MET 330 HW 3.1 John Butler

11.5) $Q = 0.015\ m^3/s$

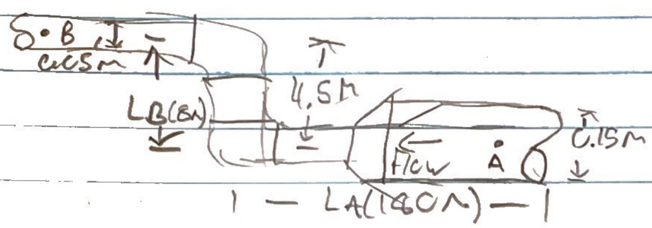
Oil Specific weight $(\gamma_o) = 8.80\ kN/m^3$

Oil kinematic viscosity $(\nu) = 2.12E\text{-}5\ m^2/s$

Length of DN 150 Pipe $(L_A) = 180\ m$

Length of DN 50 Pipe $(L_B) = 8\ m$

FBD



Solve for Velocity

$Q = A \times V \Rightarrow 0.015\ m^3/s = \frac{\pi}{4}(D^2) \times V$

$$V = \frac{0.015\ m^3/s}{\frac{\pi}{4}(D^2)}$$

$$V_A = \frac{0.015\ m^3/s}{\frac{\pi}{4}(0.15\ m^2)} = 0.848\ m/s$$

$$V_B = \frac{0.015\ m^3/s}{\frac{\pi}{4}(0.05\ m^2)} = 7.639\ m/s$$

Solve for Reynold's #

$$(Re)_A = \frac{V \times D}{\nu} = \frac{0.848\ m/s \times 0.15\ m}{2.15E\text{-}5\ m^2/s} = 5{,}916.28$$

$$(Re)_B = \frac{7.639\ m/s \times 0.05\ m^3/s}{2.15E\text{-}5\ m^2/s} = 17{,}765.12$$

Losses in Pipe - Find f

From chart in Book, $f_A = 0.016$ and $f_B = 0.019$

$$(h_L)_A = \frac{fLV^2}{2Dg} = \frac{0.016 \times 180\ m \times (0.848\ m/s)^2}{2 \times 0.15\ m \times 9.81} = 0.703\ m$$

$$(h_L)_B = \frac{0.019 \times 8\ m \times 7.639\ m/s}{2 \times 0.05\ m \times 9.81} = 9.042\ m$$

Solve for Minor losses in "Reducer"

$$(h_L)_m = \frac{0.5\, V_B^2}{2g} = \frac{0.5\,(7.639\,\tfrac{m}{s})^2}{2 \times 9.81} = 1.487\ m$$

Now Apply Bernoulli's Equation

$$\frac{P_A}{\gamma_o} + \frac{V_A^2}{2g} + z_1 = \frac{P_B}{\gamma_o} + \frac{V_B^2}{2g} + z_2 + h_{L(A,B,M)}$$

$$\Rightarrow \frac{P_A}{\gamma} = \frac{P_B}{\gamma} + \frac{V_B^2 - V_A^2}{2g} + z_2 + h_{L(A,B,M)}$$

$$\Rightarrow \frac{P_A}{\gamma} = \frac{12.5E6}{8.6E3\ N/m^3} + \frac{7.639\ m/s^2 - 0.848\ m/s^2}{2 \times 9.81} + 4.5m + 0.703m + 9.042m + 1.487m$$

$$\frac{P_A}{\gamma} = 1718.89 \times 8.8E3\ N/m^3$$

$$\boxed{P_A = 15.13\ MPa}$$

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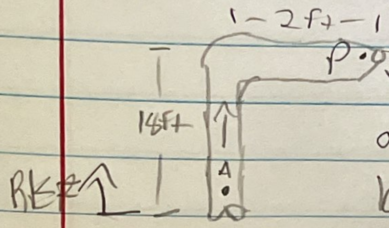
11.13) FBD



Given

Diameter of Pipe = 0.5 in

Diameter of nozzle = 0.25 in

a) $P_1 = 20$ psig $= 46.13$ ft

b) $P_1 = 80$ psig $= 184.52$ ft

* Apply Bernoulli's at Points A and B to solve for V_2

a) $$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{z_1} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + K\frac{V_2^2}{2g}$$

$$\Rightarrow 46.13\,ft + \frac{V_1^2}{2g} = \frac{V_2^2}{2g}(1+K + 20\,ft$$

$$\boxed{\begin{aligned} a_1 V_1 &= a_2 V_2 \\ V_1 &= 1/144\, V_2 \end{aligned}}$$

$$\Rightarrow \frac{V_2^2}{2g}\left(1 + 0.15 - 1/(144)^2\right) = 23.13$$

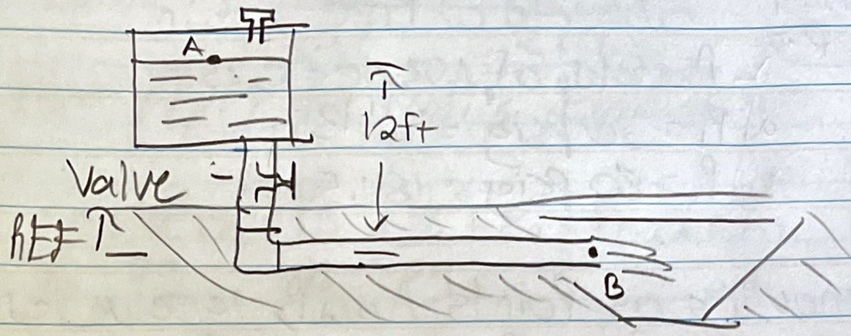
$$\boxed{V_2 = 50.9\ ft/s}$$

b) $$184.52\,ft + \frac{V_1^2}{2g} = \frac{V_2^2}{2g}(1+K + 20\,ft$$

$$\frac{V_2^2}{2g}\left(1 + 0.15 - 1/(144)^2\right) = 164.52$$

$$\boxed{V_2 = 95.9\ ft/s}$$

11.20) FBD



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

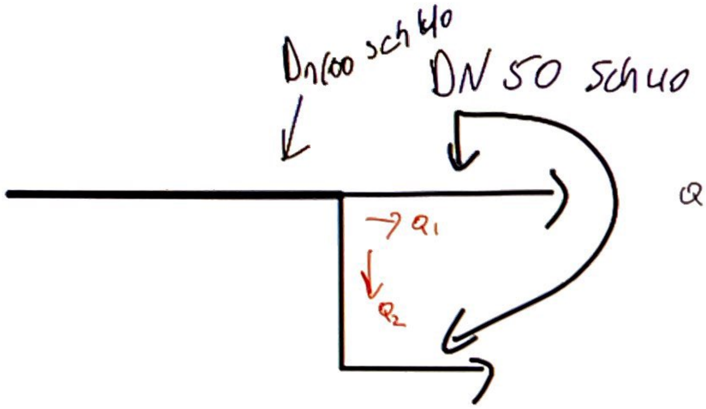
$$z_1 = \frac{V_2^2}{2g} \Rightarrow V_2^2 = 2g \times z_1$$

$$V_2 = \sqrt{2g \times z_1}$$

$$V_2 = \sqrt{2 \times 9.81 \times 12ft}$$

$$V_2 = 15.34\ ft/s$$

Chapter 12 Homework



850L/min (100 DN)

$$Q = \frac{850\ L}{min} \cdot \frac{0.001\ m^3}{1L} \cdot \frac{1 min}{60 sec} = 0.01417\ m^3/sec$$

$a = \frac{1}{2}Q$ (for Dn100)

B)

$Q = Q_1 + Q_2$: Parallel connection $h_{f_1} = h_{f_2}$

a)

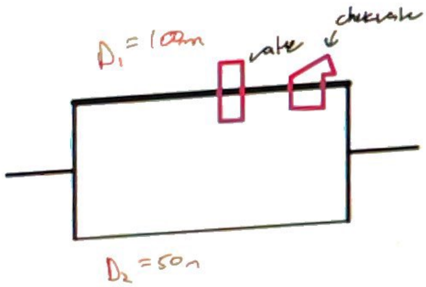
$Q_{Dn50} = 0.007085\ m^3/sec$

$$\frac{fLv_1^2}{2gD_1} = \frac{fLv_2^2}{2gD_2}$$ sub q

$$v = \frac{0.01417\ m^3/sec}{\pi \cdot 0.0525} = 0.0859$$

Confsed

12.5



$$Q = \frac{500\ L}{m} = \frac{0.5\ m^3}{60\ sec} = 0.0083\ m^3/sec$$

$D_1 = 100m$

$D_2 = 50m$

due to it being parallel:

$H_{L_1} = H_{L_2}$ (sub) → $\frac{fLv_1^2}{2gD_1} + k\frac{v_1^2}{2g} = \frac{fLv_2^2}{2gD_2}$

solve V's

$v_1 = \frac{0.0083\ m^3/sec}{\pi \cdot 0.1^2} = 0.264\ m/s$ $\qquad f = 0.017$

$v_2 = \frac{0.0083\ m^3/sec}{\pi \cdot 0.05^2} = 1.056\ m/s$

(sub all, use online calculator)

$$\frac{0.017 \cdot 20 \cdot (0.264)^2}{2 \cdot 9.81 \cdot 0.1} + k \cdot \frac{(0.264)^2}{2 \cdot 9.81} = \frac{0.017 \cdot 30 \cdot (1.056)^2}{2 \cdot 9.81 \cdot 0.05}$$

$k = 159.8$