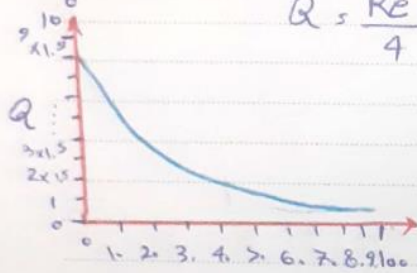


2-7) در آندوسیمان راجب با $D = 30 \text{ mm}$ جریان آرام ($\theta: 0-100$)

15 شعبان 1444

8 March 2023

$$Q = \frac{Re}{4} D \nu \pi = 0.003 \times \pi \times \nu \times \frac{2100}{4} \Rightarrow Q = 49.5 \nu$$



7-5) $v = 2.5 \text{ cm/s}$ $D = 5 \text{ cm}$ $\frac{\Delta P}{L} = ?$ $\nu = 10^{-6} \text{ m}^2/\text{s}$ $\rho = 1000 \text{ kg/m}^3$

$$Re = \frac{\rho v D}{\mu} = \frac{D v}{\nu} = \frac{5 \times 10^{-2} \times 2.5 \times 10^{-2}}{10^{-6}} = 1250 \rightarrow \text{جریان آرام}$$

$$\Delta P = \frac{32 \mu L v}{D^2} \Rightarrow \frac{32 \times \frac{10^{-6}}{1000} \times 2.5 \times 10^{-2}}{(5 \times 10^{-2})^2} = \underline{\underline{1.32}} \quad \text{گزیته}$$

7-9) $D = 60 \text{ cm}$ $l = 15$ $\Delta P = 70 \text{ Kpa}$

$$\Delta P = \frac{4 l}{D} \gamma_0 \rightarrow 70 \times 10^3 \text{ pa} = \frac{4 \times 15 \text{ m}}{60 \times 10^{-2} \text{ m}} \times \gamma_0 \rightarrow \gamma_0 = 700 \text{ pa} \rightarrow \text{گزیته}$$

7-13) $D = 2.54 \text{ mm}$ $Re = 1500$ $l = 6$ $h_l = 1.95 \text{ m}$

$$f = \frac{64}{Re} = 0.043 \quad h_f = f \frac{l}{D} \times \frac{v^2}{2g} \rightarrow v = \sqrt{\frac{h_f \times D \times 2g}{f l}} = \sqrt{\frac{1.95 \times 2.54 \times 10^{-3} \times 2 \times 9.81}{0.043 \times 6}}$$

$$= 0.613 \text{ m/s}$$

7-17) $\bar{v} = 1,2$ $D = 2\text{mm}$ $\mu = 1,307 \times 10^{-3} \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ $\rho = 999,7$ $\nu = 15$

$\Delta p?$ $h_f?$ $\dot{W}?$ $Re = \frac{\rho \bar{v} D}{\mu} = \frac{999,7 \times 1,2 \times 2 \times 10^{-3}}{1,307 \times 10^{-3}} = 1839,72 \rightarrow$ جریان آرام

$\Delta p = \frac{32 \mu \bar{v} L}{D^2} = \frac{32 \times 1,307 \times 10^{-3} \times 15 \times 1,2}{(2 \times 10^{-3})^2} = 1882,8 \text{ Pa} \approx 19,0 \text{ kPa}$

$h_f = \frac{\Delta p}{\gamma} = 19,37 \text{ m}$

$\dot{W}_{\text{shaft}} = \gamma Q h_f = \Delta p Q = 19,0 \times 10^3 \times 1,2 \times (\pi \times 10^{-6}) = 0,716$

$\Delta p = 0$ در $D = 0,1 \text{ mm}$ و $\nu = 1409$ در برابری لایق با اندازه Δz تغییر ارتفاع Δz در صورت تغییر ثابت ν و ρ و μ است. سؤال ۲۲

$Re \ll 1 \Rightarrow \frac{\rho \bar{v} D}{\mu} \ll 1 \Rightarrow \bar{v} = \frac{\nu (999 \text{ kg/m}^3) (0,1 \text{ m})}{(1,12 \times 10^{-3} \text{ Pa}\cdot\text{s})} \ll 1$

از جدول ثابت	}	$\mu = 1,12 \times 10^{-3}$	}	$\rho = 999 \text{ kg/m}^3$	}	$\nu = 1409$	}	$\gamma = 9,8 \text{ kN/m}^3$	}	$\Delta p = 0$	}	$\bar{v} = 0,1 \text{ m/s}$	}	$\Delta z = 0,1 \text{ m}$	}	$\Delta z = 0,1 \text{ m}$								

$\Rightarrow -1,49 \Delta z \ll 0,1 \text{ m} \rightarrow \Delta z = 0,1 \text{ m} = 100 \text{ mm}$

$\Delta z = 0,1 \text{ mm}$

7-25) $D = 40 \text{ mm}$ $U = 0.4 \text{ m/s}$ $T = 20^\circ\text{C}$ $\rho = 1260 \text{ kg/m}^3$

$Re = \frac{\rho U D}{\mu} = \frac{1260 \times 0.4 \times 0.04 \times 10^{-3}}{1.52} = 13.26 \rightarrow$ جریان آرام $\mu = 1.52 \text{ poise}$

$v = \frac{v_c}{2} \rightarrow v_c = 0.8$ $\tau = -\mu \frac{dv}{dr} = -\mu \frac{d}{dr} \left(\frac{v_c}{2} \left(1 - \left(\frac{2r}{D} \right)^2 \right) \right) = \frac{2\mu v_c}{D^2} r$

$\tau_{r=0} = 0$

$\tau_{r=r_0} = 120 \text{ pa}$

$\Delta p - \gamma \Delta z = \frac{32\mu L v}{D^2} \rightarrow \frac{\Delta p}{L} - \gamma \frac{\Delta z}{L} = \frac{\gamma 32 v}{9 D^2}$

$\frac{\Delta p}{L} = - (1260 \times 9.81) + \frac{32 \times 1.52 \times 0.4}{(0.04)^2} \rightarrow \frac{\Delta p}{L} = -361 \text{ pa}$

$\Delta p = P_1 - P_2 \rightarrow P_2 > P_1 \rightarrow$ سائزگی در جهت جریان

$P_2 + \gamma_{oil} (z_2 + \alpha) - \gamma_{hg} \alpha - \gamma_{oil} z_1 = P_1$: 19-1

$\frac{P_1 - P_2}{\gamma_{oil}} - \Delta z = \frac{\Delta p}{\gamma_{oil}} - \Delta z = hf = \alpha \left[\frac{\gamma_{hg} - \gamma_{oil}}{\gamma_{oil}} \right]$

$hf = \alpha \left[\frac{SG_{hg} - SG_{oil}}{SG_{oil}} \right] = (0.1) \left[\frac{13.6 - 0.8}{0.8} \right] = 1.59 \text{ m}$

$hf = \frac{f L v^2}{D 2g} = 1.59 \rightarrow f = \frac{(1.59) (0.05)^2 (9.81)}{10 (1.2)} = 0.108$ ✓

$f = \frac{64}{Re} \rightarrow Re = \frac{64}{f} = \frac{64}{0.108} \rightarrow Re = 592 < 2100$

$hf = \frac{32\mu L v}{\gamma D^2}$, $\mu = \frac{\gamma D^2 hf}{32 L v} = \frac{(0.8)(9810)(0.05)^2 (1.59)}{32(10)(1.2)}$

$\mu = 0.0812 \text{ Pa.s}$ ✓

$$\frac{P_r}{y} + \frac{v_r^r}{k_g} + r_r = \frac{P_r}{y} + \frac{v_r^r}{k_g} + z_r + h_p$$

$$h_p + h_f + h_m = \left(\left(f \frac{L}{D} + \sum_{i=1}^r k_{mi} \right) \frac{v_r^r}{k_g} \right) \Rightarrow \frac{1.01 \times 10^6 \cdot 20}{.94 \times 9.81} + 0 + 0 = \frac{1.2 \times 10^5}{.94 \times 9.81} + .1124 \int \frac{v_r^r}{k_{mi} \cdot 10^{-2} + 1} dx \quad 18$$

$$\frac{v_r^r}{k_g} + \left(f + \sum_{i=1}^r k_{mi} \right) \frac{v_r^r}{k_g} \Rightarrow \frac{.1124}{v} + \frac{.1124 \cdot 10^6 \cdot v^2}{.94 \times 10^6 \times 9.81} \Rightarrow v = 1.11 \quad 21$$

$$I_s \frac{Q_F}{Re} = \frac{.45 \times 9.81 \times 10^{-2}}{.94 \times 10^6 \times v \times 10^{-2}} = \frac{.1124}{v} \quad Q_s \cdot A \cdot v = 1.11 \times \frac{\pi}{4} \times (20 \times 10^{-2})^2 \cdot v = 0.35 \times 10^{-1} \times v$$

Re, Pr, D, EVF => EVF < Pr - $\int \frac{v_r^r}{k_g} dx$ PASARGAD

7-39) $v = 1 \cdot 10^{-5} \text{ m}^2/\text{s}$ $Q = 140 \text{ l/s}$ $l = 2 \text{ m}$ $D = 20 \text{ mm}$
 $h_f = ?$ $Re = \frac{Dv}{\nu} = \frac{2 \cdot 10^{-3} \times 140 \times 10^{-3}}{1 \cdot 10^{-5} \times (\pi \times 10^{-3})^2 \times \pi} = 8,9 \times 10^4 = 89000 \rightarrow$ میران آسفته

$$f = 0,316 \times (89000)^{-0,25} = 3,17$$

$$\Delta p = f \frac{\rho l}{D} \cdot \frac{v^2}{2} = 3,17 \times \frac{2000}{2 \cdot 10^{-3}} \times \frac{((140 \times 10^{-3})^2)}{\pi^2 \times (10^{-3})^2} = 31.714$$

$$h_L = \frac{\Delta p}{\gamma} = \frac{31.714}{9810} = 3,232$$

7-46) $P_1 + \gamma_w h_1 + \gamma g a - \gamma_w a - \gamma_w h_1 = P_2 \rightarrow \Delta P = (\gamma g - \gamma_w) a$

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 + h_p = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_L \rightarrow \frac{\Delta P}{\gamma} + h_p = 0$$

$$\frac{\Delta P}{\gamma_w} = \frac{(\gamma g - \gamma_w) a}{\gamma_w} \rightarrow (S_g - 1) a = (13,6 - 1) a \rightarrow h_p = 12,6 a$$

$$\frac{P_A}{\gamma} + \frac{v_A^2}{2g} + z_A + h_p = \frac{P_B}{\gamma} + \frac{v_B^2}{2g} + z_B + h_f$$

$$h_p = 12,6 a = h_f = \frac{8 f l Q^2}{g \pi^2 D^5} \rightarrow a = \frac{8 a^2}{g \pi^2 D^4}$$

7-51) $Q_2 = 2Q_1$

$w_p \quad f = 0.2$

$w = \gamma Q h_p$

$$\frac{P_1^0}{\gamma} + z_1 + \frac{v_1^2}{2g} + h_p = \frac{P_2^0}{\gamma} + z_2 + h_L + \frac{v_2^2}{2g}$$

$$1.5 + \frac{v_1^2}{2g} = 0.2 \times \frac{6000}{0.1} \times \frac{v_2^2}{2g} + \frac{v_2^2}{2g}$$

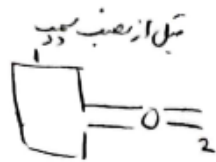
$$1.5 = (12 + 1) \frac{v_2^2}{2g} \rightarrow v_2 = 1.5$$

$$v_2 = 2 \times 1.5 = 3$$

$$\frac{P_1^0}{\gamma} + z_1 + \frac{v_1^2}{2g} + h_p = \frac{P_2^0}{\gamma} + z_2 + \frac{v_2^2}{2g} + h_L$$

$$1.5 + h_p = \frac{3^2}{2 \times 9.8} + 0.2 \times \frac{6000}{0.1} \times \frac{9}{2 \times 9.8} \rightarrow h_p = 4.5$$

$$w = 10000 \times 3 \times \pi \times (0.1)^2 \times 4.5 = \underline{\underline{4200}}$$



سوال از نصب در

7-57)

$$\frac{P_A}{\gamma} + \frac{v_A^2}{2g} + z_A = \frac{P_C}{\gamma} + \frac{v_C^2}{2g} + z_C + h_f$$

$$0 + 0 + z_A = \frac{P_C}{\gamma} + \frac{v_C^2}{2g} + z_C + f \frac{l}{D} \frac{v_C^2}{2g}$$

$$0 - (3) - \left(1 + 0.2 \frac{100}{0.12}\right) \cdot \frac{2.8}{2 \times 9.8} = \frac{P_C}{\gamma} = -7.4$$

$$7-70) \frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_f + h_m$$

$$0 + 0 + z_1 = 0 + \frac{v^2}{2g} + 0 + f \frac{L}{D} \left[K_m \frac{v^2}{2g} \right]$$

$$1) 5 = \left(1 + f \frac{1.5}{2.12} + 1.5 + 2 \times 1.5 \right) \times \frac{v^2}{2g} \rightarrow v = \sqrt{\frac{78.1}{4.5 + 6.0 \cdot f}} = 2.16$$

$$\left\{ \frac{e}{D} = 0.0075 \quad Re = 4.6 \times 10^4 \right.$$

$$2) v = 2.9 \rightarrow Re = 3.7 \times 10^4 \quad 3) \rightarrow v = 2.8 \checkmark \rightarrow h = \frac{v^2}{2g} = 0.22$$

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_f \quad (77-7)$$

$$0 + 0 + 8 = 0 + 0 + 0 + f \frac{3500 (0.28)^2}{12.1} \cdot \frac{f}{D^5} = 0.353$$

$$f = 0.02 \text{ (assumed)}$$

$$\frac{0.02}{D^5} = 0.353 \quad , \quad D = 0.563 \text{ m} \quad v = \frac{Q}{A} = \frac{0.28}{\pi (0.563)^2 / 4} = 1.12 \text{ m/s} \checkmark$$

$$\left\{ \frac{e}{D} = \frac{0.26}{563} = 0.00046 \right.$$

$$\left. Re = \frac{\gamma D}{\mu} = \frac{1.12 (0.563)}{1.12 \times 10^{-6}} = 5.6 \times 10^5 \rightarrow f = 0.0175 \checkmark \right.$$

$$\frac{0.0175}{D^5} = 0.353 \quad , \quad D = 0.548 \text{ m} \quad , \quad v = \frac{Q}{A} = \frac{0.28}{\frac{\pi}{4} (0.548)^2} = 1.19 \text{ m/s}$$

$$\left\{ \frac{e}{D} = \frac{0.26}{548} = 0.00047 \right.$$

$$\left. Re = \frac{1.19 \times 0.563}{1.12 \times 10^{-6}} = 5.8 \times 10^5 \rightarrow f = 0.0175 \right.$$

550 mm \rightarrow $D = 0.548 \text{ m}$

$$\sum m \vec{V} = \sum \vec{F} ; 0 = P_1 A_1 + F - W_W - W_{D,P_2} \quad (82-7)$$

توازن در جهت افقی

$$F = 0 ; W_W = \gamma A l ; W_{D,P_2} = 4 N/m$$

$$P_1 \left[\frac{\pi (0.12)^2}{4} \right] + 0 - \gamma \left[\frac{\pi (0.12)^2}{4} \right] l - 4l = 0 ; P_1 = \gamma l + 353.$$

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_f$$

$$\frac{P_1}{\gamma} + \frac{v^2}{2g} + 0 = 0 + \frac{v^2}{2g} + l + \frac{f l v^2}{D 2g}$$

$$\gamma l + 353.7l = \gamma l + \frac{f l \rho v^2}{D 2} ; 353.7l = \frac{f l}{0.120} \frac{1000 v^2}{2}$$

$$v = \sqrt{\frac{0.8489}{f}}$$

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Date:

$$f = 0.02 ; \text{ عدد فریتو } \frac{v}{v_c}$$

$$\frac{v = \sqrt{\frac{0.8489}{0.02}} = 2.06 \frac{m}{s}}{f = 0.025} \left\{ \begin{array}{l} \frac{v}{D} = \frac{0.26}{120} = 0.002 \\ Re = \frac{\gamma D}{\mu} = \frac{2.06 \times 0.12}{1.12 \times 10^{-6}} = 2.2 \times 10^5 \end{array} \right.$$

$$\frac{v = \sqrt{\frac{0.08489}{0.02}} = 1.84 \frac{m}{s}}{f = 0.024} \quad Re = \frac{1.88 \times 0.12}{1.12 \times 10^{-6}} = 2 \times 10^5$$

$f = 0.024$ ✓ $\text{ عدد فریتو } \frac{v}{v_c} = 1.84 \frac{m}{s}$

$$Q_D = Q_1 + Q_2 + Q_3 = n Q_d \quad \left. \begin{array}{l} v_D \left(\frac{n}{2} D^r \right) = n v_{d1} \left(\frac{n}{2} d^r \right) \\ h_{d1} = h_{d2} \end{array} \right\} \Rightarrow f = \frac{2 v_D^r}{D^{2g}} = f \frac{d}{d} \frac{v_d^r}{2g}$$

(v-18) 9

$$\left\{ \begin{array}{l} v_D D^r = n v_{d1} d^r \\ v_{d1} = \left(\frac{d}{D} \right)^{1/2} v_D \end{array} \right. \Rightarrow v_D D^r = n \left(\left(\frac{d}{D} \right)^{1/2} v_D \right) d^r \quad D^{3/2} \cdot n d^{1/2} \Rightarrow d = \frac{D}{n^{2/3}}$$

12

استدلال مناس 1-95-7

$$\begin{aligned} & \rightarrow h_1 = h_2 = h_3 \\ & \left. \begin{array}{l} l_1 = 2l_2 \\ l_3 = 4l_2 \end{array} \right\} \\ & \text{میل } \rightarrow d_1 = d_2 = d_3, f_1 = f_2 = f_3 \\ & \left\{ \begin{array}{l} h_1 = f_1 \frac{l_1}{d_1} \frac{v_1^3}{2g} \\ h_2 = f_2 \frac{l_2}{d_2} \frac{v_2^3}{2g} \end{array} \right. \Rightarrow f_1 \frac{2l_2}{d_1} \frac{v_1^3}{2g} = f_2 \frac{l_2}{d_2} \frac{v_2^3}{2g} \Rightarrow v_1^3 = 2 v_2^3 \Rightarrow \underline{v_1 = \sqrt[3]{2} v_2} \\ & \left\{ \begin{array}{l} h_1 = f_1 \frac{l_1}{d_1} \frac{v_1^3}{2g} \\ h_3 = f_3 \frac{l_3}{d_3} \frac{v_3^3}{2g} \end{array} \right. \Rightarrow f_1 \frac{2l_2}{d_1} \frac{v_1^3}{2g} = f_3 \frac{4l_2}{d_3} \frac{v_3^3}{2g} \Rightarrow v_1^3 = 4 v_3^3 \Rightarrow \underline{v_1 = \sqrt[3]{4} v_3} \\ & \rightarrow \underline{v_1 = \sqrt{2} v_2 = 2 v_3} \quad \checkmark \end{aligned}$$

	Year:	Month:	Day:
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$$Q = C_v Q_{ideal} = C_v A_T \sqrt{\frac{\gamma (P_1 - P_2)}{\gamma (1 - \beta^4)}} \quad : v-b1$$

$$\Delta T = \frac{\rho g}{\gamma} d^r = \gamma \Delta h = \gamma h = 1000 \times 9.81 \times 0.15 = 1471.5 \text{ Pa}$$

$$\rightarrow \beta = 0.15$$

$$Q = \gamma \Delta h \times \frac{1}{\gamma} \times \frac{1}{\sqrt{1 - \beta^4}} \times \frac{\sqrt{\gamma \Delta h \times \gamma}}{\sqrt{1 - \beta^4}} = 0.14715 \frac{\text{m}^3}{\text{s}}$$