Master Typing Sheet
10% Reduction
8 1/2 x 11 trim size

8.27

8.27 Water at 80 °F flows in a 6-in.-diameter pipe with a flowrate of 2.0 cfs. What is the approximate velocity at a distance 2.0 in. away from the wall? Determine the centerline velocity.

$$V = \frac{Q}{A} = \frac{2.0\,\frac{ft^3}{s}}{\frac{\pi}{4}\left(\frac{6}{12}\,ft\right)^2} = 10.2\,\frac{ft}{s} \text{ so that } Re = \frac{VD}{\nu} = \frac{\left(10.2\,\frac{ft}{s}\right)\left(\frac{6}{12}\,ft\right)}{9.26\times10^{-6}\,\frac{ft^2}{s}} = 5.51\times10^5$$

The flow is turbulent with $\frac{\bar{u}}{V_c} = \left(1-\frac{r}{R}\right)^{\frac{1}{n}}$, where $n \approx 8.3$ (see Fig. 8.17)

Thus, (see Example 8.4)

$$\frac{V}{V_c} = \frac{2n^2}{(n+1)(2n+1)} = \frac{2(8.3)^2}{(8.3+1)(2\times8.3+1)} = 0.842$$

or

$$V_c = \frac{10.2\,\frac{ft}{s}}{0.842} = \underline{\underline{12.1\,\frac{ft}{s}}}$$

Also, at $r = 3\,in. - 2.0\,in. = 1.0\,in.$, $\bar{u} = V_c\left(1-\frac{r}{R}\right)^{\frac{1}{n}} = 12.1\,\frac{ft}{s}\left(1-\frac{1.0\,in.}{3\,in.}\right)^{\frac{1}{8.3}} = \underline{\underline{11.5\,\frac{ft}{s}}}$