(b) The water in the stagnation tube will rise above the jet surface by an amount equal to the stagnation pressure head of the jet:

$$\mathbf{H} = R_{jet} + \frac{V_{jet}^2}{2g} = 0.02\ \text{m} + \frac{(4.19)^2}{2(9.81)} = 0.02 + 0.89 = \mathbf{0.91\ m} \quad \textit{Ans.}\ \text{(b)}$$

3.165 A *venturi meter*, shown in Fig. P3.165, is a carefully designed constriction whose pressure difference is a measure of the flow rate in a pipe. Using Bernoulli's equation for steady incompressible flow with no losses, show that the flow rate Q is related to the manometer reading h by

$$Q = \frac{A_2}{\sqrt{1-(D_2/D_1)^4}}\sqrt{\frac{2gh(\rho_M - \rho)}{\rho}}$$

where ρM is the density of the manometer fluid.

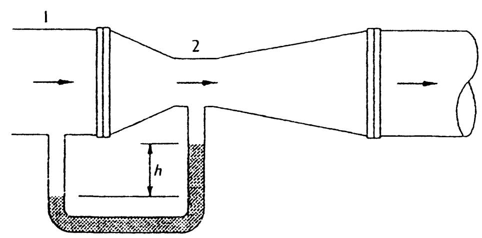

Fig. P3.165

Solution: First establish that the manometer reads the pressure difference between 1 and 2:

$$p_1 - p_2 = (\rho_M - \rho)gh \qquad (1)$$

Then write incompressible Bernoulli's equation and continuity between (1) and (2):

$$(\Delta z = 0):\quad \frac{p_1}{\rho} + \frac{V_1^2}{2} \approx \frac{p_2}{\rho} + \frac{V_2^2}{2} \quad \text{and} \quad V_2 = V_1(D_1/D_2)^2, \quad Q = A_1V_1 = A_2V_2$$

Eliminate V_2 and $(p_1 - p_2)$ from (1) above: $\mathbf{Q} = \dfrac{\mathbf{A_2}\sqrt{\mathbf{2gh}(\rho_\mathbf{M} - \rho)/\rho}}{\sqrt{\mathbf{1-(D_2/D_1)^4}}}$ *Ans.*

3.166 A wind tunnel draws in sea-level standard air from the room and accelerates it into a 1-m by 1-m test section. A pressure transducer in the test section wall measures Δp = 45 mm water between inside and outside. Estimate (a) the test section velocity in mi/hr; and (b) the absolute pressure at the nose of the model.