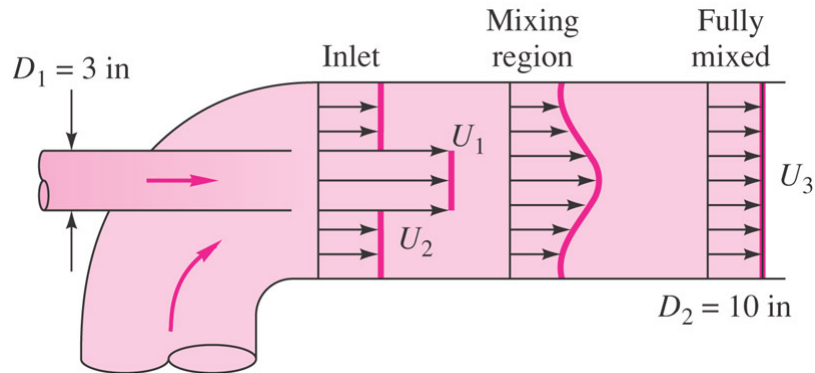NAME

Fluids-ID

Quiz 4. A jet pump injects water at U_1 = 40 m/s through a 3-in-pipe and entrains a secondary flow of water U_2 = 3 m/s in the annular region around the small pipe. The two flows become fully mixed downstream, where U_3 is approximately constant. For steady incompressible flow, compute U_3 in m/s.

Solution:

For incompressible flow, the volume flows at inlet and exit must match,

$$Q_1 + Q_2 = Q_3$$

or,

$$\frac{\pi}{4}D_1^2 U_1 + \frac{\pi}{4}(D_2^2 - D_1^2)U_2 = \frac{\pi}{4}D_2^2 U_3$$

Then,

$$U_3 = \frac{D_1^2 U_1 + (D_2^2 - D_1^2)U_2}{D_2^2} = \left(\frac{D_1}{D_2}\right)^2 U_1 + \left(1 - \left(\frac{D_1}{D_2}\right)^2\right)U_2$$

$$= \left(\frac{3\,\text{in}}{10\,\text{in}}\right)^2 \times 40\,\text{m/s} + \left(1 - \left(\frac{3\,\text{in}}{10\,\text{in}}\right)^2\right) \times 3\,\text{m/s} = 6.33\,\text{m/s}$$

Ans) $U_3 = 6.33\,\text{m/s}$