mu}{\rho v D}, \frac{\sigma}{\rho v^2}\right)}$.

$Re_1 = Re_2$ $\qquad \mu = \rho \cdot \nu \Rightarrow \nu = \frac{\mu}{\rho}$

$$\frac{\nu_1 \cdot D_1}{\nu_1} = \frac{\nu_2 \cdot D_2}{\nu_2}$$

$$\frac{\nu_1 \cdot D_1 \rho_1}{\mu_1} = \frac{\nu_2 \cdot D_2 \cdot \rho_2}{\mu_2} \Rightarrow \frac{D_1}{D_2} = \frac{\nu_2}{\nu_1} \cdot \frac{\rho_2}{\rho_1} \cdot \frac{\mu_1}{\mu_2}$$

$Fe_1 = F_{R2}$

$$\frac{\nu_1^2}{D_1 \cdot g} = \frac{\nu_2^2}{D_2 \cdot g} \Rightarrow \frac{\nu_2}{\nu_1} = \sqrt{\frac{D_2}{D_1}}$$

$$\frac{D_1}{D_2} = \sqrt{\frac{D_2}{D_1}} \cdot \frac{\rho_2}{\rho_1} \cdot \frac{\mu_1}{\mu_2}$$

$$\frac{D^3}{D_2^3} = \frac{\rho_2}{\rho_1} \cdot \frac{\mu_1}{\mu_2} \Rightarrow \frac{D_1}{D_2} = \sqrt[3]{\left(\frac{\rho_2}{\rho_1}\right)^2 \cdot \left(\frac{\mu_1}{\mu_2}\right)^2}$$