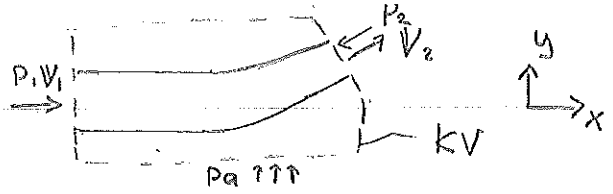


MTF052 Strömn. mek 2015-01-05

3.40 stationärt 1-dim

$\sum F = (\dot{m}V)_{ut} - (\dot{m}V)_{in}$

räkna med övertryck $p_1^{\ddot{o}} = p_1 - p_a = 50 kPa$

$\hat{x}$: $p_1^{\ddot{o}} A_1 - p_2^{\ddot{o}} A_2 \cos 30^\circ + F_x = \dot{m}(u_2 \cos 30^\circ - u_1)$ (1)

$\hat{y}$: $-p_2^{\ddot{o}} A_2 \sin 30^\circ + F_y = \dot{m} u_2 \sin 30^\circ - 0$ (2)

$u_1 = \frac{\dot{m}}{\rho \frac{\pi D_1^2}{4}} = 0,78 \, m/s$ (4)

$u_2 = \frac{\dot{m}}{\rho \frac{\pi D_2^2}{4}} = 2,39 m/s$ (5)

$F_x = \dot{m}(u_2 \cos 30^\circ - u_1) - p_1^{\ddot{o}} A_1 + p_2^{\ddot{o}} A_2 \cos 30^\circ$ (6)

$F_y = \dot{m} u_2 \sin 30^\circ + p_2^{\ddot{o}} A_2 \sin 30^\circ$ (7)

bernoulli: $p_1^{\ddot{o}} + \frac{\rho u_1^2}{2} = p_2^{\ddot{o}} + \frac{\rho u_2^2}{2}$

$p_2^{\ddot{o}} = p_1^{\ddot{o}} + \frac{\rho}{2}(u_1^2 - u_2^2)$ (8)

sätt in (8) i (6) & (7)

$F_x = \dot{m}(u_2 \cos 30^\circ - u_1) - p_1^{\ddot{o}} A_1 + \left(p_1^{\ddot{o}} + \frac{\rho}{2}(u_1^2 - u_2^2)\right) A_2 \cos 30^\circ =$

$= -137 N$ $\quad F_{F_x} = 137 N$

$F_y = \dot{m} u_2 \sin 30^\circ + \left(p_1^{\ddot{o}} + \frac{\rho}{2}(u_1^2 - u_2^2)\right) A_2 \sin 30^\circ =$

$= 33,4 N$ $\quad F_{F_y} = -33,4 N$

Svar: $(137, -33,4)$ N

$d = 40$ mm $\quad m = 2,7$ g $\quad D_0 = 0,2$ m $\quad U_0 = 20$ m/s $\quad \rho = 1,189$ kg/m³ $\quad \theta = 5^\circ$ $\quad \nu = 15,2 \cdot 10^{-6}$ m²/s

$F_D = F_g \Rightarrow c_D \frac{\rho U^2}{2} \cdot \frac{\pi d^2}{4} = mg$ (1)

KE: $U_2 A_2 = U_0 A_0 \Rightarrow U_2 = \frac{U_0 A_0}{A_2} = U_0 \frac{D_0^2}{D_2^2}$ (2)

$\Delta r = z \tan\theta \Rightarrow D_2 = D_0 + \Delta D = D_0 + 2\Delta r = D_0 + 2z\tan\theta$ (3)

Antag $c_D = 0,5$, $U = U_0$ $\Rightarrow$ $F_D = 0,5 \cdot \frac{1,189}{2} \cdot 20^2 \cdot \pi \cdot \frac{0,040^2}{4} = 0,1149 N > F_g$ $\quad F_g = 0,00027 \cdot 9,81 = 0,026 N$

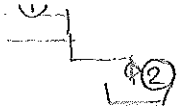
$U = 8,3$ m/s $\Rightarrow F_D = 0,026$ N, balans

$\Rightarrow Re = \frac{8,3 \cdot 0,04}{15,2 \cdot 10^{-6}} = 21842$ $\Rightarrow c_D$ OK enl Fig 5.3 eller Fig 7.16b i White

(2) $\Rightarrow D_2 = \sqrt{\frac{U_0}{U_2}} D_0 = \sqrt{\frac{20}{8,3}} \cdot 0,2 = 0,310$ m

(3) $\Rightarrow z = \frac{D_2 - D_0}{2\tan\theta} = \frac{0,310 - 0,2}{2\tan 5^\circ} = 0,631$ m $\quad$ Svar: 0,63 m

5.68b $w_s = 0$



$$p_1 + \rho g z_1 + \frac{1}{2}\rho V_1^2 = p_2 + \rho g z_2 + \frac{1}{2}\rho V_2^2 + \Delta p_F$$

$p_1 = p_2 = p_{atm}$ $V_1 = 0$

$$\frac{1}{2}\rho V_2^2 + \Delta p_F = \rho g (z_1 - z_2) \quad (1)$$

(6.100b)

$$\Delta p_F = f\frac{\rho V^2}{2}\frac{\Delta L}{D} + (K_1 + K_2 + K_3)\frac{\rho V^2}{2} \quad (2)$$

(2) i (1) $\Rightarrow$

$$\frac{1}{2}\rho V_2^2 + f\frac{\rho V_2^2}{2}\frac{\Delta L}{D} + (K_1 + K_2 + K_3)\frac{\rho V_2^2}{2} = \rho g (z_1 - z_2)$$

$$\frac{1}{2}\rho V_2^2 \left(1 + f\frac{\Delta L}{D} + \underbrace{\frac{K_1 + K_2 + K_3}{2{,}46}}\right) = \rho g \underbrace{(z_1 - z_2)}_{h + L_1 + L_3 = 4}$$

$$V_2 = \sqrt{\frac{8g}{3{,}46 + f\frac{\Delta L}{D}}} \quad (3)$$

f fås ur Moodydiag. $\frac{\varepsilon}{d} = 0{,}002$

$\nu = 10^{-6}$

gissa $V_2 = 1\,m/s \Rightarrow Re = 100000 \Rightarrow$

$f = 0{,}0255$ (3) $\Rightarrow V_2 = 3{,}97\,m/s$

gissa $V_2 = 3{,}92 \Rightarrow Re = 397000$

$\Leftrightarrow f = 0{,}024$ (3) $\Rightarrow V_2 = 4{,}0\,m/s$ OK

$$Q = V_2 \cdot A = V_2 \frac{\pi D^2}{4} = 3{,}14 \cdot 10^{-2}\,m^3/s$$

$$t = \frac{Vol}{Q} = \frac{1}{3{,}14 \cdot 10^{-2}} = \underline{32\,s}$$

Svar: 32 s

$P = 1\,bar$

$T = 20°C$

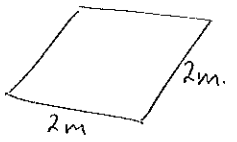
U 3 m/s

$A = 4\,m^2$

Luft $\begin{cases} \mu = 18{,}1 \cdot 10^{-6}\ Ns/m \\ \rho = 1{,}189\ kg/m^3 \end{cases}$

Vatten $\begin{cases} \mu = 1005 \cdot 10^{-6}\ Ns/m \\ \rho = 998\ kg/m^3 \end{cases}$

$\Rightarrow$



$$D = 120\,N$$

Dragkraften

Luft.: $D = 2 \cdot \frac{1}{2} C_D \rho U^2 b \cdot L$

$Re_L = \frac{\rho U L}{\mu} = 394 \cdot 10^3$ $\therefore$ Lam.

(7.27) $C_D = \frac{1{,}328}{Re_L^{1/2}} = 0{,}00211$

$$D = 90{,}5 \cdot 10^{-3}\,N$$

Vatten:

$Re_L = \frac{\rho U L}{\mu} = 5{,}96 \cdot 10^6$ $\therefore$ Turb

7.45) $C_D = \frac{0{,}031}{Re_L^{1/7}} = \underline{0{,}00334}$

Hastighet.

Luft: $y = 0{,}5\,mm$ $x = 2\,m$.

$$y \cdot \left(\frac{U}{\nu x}\right)^{1/2} = 0{,}144$$

Interpolering $\Rightarrow$ $u/U = 0{,}048$

$$u = 0{,}143\ m/s$$

Vatten:

(7.44) $\tau_w = \frac{0{,}0135\,\mu^{1/7}\rho^{6/7}U^{13/7}}{L^{1/7}}$

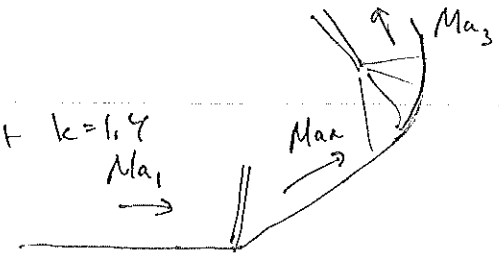
$= 13{,}06\,Pa$

$u^* = \sqrt{\frac{\tau_w}{\rho}} = 114{,}4 \cdot 10^{-3}\,m/s$

$y^+ = \frac{y u^* \rho}{\mu} = 56{,}8 \Rightarrow$ log-lag

$\frac{u}{u^*} = 2{,}44 \ln y^+ + 5 \Rightarrow \underline{u = 1{,}7\,m/s}$

P2



Sned stöt med $\beta = 40°$

$Ma_1 = 3$

$Ma_{1n} = Ma_1 \cdot \sin\beta = \ldots = 1,92836$

Räkna över stöt

7.83f)

$$Ma_{2n}^2 = \frac{(k-1)\,Ma_{1n}^2 + 2}{2k\,Ma_{1n}^2 - (k-1)} = 0,3483$$

$$\Rightarrow Ma_{2n} = 0,5901$$

(9.86) $\Rightarrow \tan\Theta = f(\beta, Ma_1)$

$\Rightarrow \Theta = 21,8461$

$$Ma_2 = \frac{Ma_{2n}}{\sin(\beta - \Theta)} = 1,893953$$

Efter stöten komprimeras luften när väggen med en Ma-fana till $Ma_3 = 1$

Läs av

$\omega(Ma_2)$ i tabell B5

$\Rightarrow \omega(Ma_2) = 23,417$

Eftersom $\omega(Ma=1) = 0$ så blir vinkeln

$\Delta\omega = 0 - 23,417 \approx -23,4°$