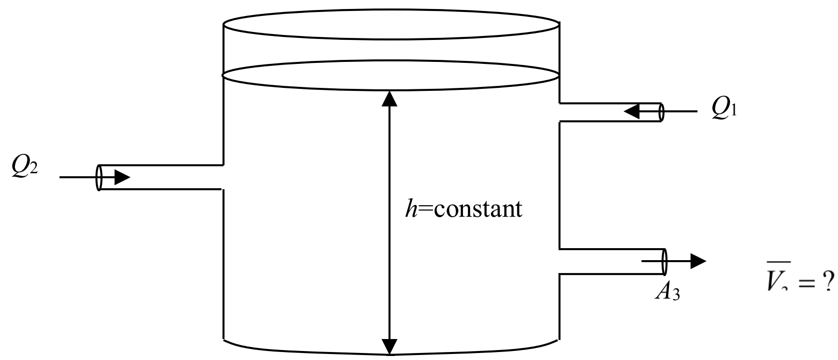
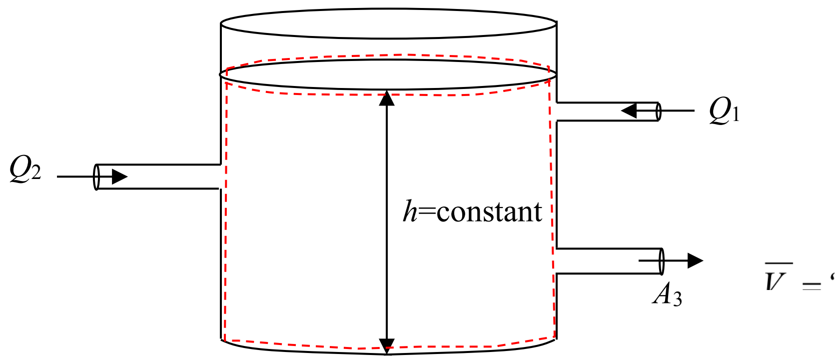
Water enters a cylindrical tank through two pipes at volumetric flow rates of Q_1 and Q_2. If the level in the tank remains constant, calculate the average velocity of the flow leaving the tank through a pipe with an area, A_3.



SOLUTION:

Apply conservation of mass to the fixed control volume shown below.



$$\frac{d}{dt}\int_{\mathrm{CV}} \rho dV + \int_{\mathrm{CS}} \rho \mathbf{u}_{\mathrm{rel}} \cdot d\mathbf{A} = 0 \tag{1}$$

where

$$\frac{d}{dt}\int_{\mathrm{CV}} \rho dV = 0 \quad \text{(steady flow, the mass in the control volume isn't changing with time)}$$

$$\int_{\mathrm{CS}} \rho \mathbf{u}_{\mathrm{rel}} \cdot d\mathbf{A} = -\rho Q_2 - \rho Q_1 + \rho \overline{V}_3 A_3$$

Substitute and re-arrange.

$$-\rho Q_2 - \rho Q_1 + \rho \overline{V}_3 A_3 = 0$$

$$\boxed{\therefore \overline{V}_3 = \frac{Q_1 + Q_2}{A_3}} \tag{2}$$