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**

**FRAME: KEROSENE VELOCITY**

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

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

**MANOMETER IS USED TO MEASURE (p_1 - p_2).**

**USE PIEZOMETRIC HEAD EQUATION TO ANALYZE MANOMETER.**

1. TO 4 \[ p_1 + \gamma_k z_1^0 = p_4 + \gamma_k z_4 \]
2. TO 3 \[ p_4 + \gamma_m z_4 = p_3 + \gamma_m z_3 \]
3. \[ p_4 - p_3 = \gamma_m (z_3 - z_4) = \gamma_m y \]
4. TO 3 \[ p_2 + \gamma_k z_2 = p_3 + \gamma_k z_3, \quad z_2 = -C, \quad z_3 = -C - l + y \]

**COMBINE THESE EQUATIONS TO ELIMINATE p_3 AND p_4.**

1. TO 4 \[ p_4 = p_1 - \gamma_k z_4 \]
2. TO 3 \[ p_4 - p_3 = \gamma_m y \Rightarrow p_1 - p_3 = \gamma_m y + \gamma_k z_4 \]
3. TO 3 \[ p_3 = p_2 + \gamma_k (z_2 - z_3) \]

\[ p_1 - p_2 = \gamma_m y + \gamma_k z_4 + \gamma_k (z_2 - z_3) \]

\[ p_1 - p_2 = \gamma_m y + \gamma_k (-C - l - C + C + l - y) = (\gamma_m - \gamma_k) y - \gamma_k C \]

\[ V = \sqrt{2g \left[ \left( \frac{\gamma_m}{\gamma_k} - 1 \right)y + z_1 - z_2 - C \right]} \]

**BUT** \[ C = z_1 - z_2 \]

\[ V = \sqrt{2g \left( \frac{\gamma_m}{\gamma_k} - 1 \right)y} = \sqrt{2 \cdot 32.2 \times \frac{\text{ft}}{s^2} (16.7 - 1) \cdot \frac{7\text{in}}{12\text{in/ft}}} \]

\[ V = 24.3 \frac{\text{ft}}{s} \]