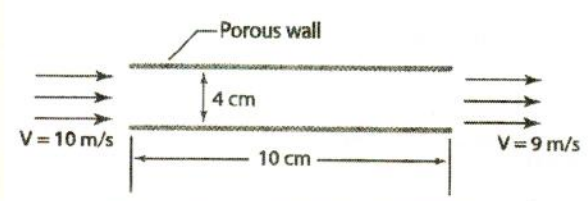
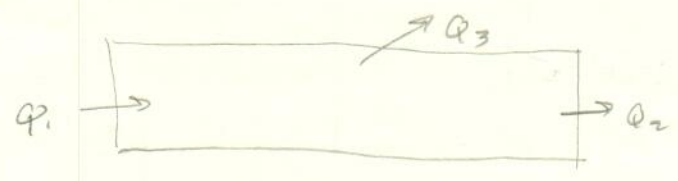


Water flows steadily through a 4 cm diameter pipe that is 10 cm long. The pipe wall is porous, leading to a small flow through the wall. The inlet velocity is 10 m/s and the average exit velocity is 9 m/s.



Find the average velocity of the water that is passing through the porous surface.



Continuity eqn for incompressible fluids { for steady flow

$$Q_1 = Q_2 + Q_3$$

$$V_1 A_1 = V_2 A_2 + V_3 A_3$$

$$\therefore V_3 = \frac{V_1 A_1 - V_2 A_2}{A_3}$$

$$= (V_1 - V_2) \frac{A_1}{A_3}$$

$$= (10 - 9) \frac{\text{m}}{\text{s}} \left( \frac{.0004 \pi}{.004 \pi} \right)$$

$$= (1)(.1)$$

$$V_3 = 0.1 \text{ m/s}$$

$$\Rightarrow V_3 = 10 \text{ cm/s}$$

ans

$$A_1 = A_2 = \frac{\pi}{4} (0.04 \text{ m})^2 = .0004 \pi \text{ m}^2 = 0.001257 \text{ m}^2$$

$$A_3 = \pi D L = \pi (.04 \text{ m})(.1 \text{ m}) = 0.004 \pi \text{ m}^2 = 0.01257 \text{ m}^2$$

Note:  $Q_1 = V_1 A_1 = (10 \text{ m/s})(0.0004 \pi \text{ m}^2) = 0.01257 \text{ m}^3/\text{s}$

$$Q_2 = V_2 A_2 = (9)(0.0004 \pi) = 0.01131 \text{ m}^3/\text{s}$$

$$\therefore Q_3 = Q_1 - Q_2 = 0.00126 \text{ m}^3/\text{s}$$