Purpose

Calculate the pressure at A

Design Considerations

- Incompressible fluid
- isothermal process
- Steady state

Data and Variables

Oil

Specific weight = 8.80 kN/m³

Kinematic viscosity = 2.12×10^{-5} m²/s

Length of DN 150 pipe = 180 m

Length of DN 50 pipe = 8 m

Flow rate = 0.015 m³/s = Q

Elbows are long radius type

Pressure at B = 12.5 mpa

11.5)

Drawing

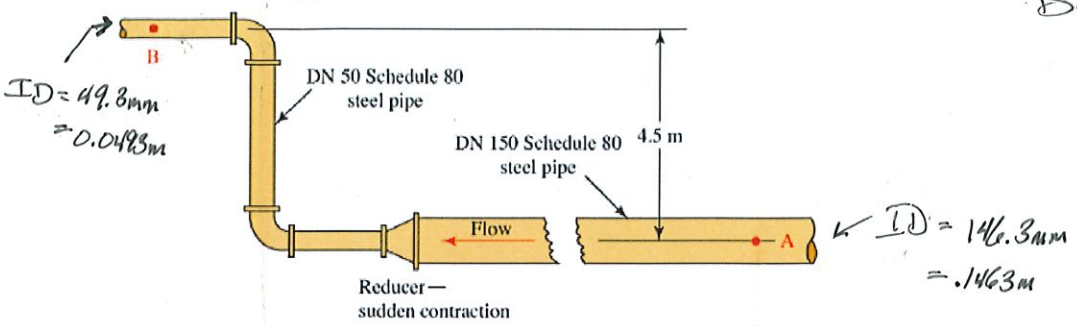

Figure 11.17
Problem 11.5

Done Back

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + \cancel{Z_A}^{0} = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B + h_L$$

$A_A = \frac{\pi D^2}{4}$

$= \frac{\pi(.1463m)^2}{4}$

$= 0.017 m^2$

$V_A = \frac{Q}{A}$

$= \frac{0.015 m^3/s}{0.017 m^2}$

$= 0.882 m/s$

$Re = \frac{VD}{\nu}$

$= \frac{0.882(.1463)}{2.12 \times 10^{-5}}$

$= 6086.63$

$\frac{D}{\varepsilon} = \frac{0.1463}{4.6 \times 10^{-5}}$

$= 3180.43$

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

$f = 0.036$

$A_B = \frac{\pi D^2}{4}$

$= \frac{\pi(0.0493)^2}{4}$

$= 0.0019 m^2$

$V_B = \frac{Q}{A}$

$= \frac{0.015 m^3/s}{0.0019 m^2}$

$= 7.895 m/s$

$Re = \frac{VD}{\nu}$

$= \frac{7.895(0.0493)}{2.12 \times 10^{-5}}$

$= 18,359.60$

$\frac{D}{\varepsilon} = \frac{0.0493}{4.6 \times 10^{-5}}$

$= 1071.74$

$f = 0.028$

$h_L = h_1 + h_2 + h_3$

$h_1 = f\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$

$= 0.036\left(\frac{180}{.1463}\right)\left(\frac{0.882^2}{2(9.81)}\right)$

$= 1.76m$

$h_2 = f\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$

$= 0.028\left(\frac{8}{.0493}\right)\left(\frac{7.895}{2(9.81)}\right)$

$= 18.56m$

$h_3 = 2 f_{dT}\left(\frac{L_e}{D}\right)\left(\frac{V^2}{2g}\right)$

$= 2(0.028)(30)\left(\frac{7.895}{2(9.81)}\right)$

$= 6.86m$

$h_L = 27.16m$

12.5 mpa = 12500 kN/m²

$P_A = \left(\frac{P_B}{\gamma} + \frac{V_B^2}{2g} - \frac{V_A^2}{2g} + Z_B + h_L\right)\gamma$

$= \left(\frac{12,500 kN/m^2}{8.8 kN/m^3} + \frac{(7.895)^2 - (0.882)^2}{2(9.81)} + 4.5m + 27.16m\right)(8.8)$

$= 12,806 kPa$

$= 12.81 Mpa$

11.13)

Purpose

Determine velocity of flow from nozzle

a) at 20 psig = 2880 psf

b) at 80 psig = 11,520 psf

Design considerations

- Incompressible fluid
- Isothermal process
- Steady state

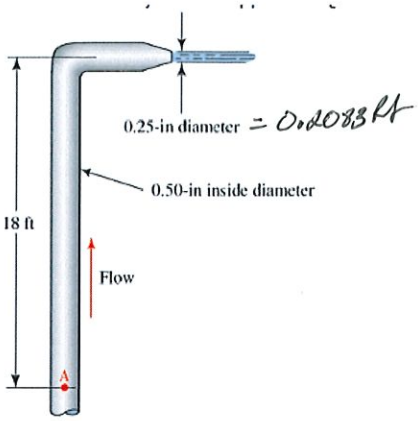

Figure 11.20
Problem 11.13

Data and Variables

$K = 0.15$

Aluminum = ID = 0.50 in = 0.0417 ft

90° Bend radius = 6 in = .5 ft

Total length of pipe = 20 ft

Water temp = 100 °F

$\gamma = 62.4\ lb/ft^3$

$\nu = 7.37 \times 10^{-6}\ ft^2/s$

$A_A = \frac{\pi D^2}{4}$

$= \frac{\pi (0.0417)^2}{4}$

$= 0.0014\ ft^2$

$\frac{D}{\delta} = \frac{0.0417}{1.5 \times 10^{-4}}$

$= 278$

a) at 20 psig

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

$$h_L = \frac{P_B - P_A}{\gamma}^{0} + \frac{V_B^2 - V_A^2}{2g}^{0} + Z_B - Z_A$$

$$h_L = \frac{2880\ lb/ft^2}{62.4\ lb/ft^3} - 18\ ft$$

$= 28.15\ ft$

$$Q_a = -2.22(D)^2 \sqrt{\frac{g D h_L}{L}} \log\left(\frac{1}{3.7 D/\varepsilon} + \frac{1.784\nu}{D\sqrt{g D h_L / L}}\right)$$

$= 0.0132\ ft^3/s$

$V_a = \frac{Q}{A}$

$= \frac{0.0132\ ft^3/s}{0.0014\ ft^2}$

$= 9.43\ ft/s$

b) at 80 psig

$h_L = \frac{11,520\ lb/ft^2}{62.4\ lb/ft^3} - 18\ ft$

$= 166.62\ ft$

$Q_b = 0.0351\ ft^3/s$

$V_b = \frac{Q}{A}$

$= \frac{0.0351\ ft^3/s}{0.0014\ ft^2}$

$= 25.07\ ft/s$