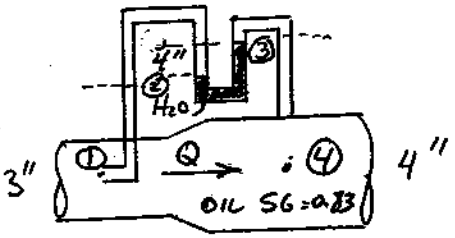
3.30 G: AS SHOWN IN SKETCH; NEGLECT VISCOUS EFFECTS.

F: FLOW RATE



- ① AND ④ ARE ON A STREAMLINE
- STEADY FLOW
- INVISCID
- NO PUMPS (SHAFT WORK)

$$\gamma = \left(62.4\,\frac{\#}{ft^3}\right)(0.83) = 51.8\,\frac{\#}{ft^3}$$

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

$$A_1 = \frac{\pi (0.25)^2}{4} = 0.049\,ft^2$$

$$A_4 = \frac{\pi\, 0.33^2}{4} = 0.086\,ft^2$$

BERNOULLI

$$\frac{P_1}{\gamma} + \cancel{\frac{V_1^2}{2g}}^{\,0} + \cancel{z_1}^{\,0} = \frac{P_4}{\gamma} + \frac{V_4^2}{2g} + \cancel{z_4}^{\,0}$$

STAGNATION

$$Q = A\,V$$

$$Q = A_4\,V_4$$

$$\frac{V_4^2}{2g} = \frac{P_1 - P_4}{\gamma}$$

$$V_4 = \sqrt{2g\,\frac{(P_1 - P_4)}{\gamma}}$$

HYDROSTATICS OF MANOMETER

$$P_1 = P_2 + \gamma_{oil}\,h_{2-1} \qquad P_3 = P_4 - \gamma_{oil}\,h_{3-4}$$

$$P_2 = P_3 + \gamma_{H_2O}\left(\tfrac{1}{3}'\right)$$

$$h_{3-4} - h_{2-1} = \tfrac{1}{3}'$$

$$P_1 = P_3 + \gamma_{H_2O}\left(\tfrac{1}{3}'\right) + \gamma_{oil}\,h_{2-1}$$

$$P_1 = P_4 - (\gamma_{oil})(h_{3-4}) + (\gamma_{oil})(h_{2-1}) + \gamma_{H_2O}\left(\tfrac{1}{3}'\right)$$

$$P_1 = P_4 + (\gamma_{H_2O} - \gamma_{oil})\left(\tfrac{1}{3}'\right)$$

$$V_4 = \sqrt{2g\left[\frac{(\gamma_{H_2O} - \gamma_{oil})\left(\frac{1}{3}'\right)}{\gamma_{oil}}\right]} = \sqrt{2\left(32.2\,\frac{ft}{s^2}\right)\left[\frac{62.4 - 51.8}{51.8}\right]\left(\tfrac{1}{3}\,ft\right)}$$

$$V_4 = 2.1\,\frac{ft}{s}$$

$$Q = A_4 V_4 = \left(0.086\,ft^2\right)\left(2.1\,\frac{ft}{s}\right) = \boxed{0.183\,\frac{ft^3}{s}}$$