$$Re = \frac{2{,}5 \times 10^{-2} \times 10^{-2} \times 5}{10^{-6}} = 1250 \rightarrow \text{laminar} < 2100$$

$$\Delta P = \frac{32 \mu L V}{D^2} = \frac{32 \times 10^{-6} \times 1 \times 2{,}5 \times 10^{-2}}{25 \times 10^{-4}} = 0{,}32 \text{ Pa} \checkmark$$

(5)

Exercise 2 (5)

$$0{,}025 = \frac{3{,}14 \times 10^{-2} V_c}{8} \rightarrow V_c = 6{,}36$$

$$\hookrightarrow Q = \frac{\pi D^2 V_c}{8}$$

$$6{,}36 \left[1 - \left(\frac{3}{5}\right)^2\right] = 4{,}1 \checkmark$$

$$V_c = \left[1 - \left(\frac{r}{R}\right)^2\right]$$

(3)

Exercise 2 (11)

$P_2 + \gamma_o (z_2 + x) - \gamma_{hg}\, x - \gamma_{oil}\, z_1 = P_1$ $\quad \frac{\Delta P}{\gamma_{oil}} - \Delta z = h_f =$ (29)

(30)

$h_f = x \left(\frac{SG_{hg} - SG_{oil}}{SG_{oil}} \right) = oil \left\{ \frac{13,6 - 0,8}{0,8} \right\}$ $\quad x \left(\frac{\gamma_{hg} - \gamma_{oil}}{\gamma_{oil}} \right)$

$h_f = 1,59 m$ ✓ $\quad h_f = f \frac{l}{D} \frac{V^2}{2g} = 1,59 \rightarrow 1,59 = f \times \frac{0,05}{10} \times \frac{2 \times 9.81}{(1,2)^2} = f = 0,108$

$f = \frac{64}{Re}$ $\quad Re = \frac{64}{0,108} = 592 < 2100 \rightarrow$ laminar (5)

$h_f = \frac{32 \mu l V}{\gamma D^2} \rightarrow \mu = \frac{0,8 \times 9810 \times (0,05)^2 \times 1,59}{32 \times 10 \times 1,2} = 0,0812 \; Pa.s$ ✓

$\tau_0 = \frac{\rho f V^2}{8} = \frac{1,2 \times 0,02 \times 10}{8} = 0,3 Pa$ (5)

1 نقطة (40)

$\frac{P_A}{\gamma} + \alpha_A \frac{V_A^2}{2g} + z_A + h_p = \frac{P_B}{\gamma} + \alpha_B \frac{V_B^2}{2g} + z_B + h_L$ (47)

$h_p = h_p - \frac{P_A}{\gamma} \rightarrow 0,02 \times \frac{2000}{0,4} \times \frac{1,59}{2 \times 10} - \frac{50000}{10^4} + 25 = 32,64$

(5)

$P = \gamma Q h_p = 10 \times 0,2 \times 32,64 = 65,28 \; kw$

: V-VII السؤال

$$\frac{P_1}{\gamma}+\frac{v_1^2}{2g}+z_1+hp=\frac{P_3}{\gamma}+\frac{v_3^2}{2g}+z_3+h_4 \rightarrow P/\gamma+\frac{v^2}{2g}+0+hp=\frac{P}{\gamma}+\frac{v^2}{2g}$$

$$+0.8+h_4 \rightarrow hp=0.8+h_4=0.8+\left(f\frac{l}{D}+\cancel{4}\right)\frac{v^2}{2g} \rightarrow \frac{\Sigma}{D}=\frac{(0.03)}{20}=0.0015 \quad (5)$$

$$f=0.0265 \rightarrow Re=\frac{vD}{\mu}=\frac{(0.955)(0.02)}{5.47\times10^{-7}}=3.5\times10^4 \rightarrow hp=0.8+\left[0.0265\times\frac{2}{0.02}+19(0.32)\right]$$

$$\times\frac{(0.955)^2}{2\times9.81} \rightarrow \boxed{hp=2.31m} \rightarrow wp=\gamma Q hp=(9810)\times3\times10^{-4}\times2.3=\boxed{6.8w}$$

: V-VI السؤال

$$\frac{P_1}{\gamma}+\frac{v_1^2}{2g}+z_1=\frac{P_2}{\gamma}+\frac{v_2^2}{2g}+z_2+hf+hm \rightarrow 0+0+z_1=0+0+0+$$

$$\left(f\frac{l}{D}+\sum_{i=1}^{4}km\right)\frac{v^2}{2g} \rightarrow R=\left\{f\frac{(14)}{0.1}+(0.5+2(1.5)+0.15+1)\right\}\frac{v^2}{2\times9.81} \rightarrow v=\sqrt{\frac{39.24}{140f+4.65}}$$

$$v=\sqrt{\frac{39.24}{140(0.02)+4.65}}=2.3 \rightarrow \begin{cases}\frac{\Sigma}{D}=\frac{0.045}{20}=0.00045 \rightarrow f=0.0185\\ Re=\frac{vD}{\mu}=\frac{2.3\times0.1}{1.12\times10^{-6}}=2.1\times10^5\end{cases} \quad (5)$$

$$v=\sqrt{\frac{39.24}{140(0.0185+4.65}}=2.33 \rightarrow Re=\frac{2.33\times0.1}{1.12\times10^{-6}}=2.1\times10^5 \quad f=0.0184$$

$$v=\frac{2.33}{2}=1.17 \quad Re=\frac{vD}{\mu}=\frac{1.17\times0.1}{1.12\times10^{-6}}=1.1\times10^5 \quad f=0.02$$

$$2=\left\{0.02\times\frac{14}{0.1}+\left[0.5+2(1.5)+k_{mv}+1\right]\right\}\frac{(1.17)^2}{2(9.81)} \rightarrow k_{mv}=21.4$$

سوال V-100 :

$$Q = C Q_{ideal} = C \sqrt{\frac{2(P_1 - P_2)}{\rho(1-\beta^4)}} = 0.98 \times \frac{\pi}{4} \times 0.3^2 \sqrt{\frac{2 \times 5 \times 10^3}{10^3 \left(1 - \frac{3}{5}\right)}}$$

$$Q = 2.348 \frac{l}{s} \longrightarrow v = \frac{Q}{A} \longrightarrow \frac{2.348 \times 10^{-3}}{\frac{\pi}{4}(0.015)^2} = 1.2 \frac{m}{s}$$

(5)

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_f$$

۷-۱۷

$$0 + 0 + 18 = 0 + 0 + 0 + f \frac{2500}{D^5} \frac{(0.128)^2}{19.6} \longrightarrow \frac{f}{D^5} = 0.2532$$

$f = 0.02 \longrightarrow D = 0.254$, $V = \frac{Q}{A} = \frac{0.128}{\pi (0.254)^2 / 4} = 2.52 \, m/s$ (5)

$\varepsilon/D = \frac{1.52}{0.254} = 0.0064$

$Re = \frac{VD}{\nu} = \frac{2.52 \times 0.254}{1.12 \times 10^{-6}} = 5.71 \times 10^5 \longrightarrow f = 0.018 \longrightarrow D = 0.258$ $V = \frac{Q}{A} = \frac{0.128}{\frac{\pi}{4} \times (0.258)^2} = 2.45$

$\varepsilon/D = \frac{0.15}{258} = 0.00058 \longrightarrow f = 0.018$

$Re = \frac{2.45 \times 0.254}{1.12 \times 10^{-6}} = 5.56 \times 10^5$

$h_{L_D} = h_{L_{d_1}} + h_{L_{d_2}}$; $\frac{8 f L Q^2}{g \pi^2 D^5} = \frac{8 f L_1 Q^2}{g \pi^2 d_1^5} + \frac{8 f L_2 Q^2}{g \pi^2 d_2^5}$ $\frac{L}{D^5} = \frac{L_1}{d_1^5} + \frac{L}{d_2^5}$ ۷-۹

$L = D^5 \left(\frac{L_1}{d_1^5} + \frac{L}{d_2^5} \right)$ (5)

(۷_۵۵

سرعت دوم لوله با قطر ۰.۳ $= V_2 = Q/A_2 = \frac{2\times10^{-4}}{\frac{\pi}{4}(0.03)^2} \simeq 0.2833 \frac{m}{s}$

عدد سرعت اول $= \frac{V_2^2}{2g} = 4.082\times10^{-7}\ m$

معادله انرژی بین ۲ سطح $h = \frac{V_2^2}{2g} + \underbrace{h_f}_{\text{افت هد فیلتر}} \rightarrow h_f = 0.11 - 4.082\times10^{-7} \simeq 0.11\ m$

ضریب افت فیلتر $K = \frac{h_f}{\frac{V_2^2}{2g}} = \frac{0.11}{4.082\times10^{-7}} = 2.695\times10^{5}$

۷-۹۸) گزینه ۳) انتظار داریم دبی شیر متعلق به این لوله است. $AC < AB$ قطر

$Q_{AB} > Q_{AC}$ ⟶ جهت جریان $B \to C$

$Q_{AB} + Q_{AC} = 1$ ، $Q_{AB} - Q_{BC} = 0.1$ ، $Q_{AC} + Q_{BC} = 0.1$

رابطه افت هد $\Delta H_{T(AC)} = \Delta H_{T_{AB}} + \Delta H_{BC}$

رابطه دارسی ⟶ $\frac{f L Q^2_{AC}}{12.1 D^5_{AC}} = \frac{f_1 Q^2_{AB}}{12.1 D^5_{AB}} + \frac{f_2 L Q^2_{BC}}{12.1 D^5_{BC}} \longrightarrow \frac{Q^2_{AC}}{D^5_{AC}} = \frac{Q^2_{BC}}{D^5_{BC}} + \frac{Q^2_{AB}}{D^5_{AB}}$

$\longrightarrow \frac{(0.1 - Q_{BC})^2}{D^5} = \frac{(0.1 + Q_{BC})^2}{(3D)^5} + \frac{Q^2_{BC}}{(2D)^5} \longrightarrow Q_{BC} \approx 0.141 \frac{m^3}{s}$

پس فرض ما درست که جهت جریان از B به C است.

7 - 22)

$$\frac{P_1}{\gamma_1} + z_1 + \frac{V_1^2}{2g} = z_2 + \frac{P_2}{\gamma_2} + \frac{V_2^2}{2g} + h_f$$

$$\Rightarrow z_1 - z_2 = \Delta z = h_f$$

جریان آرام: $f = 64/Re$

$$Re \leq 2000 \longrightarrow V_{max} = \frac{2000 \times 10^{-6}}{0.05} = 0.04 \ m/s$$

$$f = \frac{64}{2000} = 0.032$$

$$\Rightarrow \Delta z = f \frac{l}{D} \frac{V^2}{2g} = 0.032 \frac{160}{0.05} \frac{0.04^2}{2 \times 9.81} = 0.0084 \ m$$

$$\boxed{\Delta z = 8.4 \ cm}$$