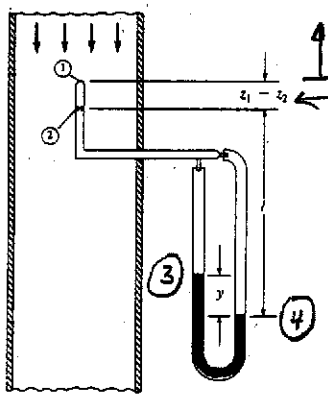
GIVEN:

A mercury–kerosene manometer is connected to the Pitot tube as shown. If the deflection on the manometer is 7 in., what is the kerosene velocity in the pipe? Assume that the specific gravity of the kerosene is 0.81.

EXAMPLE 4.4



LET $C = z_1 - z_2$

FIND: KEROSENE VELOCITY

SOLUTION: PITOT-STATIC TUBE EQUATION FROM PAGE 146, TEXT.

$$V = \sqrt{2g\left[\frac{1}{\gamma_K}(p_1 - p_2) + z_1 - z_2\right]}$$

MANOMETER IS USED TO MEASURE $(p_1 - p_2)$.
USE PIEZOMETRIC HEAD EQUATION TO ANALYZE MANOMETER.

① TO ④ $\quad p_1 + \gamma_K \cancel{z_1}^{\,0} = p_4 + \gamma_K z_4 \quad , \quad z_4 = -C - \ell$

④ TO ③ $\quad p_4 + \gamma_m z_4 = p_3 + \gamma_m z_3$

$$p_4 - p_3 = \gamma_m (z_3 - z_4) = \gamma_m y$$

② TO ③ $\quad p_2 + \gamma_K z_2 = p_3 + \gamma_K z_3 \quad , \quad z_2 = -C \quad , \quad z_3 = -C - \ell + y$

COMBINE THESE EQUATIONS TO ELIMINATE p_3 AND p_4.

① TO ④ $\quad p_4 = p_1 - \gamma_K z_4$

④ TO ③ $\quad p_4 - p_3 = \gamma_m y \Rightarrow p_1 - p_3 = \gamma_m y + \gamma_K z_4$

② TO ③ $\quad p_3 = p_2 + \gamma_K (z_2 - z_3)$

$$p_1 - p_2 = \gamma_m y + \gamma_K z_4 + \gamma_K (z_2 - z_3)$$

$$p_1 - p_2 = \gamma_m y + \gamma_K (-C - \ell - C + C + \ell - y) = (\gamma_m - \gamma_K) y - \gamma_K C$$

$$V = \sqrt{2g\left[\left(\frac{\gamma_m}{\gamma_K} - 1\right) y + z_1 - z_2 - C\right]} \qquad \text{BUT } C = z_1 - z_2$$

$$V = \sqrt{2g\left(\frac{\gamma_m}{\gamma_K} - 1\right) y} = \sqrt{2 \cdot 32.2 \frac{FT}{S^2} (16.7 - 1) \frac{7\,IN}{12\,IN/FT}}$$

$$V = 24.3 \frac{FT}{S}$$