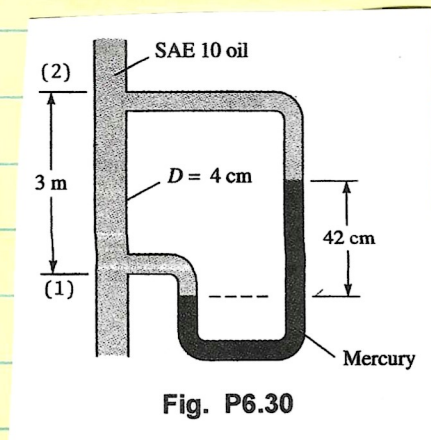


6.30 SAE 10 oil at 20°C flows through the 4-cm-diameter vertical pipe of Fig. P6.30. For the mercury manometer reading  $h = 42$  cm shown, (a) calculate the volume flow rate in  $\text{m}^3/\text{h}$ , and (b) state the direction of flow.



$$p_1 - \rho_m (0.42) - \rho_o (3 - 0.42) = p_2$$

$$p_1 - p_2 = \underbrace{(\rho_m - \rho_o)g \times 0.42}_{52,120 \text{ Pa}} + \underbrace{\rho_o g (3)}_{25,604 \text{ Pa}}$$

$$\frac{\Delta p}{\rho_o} \approx 6.12 \text{ m} \text{ neglect } \uparrow \uparrow$$

ie flow from 1  $\rightarrow$  2

$$\frac{p_1 - p_2}{\rho_o} = z_2 - z_1 + h_f \quad h_f = \frac{128 \mu L Q}{\pi \rho_o d^4}$$

$$6.12 = 3 + h_f$$

$$Q = 0.00536 \frac{\text{m}^3}{\text{s}} = 19.3 \frac{\text{m}^3}{\text{h}}$$

$$Re = 4eQ / \pi \mu d = 1430 \text{ OK}$$