MET 330
HOMEWORK 1.3
CHAPTER 6

TEAM BERNOULLI

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6-79)

GIVEN: SPECIFIC GRAVITY OF OIL $= SG_{OIL} = 0.90$
MANOMETER DEFLECTION $= h = 28$ in.

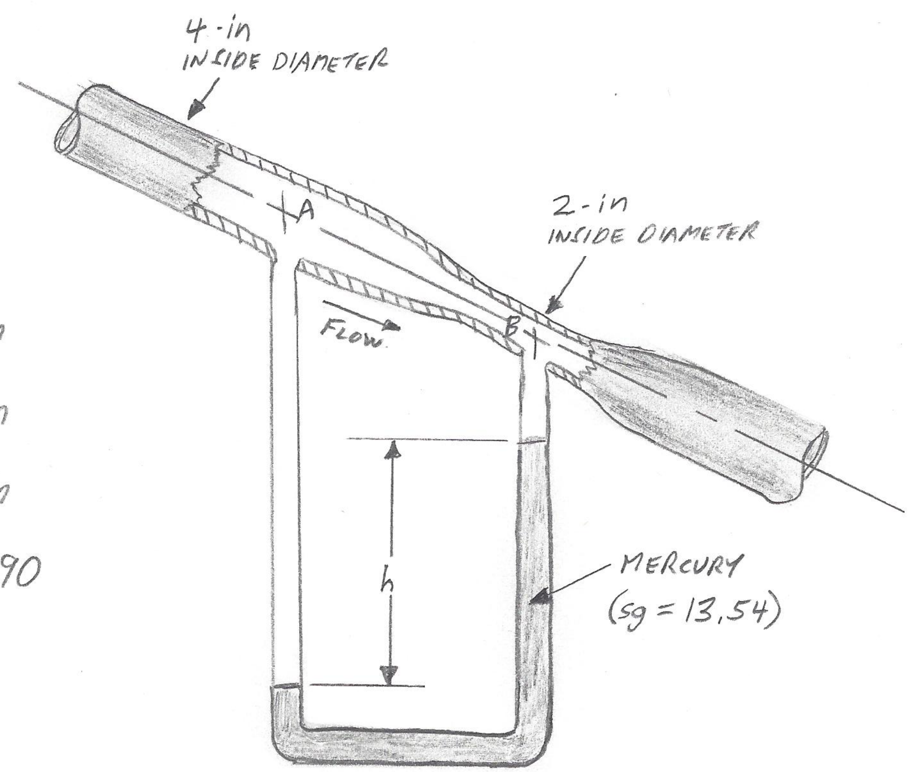
FIND: VOLUME FLOW RATE OF OIL $= Q = Av$

$D_A = 4$ in

$D_B = 2$ in

$h = 28$ in

$sg_{OIL} = 0.90$



CONTINUITY EQUATION: $A_B v_B = A_A v_A$

$$\frac{\pi D_B^2}{4} v_B = \frac{\pi D_A^2}{4} v_A \longrightarrow v_B = \frac{\cancel{\pi} D_A^2}{\cancel{4}} v_A \left(\frac{\cancel{4}}{\cancel{\pi} D_B^2}\right) = \left(\frac{D_A}{D_B}\right)^2 v_A$$

$$v_B = \left(\frac{D_A}{D_B}\right)^2 v_A = \left(\frac{4}{2}\right)^2 v_A = 4 v_A$$

BOURNOLLI'S EQUATION:

$$\frac{P_A}{\gamma_{OIL}} + Z_A + \frac{v_A^2}{2g} = \frac{P_B}{\gamma_{OIL}} + Z_B + \frac{v_B^2}{2g}$$

REWRITTEN: $\dfrac{P_A - P_B}{\gamma_{OIL}} + (Z_A - Z_B) = \dfrac{v_B^2}{2g}\left[1^2 - \left(\frac{1}{4}\right)^2\right] = \dfrac{15 v_B^2}{32g}$

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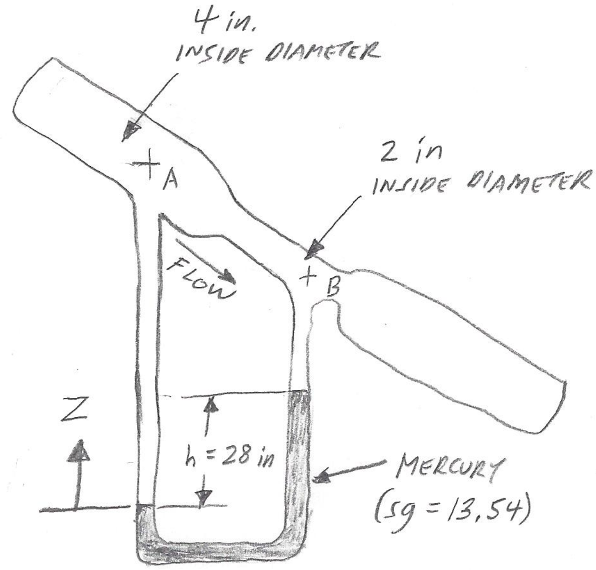
$$Q = \sqrt{\dfrac{2g\left(\dfrac{P_B - P_A}{\gamma} + (Z_A - Z_B)\right)}{\dfrac{1}{A_A^2} - \dfrac{1}{A_B^2}}}$$



FOR THE MANOMETER:

$$(P_A + \gamma_{OIL} Z_A) = P_B + \gamma_{OIL}(Z_B - h) + \gamma_{Hg} h$$

$$\therefore \frac{P_A - P_B}{\gamma_{OIL}} + (Z_A - Z_B) = \frac{(\gamma_{Hg} - \gamma_{OIL})h}{\gamma_{OIL}}$$

$$\left(\frac{13.54 - 0.9}{0.9}\right)\left(\frac{28 \text{ in}}{12 \text{ in}}\right) = 32.77 \text{ ft}$$

$$\therefore 32.77 \text{ ft} = \frac{15 V_B^2}{32g}$$

$$V_B = \sqrt{\frac{(32.77 \text{ ft})(32)(32.2 \text{ ft/s}^2)}{15}} = 47.446 \text{ ft/s}$$

$$A_B = \pi r^2 = (3.1416)\left(\frac{1}{12}\right)^2 = 0.02182 \text{ ft}^2$$

VOLUME FLOW RATE OF OIL $= Q_{OIL} = AV$

$$Q_{OIL} = (0.02182 \text{ ft}^2)(47.446 \text{ ft/s})$$

$$Q_{OIL} = 1.035 \text{ ft}^3/\text{s}$$

82) Given: $\gamma_0 = 55\ lb/ft^3$, $D_A = 4in$, $D_B = 2in$

$$A_A V_A = A_B V_B \Rightarrow \frac{\pi D_A^2}{4} V_A = \frac{\pi D_B^2}{4} V_B \Rightarrow \frac{\pi (4)^2}{4} V_A = \frac{\pi (2)^2}{4} V_B$$

$$V_B = 4V_A$$

Bernoulli's Equation

$$\frac{P_A}{\gamma_0} + z_A + \frac{V_A^2}{2g} = \frac{P_B}{\gamma_0} + z_B + \frac{(4V_A)^2}{2g}$$

$$V_A = \sqrt{\frac{2g}{15}\left(\frac{P_A - P_B}{\gamma} + (z_A - z_B)\right)}$$

$$P_1 = P_A + \gamma_0 h_1$$

$$P_1 = P_A + 64.35\ lb/ft^3 \qquad P_1 = P_2$$

$$P_3 = P_2 - \gamma_{Hg} h_2 \Rightarrow P_A + 22.54\ lb/ft^2$$

$$P_B = P_3 - \gamma_0 h_3 \Rightarrow P_A - 114.96\ lb/ft^2$$

$$P_A - P_B = \underline{114.96}$$

$$V_A = \sqrt{\left(\frac{2 \cdot 32.2}{15}\right)\left(\frac{114.96}{55} + (0-2)\right)} \Rightarrow \underline{0.621\ ft/s}$$

$$A_A = \frac{\pi D_A^2}{4} \Rightarrow \frac{\pi (0.33)^2}{4} \Rightarrow \underline{0.086\ ft^2}$$

$$Q = Av \Rightarrow 0.086 \cdot 0.621 \Rightarrow \boxed{0.053\ ft^3/s}$$

91.) Given: $h = 2.6m$, $h_1 = 0.85m$, $h_2 = 0.075m$

$h_{jet} = h - (h_1 + h_2) \Rightarrow 3.5 - (0.85 + 0.075)$

$= 2.6 - 0.925$

$\boxed{h_{jet} = 1.675m}$