20. Find: Energy loss for sudden contraction from a DN 125 schedule 80 steel pipe to a DN 50 schedule 80 pipe.

Given: Flow rate Q: 500 L/min

$\frac{500\,L}{min} = \frac{1\,m^3/s}{60{,}000\,L/min} = 8.33\times10^{-3}\,m^3/s$

DN 125 = D = .1223 m

DN 50 = D = .0493 m

$A_1 = 1.173\times10^{-2}\,m^2$

$A_2 = 1.905\times10^{-3}\,m^2$

Table 10.3 $k = .38$

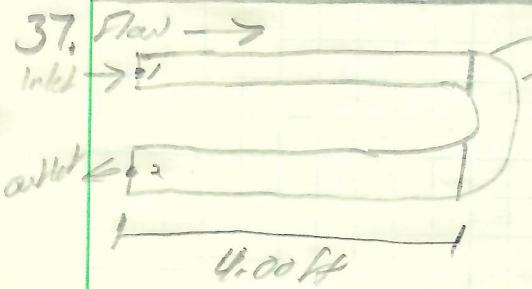
$H_L = \frac{V_2^2}{2g}$

$V_2 = \frac{Q}{A_2} \Rightarrow \frac{8.33\times10^{-3}\,m^3/s}{1.905\times10^{-3}\,m^2} = 4.373\,m/s$

$\frac{D_1}{D_2} = \frac{.1223\,m}{.0493\,m} = 2.481$

$H_L = k\frac{V_2^2}{2g} \Rightarrow .38 \times \frac{(4.373)^2}{2(9.81\,m/s^2)} = \boxed{H_L = .3704\,m}$

37.



Find: Pressure Difference between inlet & outlet for a flow rate of 12.5 gal/min of ethylene glycol at 77°F

$Q = 12.5\,gal/min \left| \frac{1\,ft^3/s}{449\,gal/min} \right. = 27.84\times10^{-3}\,ft^3/s$

D = .0518 ft

$A = .00211\,ft^2$

$S_g = 1.10 \quad \gamma = 68.47\,lb/ft^3 \quad \rho = 2.13\,slug/ft^3$

$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L \qquad z_1 = z_2 \quad V_1 = V_2 \qquad \eta = 3.38\times10^{-4}\,\frac{lb\cdot s}{ft^2}$

$P_1 - P_2 = \gamma(h_L) \Rightarrow P_1 - P_2 = \gamma(h_{pipe} + h_{bend})$

$H_{pipe} = \frac{L}{D}\frac{V^2}{2g}\cdot f \qquad Re = \frac{\rho V_1 D}{\eta} \qquad V_1 = \frac{Q}{A} \Rightarrow \frac{27.84\times10^{-3}\,ft^3/s}{.00211\,ft^2} = 13.194\,ft/s$

$\frac{D}{\varepsilon} = \frac{.0518\,ft}{1.5\times10^{-4}} = 345.33 \qquad Re = \frac{(2.13)(13.194)(.0518)}{3.38\times10^{-4}} = 4306.94$

$f = \frac{.25}{\left(\log\left(\frac{1}{3.7(\frac{D}{\varepsilon})} + \frac{5.74}{Re^{.9}}\right)\right)^2} \Rightarrow \frac{.25}{\left(\log\left(\frac{1}{3.7(345.33)} + \frac{5.74}{(4306.94)^{.9}}\right)\right)^2} = .02600$

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37. $H_{L\,pipe} = \left(\frac{2 \times 4\,ft}{.0518\,ft}\right) \cdot \left(\frac{(13.144\,ft/s)^2}{2 \cdot 32.2\,ft/s^2}\right) \cdot (.02600) = 10.854\,ft$

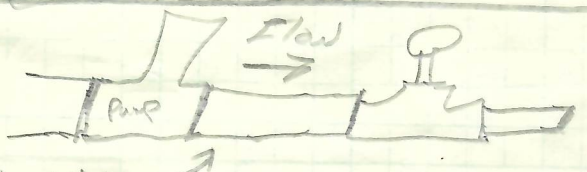
$H_{L\,bend} = k\frac{V^2}{2g}$ $k = \frac{L_e}{D} \cdot f_f = \frac{L_e}{D} = 50$ table 10.4 $f_f = .026$ table A-5

$k = (50) \cdot (.026) = 1.3$ $H_{L\,bend} = 1.3 \cdot \frac{(13.144\,ft/s)^2}{2 \cdot 32.3\,ft/s^2} = 3.514\,ft$

$P_1 - P_2 = 68.47\,lb/ft^3 \cdot (10.854 + 3.314) = 983.78\,lb/ft^2 \cdot \frac{1\,ft^2}{144\,in^2}$

$\boxed{\Delta P = 6.83\,psi}$

39.



3in schedule 40 pipe

Find: Energy loss

$Q = 0.40\,ft^3/s$ 50°F water

$\gamma = 62.4\,lb/ft^3$ $\rho = 1.94\,slugs/ft^3$

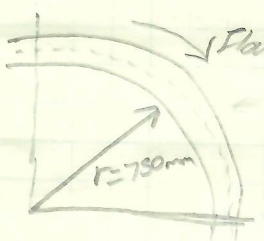
$D = .2557\,ft$ $A = .05132\,ft^2$

$h_L = k\frac{V^2}{2g}$ For Tee

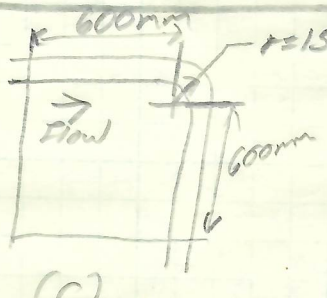
$k = 20\,f_T \Rightarrow f_T = .017$ $V = \frac{Q}{A} = \frac{.40\,ft^3/s}{.05132\,ft^2} = 7.794\,ft/s$

$H_L = (20 \cdot (.017)) \cdot \frac{(7.794\,ft/s)^2}{(2 \cdot 32.2\,ft/s^2)} \Rightarrow \boxed{H_L = .3207\,ft}$

43.



(B)



(C)

50mm OD 2.0mm wall Copper tube

$Q = 750\,L/min \frac{m^3/s}{60000\,L/min} = 1.233 \times 10^{-2}\,m^3/s$

Propyl Alcohol 25°C

$\gamma = 7.87\,kN/m^3$ $\rho = 802\,kg/m^3$

$\varepsilon_{copper} = 1.5 \times 10^{-6}\,m$ $D = 46\,mm$

$\eta = 1.92 \times 10^{-3}\,Pa \cdot s$

$A = \frac{\pi}{4}d^2 = 1.662 \times 10^{-3}\,m^2$

B) $\frac{L}{D} = \frac{750\,mm}{46\,mm} = 16.30$ $\frac{L_e}{D} = 43$

$V = \frac{Q}{A} = \frac{1.233 \times 10^{-2}\,m^3/s}{1.662 \times 10^{-3}\,m^2} = 7.42\,m/s$

$Re = \frac{\rho V D}{\eta} = \frac{802 \cdot 7.42 \cdot (.046)}{1.92 \times 10^{-3}} \Rightarrow 1.42572 \times 10^5$ $\frac{D}{\varepsilon} = \frac{.046\,m}{(1.5 \times 10^{-6}\,m)} =$

$\frac{D}{\varepsilon} = 30666.67$

4.5. B) $f = \frac{.25}{\left(1.08\left(\frac{1}{3.7(30666.67)}\right)^{1.11} + \left(\frac{5.74}{(1.4257\times10^{5})\cdot.9}\right)^{.9}\right)^2} = .32029$ $\delta_T = .0095$

$k = \delta_T \cdot \frac{L_e}{D} = .0095 \cdot 43 = .4085$ $H_L = k\frac{V^2}{2g} = (.4085)\frac{(7.42)^2}{2\cdot9.81}$

$H_L = 1.146\,m$

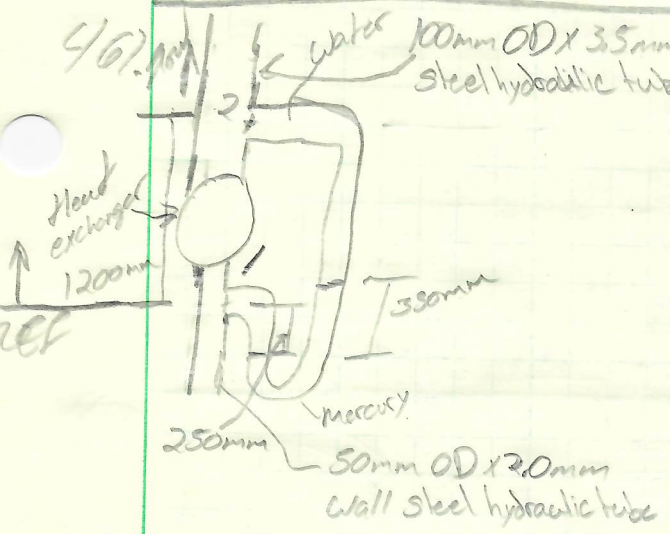
C). Lose for pipe & elbow

$\frac{r}{D} = \frac{150}{46} = 3.261$ $\frac{L_e}{D} = 13$ $h_{L_{elbow}} = f_T \frac{L_e}{D} \cdot \frac{V^2}{2g} = (.0095)\cdot 13 \cdot \frac{(7.42)^2}{2\cdot9.81}$

$h_{L_{elbow}} = .3466\,m$ $h_{L_{pipe}} = f\frac{L}{D}\frac{V^2}{2g} = .0168 \cdot \frac{1.2m}{.046m} \cdot \frac{(7.42)^2}{2\cdot9.81} = 1.2298$

$h_L\,total = h_{L_{elbow}} + h_{L_{pipe}} = .3466 + 1.2298 = 1.5764\,m$

4.61.



Find: Resistance Coefficient for heat exchanger

Water at 50°C $Q = 6.0\times10^{-3}\,m^3/s$

$\gamma_w = 9.69\,kN/m^3$ $\rho = 988\,kg/m^3$

$\gamma_{Hg} = 131.203\,kN/m^3$ $\rho = 13377.52\,kg/m^3$

$S_{g\,Hg} = 13.54$ $\eta = 5.41\times10^{-4}\,Pa\cdot s$

Inner $D_1 = 46mm$ $A_1 = 1.662\times10^{-3}\,m^2$

Inner $D_2 = 93mm$ $A_2 = 6.79\times10^{-3}\,m^2$

$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{z_1}^{0} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L_{1\to2}} \Rightarrow h_{L_{12}} = \frac{P_1 - P_2}{\gamma_w} + \frac{V_1^2 - V_2^2}{2g} - z_2$

Find $P_1 - P_2 \Rightarrow P_2 = P_1 + (9.69)(.25m) - (131.203)\cdot(.35m) - (9.69)(1.1m)$

$V_1 = \frac{Q}{A} = \frac{6.0\times10^{-3}}{1.662\times10^{-3}} = 3.61\,m/s$ $P_1 - P_2 = 54.175\,kN/m^2$

$V_2 = \frac{Q}{A} = \frac{6.0\times10^{-3}}{6.79\times10^{-3}} = .883\,m/s$

46. $h_{L12} = \frac{54.175\ kN/m^2}{9.64\ kN/m^3} + \frac{3.61^2 - (.883)^2}{2 \cdot 9.81} - 1.2m = \boxed{5.015m}$

$h_L = k\frac{v^2}{2g} \Rightarrow k = h_L \cdot \frac{2g}{v^2} = 5.015 \cdot \left(\frac{2 \cdot 9.81}{(3.61)^2}\right) \Rightarrow \boxed{k = 7.550}$

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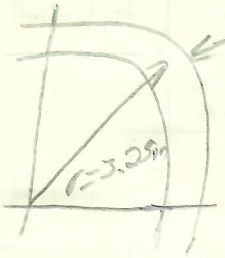
48)



Find: Energy loss in 90° bend in steel tube

$Q_{oil} = 27.5\ gal/min \frac{1\ ft^3/s}{449\ gal/min} = 6.125 \times 10^{-2}\ ft^3/s$

$Inner\ D = 1.084in / \frac{ft}{12in} = .0903ft$

$r = .2708ft$

$A = 6.409 \times 10^{-3} ft^2$

$r/D = \frac{.2708}{.0903} = 2.99 \rightarrow 3$

$L/D = 12.5$

$D/\varepsilon = \frac{.0903}{1.5 \times 10^{-4}} = 602$

$f_T = .0225$

$k = f_T(L/D) = .0225 \cdot 12.5 = .28125$

$h_L = k\frac{v^2}{2g} \Rightarrow v = \frac{Q}{A} = \frac{6.125 \times 10^{-2}}{6.409 \times 10^{-3}} = 9.557\ ft/s$

$h_L = .28125 \cdot \frac{(9.557)^2}{2 \cdot 32.2} = \boxed{.3989ft}$