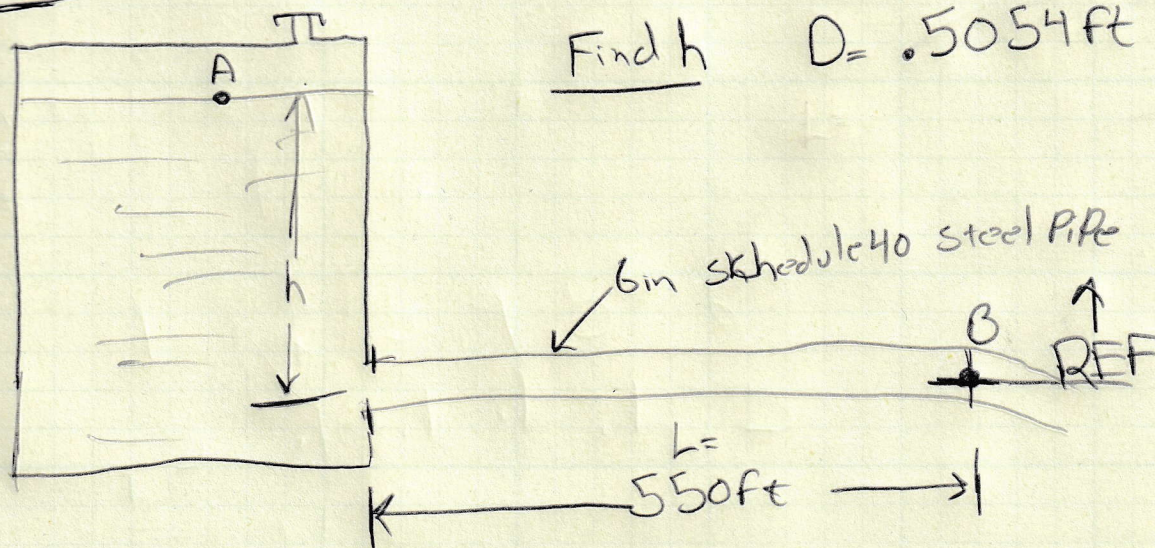


8.33

$$Q = 2.5 \text{ ft}^3/\text{s}$$

$$D = .5054 \text{ ft}$$

Find h



$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B + h_L$$

$$h = \frac{V_B^2}{2g} + h_L$$

$$h = \frac{V_B^2}{2g} + f \left(\frac{V^2}{2g} \right) \left(\frac{L}{D} \right)$$

$$h = \frac{V_B^2}{2g} \left(1 + f \frac{L}{D} \right)$$

$$V_B = \frac{Q}{A} = \frac{2.5 \text{ ft}^3/\text{s}}{.2006 \text{ ft}^2}$$

$$V_B = 12.463 \text{ ft/s}$$

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

$$Re = \frac{VD}{\nu} = \frac{(12.463 \text{ ft/s})(.5054 \text{ ft})}{9.15 \times 10^{-6} \text{ ft}^2/\text{s}}$$

$$Re = 6.884 \times 10^5$$

$$Re_1 = \frac{D}{\epsilon} = \frac{.5054 \text{ ft}}{1.5 \times 10^{-4} \text{ ft}}$$

$$Re_1 = 3369.33$$

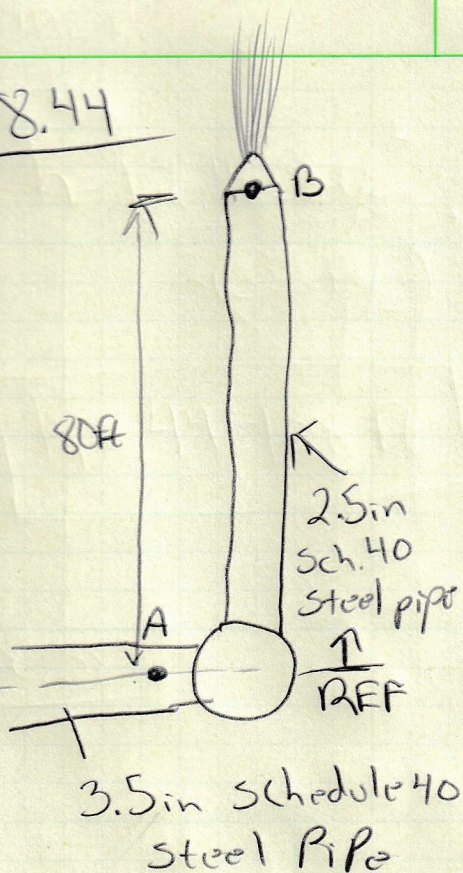
$$F = .016$$

8.33
Cont

$$h = \frac{12.463 \text{ ft/s}^2}{2(32.2 \text{ ft/s}^2)} \cdot \left(1 + .016 \left(\frac{550 \text{ ft}}{.5054 \text{ ft}} \right) \right)$$

$$h = 44.408 \text{ ft}$$

8.44



$$P_B = 25 \text{ psig} \cdot \frac{144 \text{ in}^2}{\text{ft}^2} = 3600 \text{ lb/ft}^2$$

$$P_A = -3.5 \text{ psig} \cdot \frac{144 \text{ in}^2}{\text{ft}^2} = -504 \text{ lb/ft}^2$$

$$Q = .50 \text{ ft}^3/\text{s}$$

$$\eta = 4 \times 10^{-5} \text{ lb} \cdot \text{s}/\text{ft}^2$$

$$\gamma = (1.026)(62.4 \text{ lb/ft}^3) = 64.0224 \text{ lb/ft}^3$$

$$\rho = 1.026(1.94 \text{ slugs/ft}^3) = 1.99044 \frac{\text{slugs}}{\text{ft}^3}$$

$$D_B = .2058 \text{ ft}$$

$$A_B = .03326 \text{ ft}^2$$

$$P_{\text{Pipe A}}$$

$$D_A = .2957 \text{ ft}$$

$$A_A = .06868 \text{ ft}^2$$

$$* h_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B + h_L$$

$$V_A = \frac{Q}{A_A} = \frac{.5 \text{ ft}^3/\text{s}}{.06868 \text{ ft}^2}$$

$$V_A = 7.280 \text{ ft/s}$$

$$V_B = \frac{Q}{A_B} = \frac{.5 \text{ ft}^3/\text{s}}{.03326 \text{ ft}^2}$$

$$V_B = 15.033 \text{ ft/s}$$

8.44
cont

$$h_A = \frac{P_B}{\gamma} - \frac{P_A}{\gamma} + \frac{V_B^2}{2g} - \frac{V_A^2}{2g} + Z_B + h_L$$

$$h_A = \frac{(3600 + 504) \text{ lb/ft}^2}{64.0224 \text{ lb/ft}^3} + \frac{(15.033^2 - 7.280^2) \text{ ft/s}^2}{2 \cdot 32.2 \text{ ft/s}^2} + 80 \text{ ft} + h_L$$

$$h_A = 64.103 \text{ ft} + 2.686 \text{ ft} + 80 \text{ ft} + h_L$$

$$h_A = 146.789 \text{ ft} + h_L$$

$$h_L = f \left(\frac{V_B^2}{2g} \right) \left(\frac{L}{D} \right)$$

$$f_e = \frac{V_B D \rho}{\mu} = \frac{(15.033 \text{ ft/s})(.2058 \text{ ft})(1.94 \text{ slugs/ft}^3)}{4 \times 10^{-5} \text{ lb-s/ft}^2}$$

$$h_L = .020 \left(\frac{15.033 \text{ ft/s}^2}{2(32.2 \text{ ft/s}^2)} \right) \left(\frac{80 \text{ ft}}{.2058 \text{ ft}} \right) \quad f_e = 153,950.1539$$

$$h_L = 27.282 \text{ ft}$$

$$R_{rel} = \frac{D_B}{\epsilon} = \frac{.2058 \text{ ft}}{1.5 \times 10^{-4} \text{ ft}}$$

$$R_{rel} = 1372$$

$$f = .020$$

$$h_A = 146.789 \text{ ft} + 27.282 \text{ ft}$$

$$\underline{h_A = 174.071 \text{ ft}}$$

8:41
Cont

$$P = \gamma Q h_A$$

$$= 64.0224 \text{ lb/ft}^3 \left(.50 \text{ ft}^3/\text{s} \right) (174.071 \text{ ft})$$

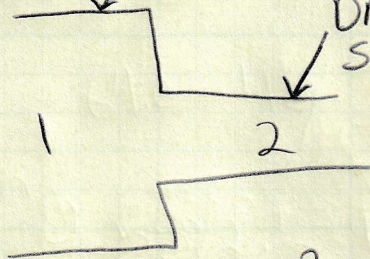
$$P = 5572.229 \frac{\text{lb} \cdot \text{ft}}{\text{s}} \cdot \frac{1 \text{ hp}}{550 \frac{\text{lb} \cdot \text{ft}}{\text{s}}}$$

$$\boxed{P = 10.131 \text{ Hp}}$$

10.20

DN125 sch80

DN50
sch80



$$h_L = K \left(\frac{V_2}{2g} \right)^2$$

$$= .39 \left(\frac{4.373 \text{ m/s}}{2(9.81 \text{ m/s}^2)} \right)^2$$

$$h_L = .380 \text{ m}$$

$$Q = 500 \text{ L/min} \cdot \frac{1 \text{ m}^3/\text{s}}{60,000 \text{ L/min}} = .00833 \text{ m}^3/\text{s}$$

1

$$D_1 = 122.3 \text{ mm or } .1223 \text{ m}$$

$$A_1 = 1.173 \times 10^{-2} \text{ m}^2$$

2

$$D_2 = 44.3 \text{ mm or } .0443 \text{ m}$$

$$A_2 = 1.905 \times 10^{-3} \text{ m}^2$$

$$\frac{D_1}{D_2} = 2.4807$$

$$V_2 = \frac{Q}{A_2} = \frac{.00833 \text{ m}^3/\text{s}}{1.905 \times 10^{-3} \text{ m}^2}$$

$$V_2 = 4.373 \text{ m/s}$$

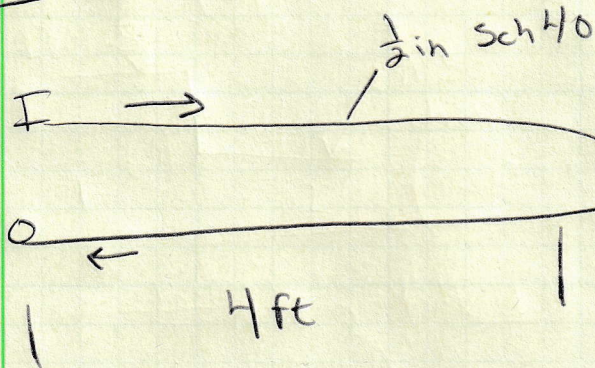
$$K \approx .39$$

Ethylene Glycol @ 77°F

10.37

$$Q = 12.5 \text{ gal/min or } .0279 \text{ ft}^3/\text{s}$$

$$\gamma = 68.47 \text{ lb/ft}^3$$



$$D = .0518 \text{ ft}$$

$$V_I = V_O$$

$$V = \frac{Q}{A} = \frac{.0279 \text{ ft}^3/\text{s}}{.00211 \text{ ft}^2}$$

$$V = 13.223 \text{ ft/s}$$

$$\frac{P_I}{\gamma} + \frac{V_I^2}{2g} + \frac{z_I}{\gamma} = \frac{P_O}{\gamma} + \frac{V_O^2}{2g} + \frac{z_O}{\gamma} + h_L$$

$$K = 50(.026)$$

$$P_I - P_O = \gamma (h_L)$$

$$h_L = f \left(\frac{L}{D} \right) \left(\frac{V^2}{2g} \right) + K \left(\frac{V^2}{2g} \right)$$

$$f \left(\frac{8 \text{ ft}}{.0518 \text{ ft}} \right) \left(\frac{13.223^2}{2(32.2)} \right) + 1.3 \left(\frac{13.223^2}{2(32.2)} \right)$$

$$h_L = f(419.309 \text{ ft}) + 3.530 \text{ ft}$$

$$f = .25$$

$$\left[\log \left(\frac{1}{5.7(P/\epsilon)} + \frac{5.74}{Re^{0.9}} \right) \right]^2$$

$$Re = \frac{VD}{\nu} = \frac{(13.223 \text{ ft/s})(.0518 \text{ ft})}{1.59 \times 10^{-4} \text{ lb.s/ft}^2}$$

$$Re = 4307.870$$

$$f = .0429$$

$$Re_{rel} = \frac{D}{\epsilon} = \frac{.0518 \text{ ft}}{1.5 \times 10^{-4} \text{ ft}} = 345.333$$

10.37
Cont

$$h_L = .0429(419.309 \text{ ft}) + 3.530 \text{ ft}$$

$$\underline{h_L = 21.526 \text{ ft}}$$

$$P_I - P_o = \gamma h_L$$

$$= (68.47 \text{ lb/ft}^3)(21.526 \text{ ft})$$

$$P_I - P_o = 1473.922 \text{ lb/ft}^2 \cdot \frac{1 \text{ ft}^2}{144 \text{ in}^2} = \boxed{10.236 \text{ PSIG}}$$