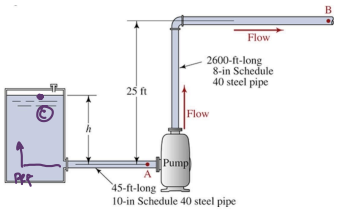
Hw 2.2

terça-feira, 8 de outubro de 2024 17:30

8.33



$T = 60°F$

$Q = 1500 gal/min = 3.342 ft^3/s$

find: h, when $P_A = 5 psig$

if $P_A = 5$ psig and $P_B = 8.5$ psig

$$h_A + \frac{P_c}{\gamma} + \frac{V_c^2}{2g} + h = \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A + h_c$$

$$h = \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + h_c$$

$$V_1 = Q/A = 3.342/0.5479 = 6.10 \frac{ft}{s}$$

$D = 0.8350$

$$Re = \frac{VD}{\nu} = \frac{(2.34 \times 10^{-5})(0.8350)}{(1.21 \times 10^{-5})} = 1.614$$

$$\frac{D}{\varepsilon} = \frac{0.8350}{1.5 \times 10^{-4}} = 5566.6$$

$$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(D/\varepsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2$$

$$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(5566.6)} + \frac{5.74}{1.614^{0.9}}\right)\right]^2 = 0.764$$

$$h_L = 0.764 \times \frac{45}{0.835} \times \frac{6.10^2}{2(32.2)} = 23.79$$

$$h = \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + h_c \rightarrow \text{if } P_A = 5 psig = 720 lb/ft^2$$

$$h = \frac{720}{62.4} + \frac{6.10^2}{2(32.2)} + 23.79 = 35.9$$

$$h_A + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L_1} + h_{L_2}$$

$$V_2 = Q/A_2 = 3.342/0.3472 = 9.63 ft/s$$

$D = 0.6651$

$Re = \frac{VD}{\nu} = \frac{(2.34 \times 10^{-5})(0.6651)}{(1.21 \times 10^{-5})} = 1.286$

$\frac{D}{\varepsilon} = \frac{0.6651}{1.5 \times 10^{-4}} = 4434$

$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(D/\varepsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2$

$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(4434)} + \frac{5.74}{1.286^{0.9}}\right)\right]^2 = 0.504$

$h_{L_2} = 0.504 \times \frac{2600}{0.6651} \times \frac{9.63}{2(32.2)} = 294.62$

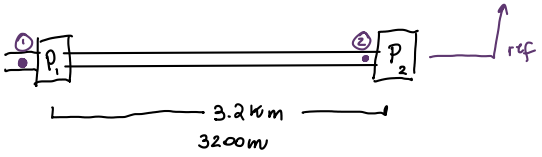
$h_A + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L_1} + h_{L_2}$

$h_A + \frac{720}{62.4} + \frac{6.1^2}{2(32.2)} + 0 = \frac{1224}{62.4} + \frac{9.63}{2(32.2)} + 25 + 23.79 + 294.62$

$h_A = 351.06$

$P = \gamma Q h_A = 32.4 \times 3.342 \times 351.06 = 38013.05$

8.38



$Sg = 0.93$

$Q = 1200\ L/min = 0.02\ m^3/s$

DN 150 schedule 80 steel pipe – $D = 0.146$, $A = 0.0168$

$T = 100°C$

$\rho = 0.93 \times 1000 = 930$

$\mu = 0.1$

$V = Q/A = 0.02/0.0168 = 1.19\ m/s$

$Re = \frac{\rho V D}{\mu} = \frac{930 \times 1.19 \times 0.146}{0.1} = 1615.78$ ⊗ < 2100

$f = 64/1615.76 = 0.03961$

$$h_L = 0.03961 \times \frac{3200}{0.146} \times \frac{1.19^2}{2 \times 9.81} = 62.66$$

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

@ we will assume there is no pump loss

$$P_1 - P_2 = \gamma \left[\frac{V_2^2}{2g} - \frac{V_1^2}{2g} + h_L \right]$$

@ since Q and A are the same

$$P_1 - P_2 = \gamma h_L = 9.12 \times 62.66 = 571.66$$

$$\gamma = 0.93 \times 9.81 = 9.12$$

if viscosity is lower the pump will have to do less work to move the fluid

$$h_L = f \times \frac{L}{D} \times \frac{v^2}{2g}$$

$$Re = \frac{\rho v D}{\mu} = \frac{930 \times 1.19 \cdot 0.146}{8 \times 10^{-3}} = 20197.27$$

$$\frac{D}{\varepsilon} = \frac{0.146}{4.6 \times 10^{-5}} = 3173.91$$

$$f = 0.25 \Big/ \left[\log \left(\frac{1}{3.7 (D/\varepsilon)} + \frac{5.74}{Re^{0.9}} \right) \right]^2$$

$$f = 0.25 \Big/ \left[\log \left(\frac{1}{37(3173.91)} + \frac{5.74}{20197.27^{0.9}} \right) \right]^2$$

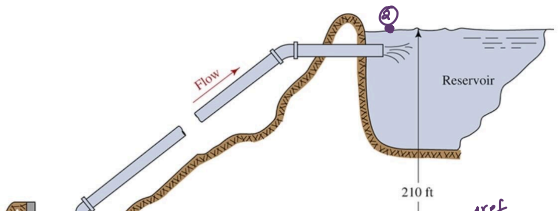
$$f = 0.026$$

$$h_L = 0.026 \times \frac{L}{0.146} \times \frac{1.19^2}{2 \times 9.81}$$

$$62.66 = 0.026 \times \frac{L}{0.146} \times \frac{1.19^2}{2 \times 9.81}$$

$$L = 4875 \text{ m} \quad \text{or} \quad 4.875 \text{ Km}$$

8.44



$T = 60°F$

$D = 0.6651$

$A = 0.3472$

$L = 2500$

$Q = 4\ ft^3/s$

$$V = \frac{Q}{A} = \frac{4}{0.3472} = 11.52\ ft/s$$

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

$$h_L = f \times \frac{L}{D} \times \frac{V^2}{2g}$$

$$Re = \frac{VD}{\nu} = \frac{(2.34 \times 10^{-5})(0.6651)}{(1.21 \times 10^{-5})} = 1.286$$

$$\frac{D}{\varepsilon} = \frac{0.6651}{1.5 \times 10^{-4}} = 4434$$

$$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(D/\varepsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2$$

$$f = 0.25 \Big/ \left[\log\left(\frac{1}{3.7(4434)} + \frac{5.74}{1.286^{0.9}}\right)\right]^2 = 0.504$$

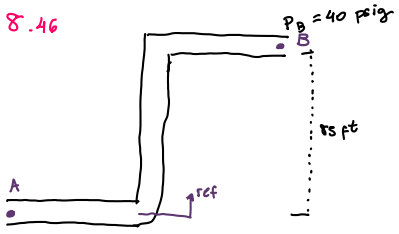
$$h_L = 0.504 \times \frac{2500}{0.6651} \times \frac{11.52^2}{2(32.2)} = 3903.93$$

$$P_1 = \gamma \left[z_2 - z_1 - \frac{V_1^2}{2g} + h_L\right]$$

$$P_1 = 62.4 \left[210 - 0 - \frac{11.52^2}{2(32.2)} + 3903.93\right]$$

$$P_1 = 256580.64\ lb/ft^2 \text{ or } 1781.81\ psi$$

8.46



$T = 50°F$

$D = 0.8350\ ft$

$A = 0.5479\ ft^2$

$L = 3200\ ft$

$Q = 4.25\ ft^3/s$

$$V = \frac{Q}{A} = \frac{4.25}{0.5479} = 7.76\ ft/s$$

$P_B = 40\ psig \rightarrow 5460\ lb/ft^2$

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

$$h_L = f * \frac{L}{D} \times \frac{V^2}{2g}$$

$$Re = \frac{VD}{\nu} = \frac{6 \times 10^{-6} \times 0.8350}{4.55 \times 10^{-6}} = 1.10$$

$$f = 64/1.1 = 58.18$$

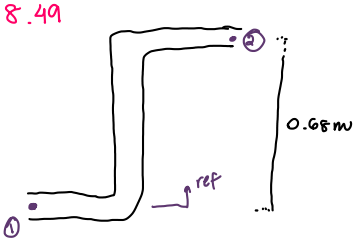
$$h_L = 58.18 \times \frac{3200}{0.835} \times \frac{7.76^2}{2(32.2)} = 208485$$

$$P_1 = \gamma \left[\frac{P_2}{\gamma} + \frac{V_2^2}{2g} - \frac{V_2^2}{2g} + z_2 + h_L \right]$$

$$P_1 = 42.4 \left[\frac{5460}{42.4} + 85 + 208485 \right]$$

$P_1 = 8848768$

8.49



$L = 25.8m$

$Q = 180\ L/min = 0.003\ m^3/s$

cooper tube

$ID = OD - 2\,wall = 20 - 2(1.2) = 17.6\ mm$

$D = 0.0176\ m$

$\gamma = 12.34$

$A = 0.000243$

$$V = \frac{Q}{A} = \frac{0.003}{0.000243} = 12.34\ m/s$$

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

$$h_L = f \times \frac{L}{D} \times \frac{V_2^2}{2g}$$

$$Re = \frac{9.6 \times 10^{-1} (0.0176)}{7.63 \times 10^{-4}} = 22.14$$

$$f = 64/22.14 = 2.89\ \frac{m^2}{kg}$$

$h_L = 0.64 \times \frac{45.5}{0.0176} \times \frac{12.37}{2(9.81)} = 32880.33$

$P_1 - P_2 = \gamma \left[\frac{V_2^2}{2g} - \frac{V_1^2}{2g} + z_2 + h_L \right]$

$= 12.34 \left[0.68 + 32880.33 \right]$

$P_1 - P_2 = 403751.66$

8.62

copper tube , 120 mm OD x 3.5 mm wall

$Q = 1000\ L/min = 0.0166\ m^3/s$

$L = 45\ m$

$D = OD - 2(wall) = 120 - 2(3.5) = 113\ mm$

$= 0.113\ m$

$A = 1.003 \times 10^{-2}\ m^2$

$V = Q/A \rightarrow 0.0166 / 1.003 \times 10^{-2} = 1.655\ m/s$

$h_L = f \times \frac{L}{D} \times \frac{V^2}{2g}$

Using values as temperature is 25°C

$Re = \frac{VD}{\nu} = \frac{(8.91 \times 10^{-4})(0.113)}{8.94 \times 10^{-7}} = 112.62$

$f = 64/112.62 = 0.568$

$h_L = 0.568 \times \frac{45}{0.113} \times \frac{1.655^2}{2(9.81)}$

$h_L = 31.577$