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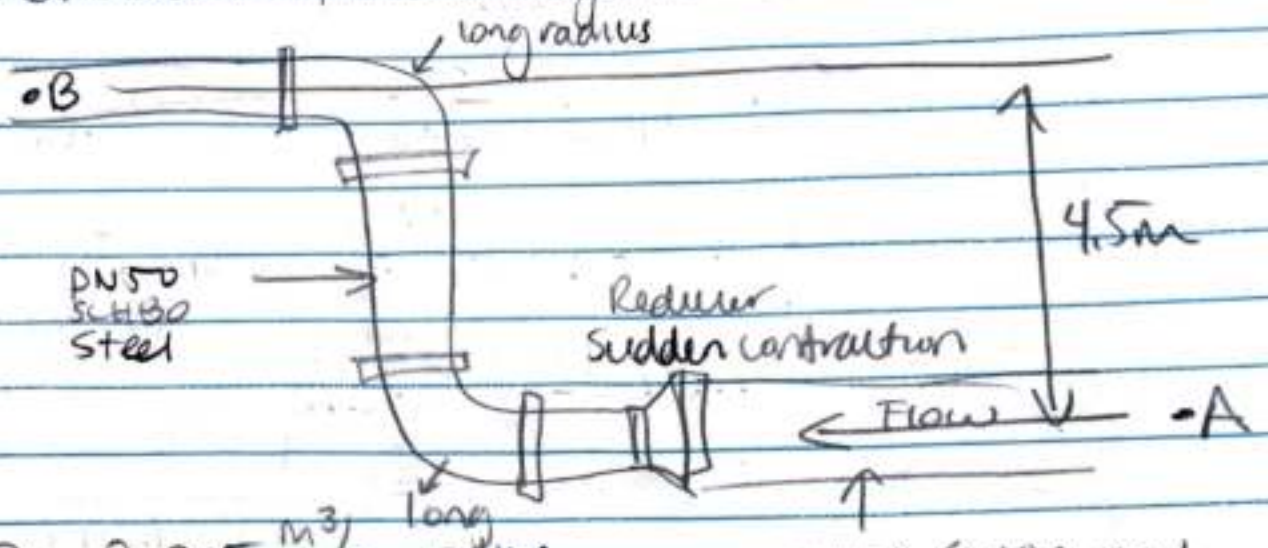
MET 330 Professor Ayala June 25th, 2023

11.5



$Q = 0.015\ m^3/s$

$\gamma_{oil} = 8.80\ kN/m^3$ $\varepsilon = 4.6 \times 10^{-5}$

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

$L_{DN150} = 180\ m$ $D_A = 0.1463\ m$ $A_A = 1.682 \times 10^{-2}$

$L_{DN50} = 8\ m$ $D_B = 0.0493\ m$ $A_B = 1.905 \times 10^{-3}$

$P_B = 12.5\ MPa$

Consider all pipe frictions and minor losses, Calculate the pressure at A.

$$\frac{P_A}{\gamma} + z_A + \frac{V_A}{2g} - h_L = \frac{P_B}{\gamma} + z_B + \frac{V_B}{2g}$$

$$P_A = P_B + z_B - z_A + \frac{V_B - V_A}{2g} + h_L$$

Continued on Pg2

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Problem 11.5 continued

$V = \frac{Q}{A}$ $V_A = \frac{0.015\ m^3/s}{1.682 \times 10^{-2}} = 0.892\ m/s$

$V_B = \frac{0.015\ m^3/s}{1.905 \times 10^{-3}} = 7.87\ m/s$

$\frac{V_A^2}{2g} = \frac{(0.892\ m/s)^2}{2(9.81)} = 0.0406m$

$\frac{V_B^2}{2g} = \frac{(7.87\ m/s)^2}{2(9.81)} = 3.16m$

$h_L = K \cdot \frac{v^2}{2g}$ $D_A/D_B = 100/50 = 3.0 = \frac{D}{\varepsilon}$

reducer $= 0.05 \frac{(0.892\ m/s)^2}{2(9.81)} = 0.002m$

from table

Long radius elbows $= K = 20 F_T$ $20 \cdot 0.028 = 0.56$

$N_{R_A} = \frac{VD}{\nu} = \frac{(0.892)(0.1463)}{2.12 \times 10^{-5}} = 6156$ $2 L_{eq} = 1.12m$

$\frac{D_A}{\varepsilon} = \frac{0.1463}{4.6 \times 10^{-5}} = 3180$ $f = 0.036$

$N_{RB} = \frac{VD}{\nu} = \frac{(7.87)(0.0493)}{2.12 \times 10^{-5}} = 18301$

$\frac{D_B}{\varepsilon} = \frac{0.0493}{4.6 \times 10^{-5}} = 1072$ $f = 0.028$

Continued on Pg3

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Problem 11.5 Continued

$$\text{elbows} = K\frac{V_B^2}{2g} = 0.56\frac{7.87^2}{2\times 9.81} = 1.77$$

$$2\text{ elbows} = 1.77 + 1.77 = 3.54\text{m}$$

elbows + reducer = 3.56m

$$P_A = P_B + z_B - z_A + \frac{V_B - V_A}{2g} + h_L$$

$$12.5 + (4.5 - 0.0406 + 3.16\text{m} + 3.56)8.80$$

(h, V_A, V_B)

$\downarrow$

98.4

$$P_B = 12.5984$$

$$\boxed{P_B = 12.6\text{ MPa}}$$

Continued on Pg 4

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11.20

Total length pipe = 75ft SCH40 steel
Temp water = 90°F $g = 32.2\ ft/s^2$
$Q = 400\ gal/min$ $\varepsilon = 1.5 \times 10^{-4}$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g}^{0} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g}^{0} + z_2 + h_L$$

$$D = 0.66\left[\varepsilon^{1.25}\left(\frac{LQ^2}{gh_L}\right)^{4.75} + \nu Q^{9.4}\left(\frac{L}{gh_L}\right)^{5.2}\right]^{0.04}$$

ν @ 90°F $= 9.15 \times 10^{-6}\ ft^2/s$ $400\ gal/min = 0.891\ ft^3/s$

$$h_L = (p_1 - p_2)/\gamma + (z_1 - z_2) = 12ft$$
$$0 \quad + \quad 12$$

^ we don't know P

$$D = 0.66\left[(1.5\times10^{-4})^{1.25}\left(\frac{75 \times (0.891)^2}{32.2\ ft/s^2 \cdot 12ft}\right)^{4.75} + (9.15\times10^{-6}\ ft^2/s)(0.891\ ft^3/s)^{9.4}\left(\frac{75}{(32.2)(12)}\right)^{5.2}\right]^{0.04}$$

Continued on PG 5

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Problem 11.20 Continued

$$D = 0.66\left[0.0000166 \cdot 0.0001387 + (0.000031)(0.0001985)\right]^{0.04}$$

$$\boxed{D = 0.300\,ft}$$