

$$\text{چون } \rightarrow Re = \frac{4Q}{\pi D v} < 2100 \Rightarrow \frac{4 \times Q}{3.14 \times 0.2 \times 10^{-3}} < 2100 \quad 7-7$$

$$\rightarrow Q < 0.3 \frac{m^3}{s} \Rightarrow \text{نرمند}$$

7-5

$$D = 0.05 m \quad v = 2.5 \frac{m}{s} \Rightarrow Re = \frac{vD}{\nu} = \frac{(2.5 \frac{m}{s})(0.05 m) \times 10^{-2}}{10^{-6}} = 1250$$

$$\Rightarrow \Delta P = \frac{32 \mu L v}{D^2} = \frac{32 [1000 \times 10^{-6}] 1 \times 0.025}{(0.05)^2} = 0.32 Pa$$

7-8

$$z = \frac{2z_0}{D} v \quad \text{در مرکز لوله برابر صفر است و به طور خطی با افزایش شعاع، افزایش می‌یابد. طبق فرمول زیرا ۲ فاصله از خط مرکزی بود است.$$

7-12

$$\frac{\Delta P}{L} = -K, \quad Q_1 = Q_2 \Rightarrow Q_1 = \frac{\pi D^4}{128 \mu L} \times \Delta P \Rightarrow \frac{\Delta P_1}{\mu_1} = \frac{\Delta P_2}{\mu_2}$$

$$\Rightarrow \Delta P_2 = \frac{\mu_2}{\mu_1} \Delta P_1 = 3.8 \times \Delta P \xrightarrow{\Delta L} \frac{\Delta P}{\Delta L} = 3.8 \times -K \Rightarrow \text{نرمند}$$

7-17

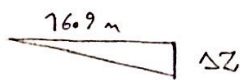
$$Re = \frac{\rho v D}{\mu} = \frac{(999.7 \text{ kg/m}^3)(1.2 \text{ m/s})(0.002 \text{ m})}{[1.307 \times 10^{-3} \text{ kg/m.s}]} = 1836 < 2100$$

$$\Delta P = \frac{32 \mu L v}{D^2} = \frac{32 [1.307 \times 10^{-3} \text{ kg/m.s}](15 \text{ m})(1.2 \text{ m/s})}{(0.002 \text{ m})^2} = 1882.8 Pa$$

$$h_L = \frac{\Delta P}{\rho g} = \frac{(1882.8 Pa)}{(999.7 \text{ kg/m}^3)(9.81 \text{ m/s}^2)} = 19.79 \text{ m}$$

$$\dot{W}_P = \rho g Q h_L = (999.7)(9.81) \left[(1.2) \frac{\pi}{4} (0.002)^2 \right] (19.79) = 0.71 \text{ W}$$

$$D = 0.05 \text{ m}$$



$$Re = 2000$$

7-22

$$Re = \frac{vD}{\nu} \Rightarrow 2000 = \frac{v \times 0.05}{10^{-6}} \rightarrow v = 0.04 \frac{\text{m}}{\text{s}^2}$$

$$v = \frac{(\Delta p - \gamma \sin \theta) D^2}{32 \mu l} \Rightarrow 0.04 = \frac{(9810 \times \Delta z) \times (0.05)^2}{32 \times 10^{-3} \times \sqrt{\Delta z^2 + 16.9^2}} \Rightarrow \Delta z = 88.18 \text{ mm}$$

$$u(r) = \frac{\gamma \omega D}{4\mu} \left[1 - \left(\frac{r}{R} \right)^2 \right] \Rightarrow \mu_{\text{max}} = \frac{\gamma R^2 \sin \theta}{4\mu}$$

7-24

$$P_2 + \gamma_{\text{oil}} (Z_2 + m) - \gamma_{\text{hg}} m - \gamma_{\text{oil}} Z_1 = P_1 \quad ; \quad \frac{P_1 - P_2}{\gamma_{\text{oil}}} - \Delta z = h_f = m \left(\frac{\gamma_{\text{hg}} - \gamma_{\text{oil}}}{\gamma_{\text{oil}}} \right) \quad \text{7-29}$$

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

$$h_f = f \frac{l}{D} \frac{v^2}{2g} = 1.59 \text{ m} \Rightarrow f = (1.59 \text{ m}) \left(\frac{0.05 \text{ m}}{10 \text{ m}} \right) \frac{2(0.04 \text{ m/s})^2}{(1.2 \text{ m/s})^2} = 0.108$$

$$f = \frac{64}{Re} \rightarrow Re = 522 < 2100 \rightarrow \text{Laminar}$$

$$\mu_f = \frac{32 \mu l v}{\gamma D^2} \rightarrow \mu = \frac{[0.8 \times 9810] \times 0.05 \text{ m} \times 1.59}{32 (10) (1.2 \text{ m/s})} = 0.0812 \text{ Pa}\cdot\text{s}$$

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + Z_2 + h_L \rightarrow \frac{101330 \text{ Pa}}{(0.96)(9810)} + \dots = \frac{1.2 \times 10^4 \text{ Pa}}{(0.96)(9810)} + 0 + 0.12 \text{ m} + \dots \quad \text{7-32}$$

$$\left[f \frac{0.1 \text{ m}}{0.00025} + 0.8 + 1 \right] \frac{v^2}{2(9.81 \text{ m/s}^2)} \rightarrow (f + 0.0045) v^2 = 0.459$$

$$\text{Cip} \rightarrow f = \frac{64}{Re} = \frac{64 \mu}{\rho v D} = \frac{64 (0.2 \times 10^{-4} \text{ Pa}\cdot\text{s})}{0.96 \times 1000 \times v \times 0.00025} = \frac{0.245}{v}$$

$$\Rightarrow v^2 + 54.44 v - 1.02 = 0; \quad v = 1.81 \text{ m/s} \rightarrow Q = vA = 1.81 \times \frac{\pi}{4} \times (0.00025)^2 = 8.89 \times 10^{-8} \text{ m}^3/\text{s}$$

$$\rightarrow Re = \frac{\rho v D}{\mu} = 472 < 2100 \rightarrow \text{Laminar}$$