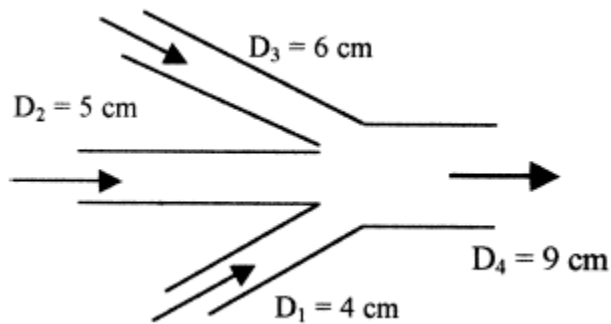


October 22, 2014

NAME

Fluids-ID

Quiz 6. Three pipes steadily deliver water to a large exit pipe in Figure. The velocity  $V_2=5$  m/s, and the exit flow rate  $Q_4=0.0333$  m<sup>3</sup>/s. Find  $V_1$ , and  $V_3$  if it is know that increasing  $Q_3$  by 20% would increase  $Q_4$  by 10%.



Note: Attendance (+2 points), format (+1 point)

**Solution:**

Continuity eq. for fixed CV with 1D flow and discrete CS's,

$$0 = \sum \dot{m}_{out} - \sum \dot{m}_{in} \quad (+4 \text{ points})$$

Where  $\dot{m} = \rho Q = \rho VA$ , thus

$$0 = (\rho Q_4) - (\rho V_1 A_1 + \rho V_2 A_2 + \rho V_3 A_3)$$

Or

$$0 = Q_4 - (V_1 A_1 + V_2 A_2 + V_3 A_3) \quad (+1 \text{ point})$$

Since  $0.2Q_3=0.1Q_4$

$$V_3 = \frac{Q_4}{2A_3} = \frac{0.0333}{\frac{\pi}{2}0.06^2} = 5.89 \frac{m}{s} \quad (+1 \text{ point})$$

Substituting  $V_3$

$$0 = 0.0333 - \left( V_1 \frac{\pi}{4} 0.04^2 + 5 \frac{\pi}{4} 0.05^2 + 5.98 \frac{\pi}{4} 0.06^2 \right)$$

Solving for  $V_1$

$$V_1 = 5.43 \frac{m}{s} \quad (+1 \text{ point})$$