For the Venturi meter shown in Figure, the deflection of mercury in the differential gage is 14.3 in. Determine the flow rate \( Q \) of water through the meter. Assume no energy loss between \( A \) and \( B \). (Note: 1 ft = 12 in, \( \gamma = 64.2 \) lb/ft\(^3\) for water, \( \text{SG} = 13.6 \) for mercury, and \( g = 32.2 \) ft/s\(^2\))

Bernoulli’s Equation:

\[
\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2
\]
Solution: Format (+3)

Manometer

\[ p_A + \left( z + \frac{14.3}{12} \right) \gamma - \frac{14.3}{12} (SG \cdot \gamma) - \left( z + \frac{30}{12} \right) \gamma = p_B \]

\[ \therefore \Delta p = p_A - p_B = \left( \frac{30}{12} + \left( \frac{14.3}{12} - 1 \right) \cdot (13.6) \right) (64.2) = 1124.46 \text{ lb/ft}^2 \quad (+1) \]

Continuity equation

\[ A_A V_A = A_B V_B \]

\[ V_A = \left( \frac{A_B}{A_A} \right) V_B = \left( \frac{6}{12} \right)^2 V_B = 0.25V_B \quad (+1) \]

Bernoulli equation

\[ \frac{p_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{p_B}{\gamma} + \frac{V_B^2}{2g} + z_B \]

\[ \frac{p_A}{64.2} + \frac{(0.25V_B)^2}{(2)(32.2)} + z_A = \frac{p_B}{64.2} + \frac{V_B^2}{(2)(32.2)} + \left( z_A + \frac{30}{12} \right) \]

\[ \therefore V_B = \sqrt{\frac{(2)(32.2) \left( \frac{p_A - p_B}{64.2} - \frac{30}{12} \right)}{1 - 0.25^2}} = 32.12 \text{ ft/s} \quad (+4) \]

\[ \therefore Q = A_B V_B = \left( \frac{\pi (6/12)^2}{4} \right) (32.12) = 6.31 \text{ ft}^3 / \text{s} \quad (+1) \]