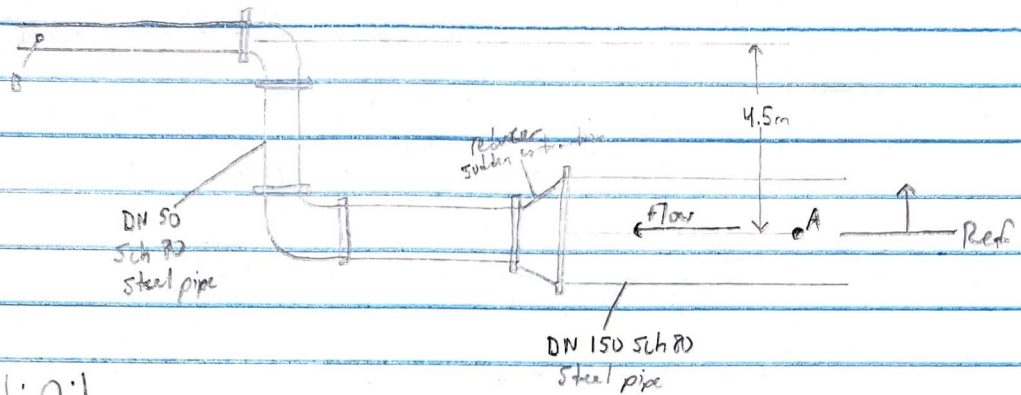


11.5) Given:



Fluid: Oil

$$Q = 0.015 \text{ m}^3/\text{s}$$

$$\gamma_{\text{oil}} = 8.80 \text{ kN/m}^3$$

$$\nu_{\text{oil}} = 2.12 \times 10^{-5} \text{ m}^2/\text{s}$$

$$L_{\text{DN50}} = 18 \text{ m}$$

$$L_{\text{DN150}} = 180 \text{ m}$$

Elbow - long radius

$$P_R = 12.5 \text{ MPa}$$

Determine: Calculate pressure at A.

Solution:

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_R}{\gamma} + \frac{V_R^2}{2g} + z_R + h_{L_{A-R}}$$

Point A: $Q = V_A A_A$

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

$$V_A = \frac{0.015 \text{ m}^3/\text{s}}{\pi r^2}$$

$$V_A = \frac{0.015}{\pi (0.073)^2}$$

$$V_A = .896 \text{ m/s}$$

Point B: $Q = V_B A_B$

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

$$A_B$$

$$V_B = \frac{0.015}{\pi r^2}$$

$$\pi r^2$$

$$V_B = \frac{0.015}{\pi (.025)^2}$$

$$V_B = 7.86 \text{ m/s}$$

$$h_{L A-B} = h_{L \text{ pipe}(B)} + 2h_{L \text{ elbow}(B)} + h_{L \text{ red}} + h_{L \text{ pipe}(A)}$$

$$h_{L A-B} = f_B \frac{L_B}{D_B} \frac{V_B^2}{2g} + 2K \frac{V_B^2}{2g} + K \frac{V^2}{2g} + f_A \frac{L_A}{D_A} \frac{V_A^2}{2g}$$

$$N_{Re} = \frac{\rho V_B D_B}{\mu}$$

$$r = \mu/\rho$$

$$= \frac{(7.86)(.0493)}{2.12 \times 10^{-5}}$$

$$= 1.83 \times 10^4$$

$$\frac{D}{\epsilon} = \frac{.0493}{4.6 \times 10^{-5}} = 1072$$

from moody diagram: $f_B = .026$

$$f_T = .018$$

$$N_{Re} = \frac{\rho V_A D_A}{\mu}$$

$$= \frac{(1.896)(.176)}{2.12 \times 10^{-5}}$$

$$= 6.18 \times 10^3$$

$$\frac{D}{\epsilon} = \frac{.176}{4.6 \times 10^{-5}} = 3180$$

From moody diagram: $f_A = .033$

$$f_T = .018$$

Redner: $\frac{D_A}{D_B} = \frac{.1463}{.0493} = 2.97$

19.62

From Fig 10.8 $k = .35$

$$h_{LA-B} = (.026) \left(\frac{8}{.0493} \sqrt{\frac{7.86^2}{2 \times 9.81}} \right) + 2(20 \times .018) + (.35) \left(\frac{7.86^2}{2 \times 9.81} \right) + (.033) \left(\frac{1.80}{.1463} \right) \left(\frac{.896^2}{2 \times 9.81} \right)$$

$$h_{LA-B} = 13.29 + 2.28 + 1.10 + 1.66$$

$$h_{LA-B} = 18.33 \text{ m}$$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{LA-B}$$

$$P_A = \left(\frac{P_B}{\gamma} + \frac{V_B^2}{2g} - \frac{V_A^2}{2g} + z_B + h_{LA-B} \right) \gamma$$

$$P_A = \left(\frac{125 \times 10^6}{8.80} + \frac{7.86^2}{2(9.81)} - \frac{.896^2}{2(9.81)} + 4.5 + 18.33 \right) 8.80$$

$$P_A = (1420454.5 + 3.15 + 4.5 + 18.33) 8.80$$

$$P_A = 12500228 \text{ N/m}^2$$

$$P_A = 12.5 \text{ MPa}$$