3.98

3.98 A conical plug is used to regulate the air flow from the pipe shown in Fig. P3.98. The air leaves the edge of the cone with a uniform thickness of 0.02 m. If viscous effects are negligible and the flowrate is 0.50 m³/s, determine the pressure within the pipe.

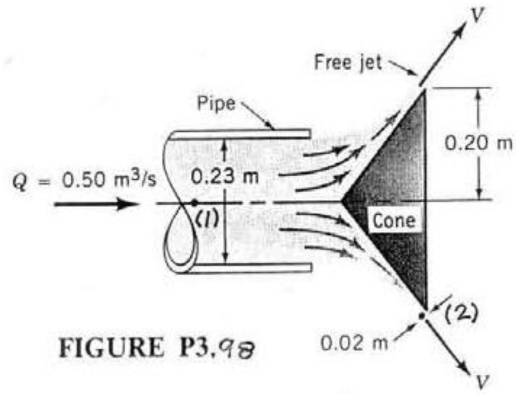

FIGURE P3.98

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

where $p_2 = 0$ and $z_2 - z_1 \approx 0$ along the circumference of the cone. Also,

$$V_1 = \frac{Q}{A_1} = \frac{0.5\ \frac{m^3}{s}}{\frac{\pi}{4}(0.23\ m)^2} = 12.0\ \frac{m}{s}$$

and

$$V_2 = \frac{Q}{A_2} = \frac{Q}{2\pi Rh} = \frac{0.5\ \frac{m^3}{s}}{2\pi(0.2\ m)(0.02\ m)} = 19.9\ \frac{m}{s}$$

Thus,

$$p_1 = \frac{1}{2}\rho(V_2^2 - V_1^2) = \frac{1}{2}\left(1.23\ \frac{kg}{m^3}\right)(19.9^2 - 12.0^2)\ \frac{m^2}{s^2} = 155\ \frac{N}{m^2}$$