side diameter. A maximum safe speed must be determined, as the stresses increase with the square of the rotational speed. When a flywheel fails while spinning, it typically flies apart and can cause serious injury.

All spinning shafts will have critical frequencies at which they will resonate with large deflections, causing failure. The fundamental lateral and torsional frequencies will be different and both must be avoided in operation by keeping the rotational speed well below the lowest critical frequency of the shaft.

A wide variety of shaft couplings are commercially available. Some types and their characteristics are briefly discussed in this chapter. The manufacturers should be consulted for more complete and definitive information.

Important Equations Used in This Chapter

See the referenced sections for information on the proper use of these equations.

Power-Torque Relationship (Section 10.4):

$$P = T\omega \tag{10.1a}$$

ASME Shaft-Design Equation (Section 10.8):

$$d = \left\{ \frac{32N_f}{\pi} \left[\left(K_f \frac{M_a}{S_f} \right)^2 + \frac{3}{4} \left(\frac{T_m}{S_y} \right)^2 \right]^{\frac{1}{2}} \right\}^{\frac{1}{3}} \tag{10.6b}$$

General Shaft-Design Equation (Section 10.8):

$$d = \left\{ \frac{32N_f}{\pi} \left[\frac{\sqrt{\left(K_f M_a\right)^2 + \frac{3}{4}\left(K_{fs} T_a\right)^2}}{S_f} + \frac{\sqrt{\left(K_{fm} M_m\right)^2 + \frac{3}{4}\left(K_{fsm} T_m\right)^2}}{S_{ut}} \right] \right\}^{\frac{1}{3}} \tag{10.8}$$

Shaft Torsional Deflection (Section 10.9):

$$\theta = \frac{Tl}{GJ} \tag{10.9a}$$

Pressure Generated by an Interference Fit (Section 10.11):

$$p = \frac{0.5\delta}{\frac{r}{E_o}\left(\frac{r_o^2 + r^2}{r_o^2 - r^2} + \nu_o\right) + \frac{r}{E_i}\left(\frac{r^2 + r_i^2}{r^2 - r_i^2} - \nu_i\right)} \tag{10.14a}$$

Tangential Stresses in Shaft and Hub of an Interference Fit (Section 10.11):

$$\sigma_{t_{shaft}} = -p\frac{r^2 + r_i^2}{r^2 - r_i^2} \tag{10.15a}$$