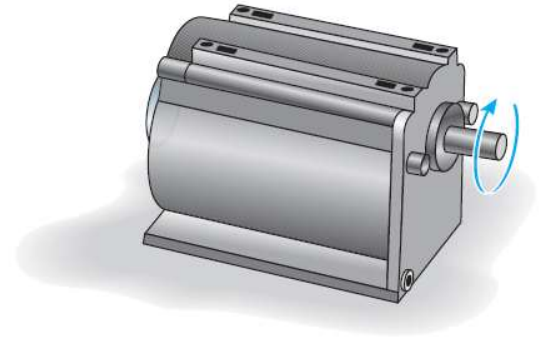


5-34. The gear motor can develop 3 hp when it turns at 150 rev/min. If the allowable shear stress for the shaft is 12 ksi, determine the smallest diameter of the shaft to the nearest 1/8 inch that can be used.

5-34. The gear motor can develop 3 hp when it turns at 150 rev/min. If the allowable shear stress for the shaft is $\tau_{\text{allow}} = 12 \text{ ksi}$, determine the smallest diameter of the shaft to the nearest $\frac{1}{8} \text{ in.}$ that can be used.

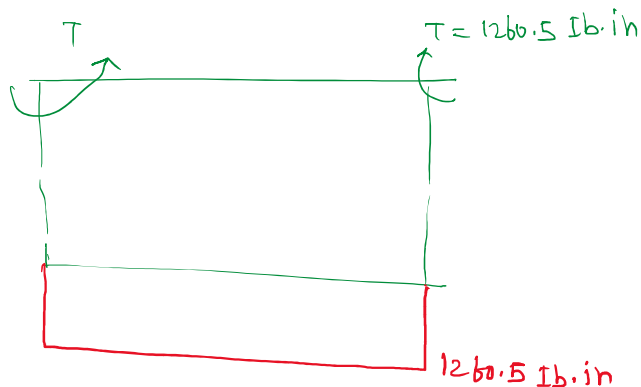


$$T = \frac{P}{\omega}$$

$$P = 3 \text{ hp} \times 550 = 1650 \text{ ft} \cdot \text{lb/s}$$

$$\omega = 2\pi N = 2\pi \times \frac{150}{60} = 5\pi \text{ rad/s}$$

$$\Rightarrow T = \frac{1650}{5\pi} = 105 \text{ lb} \cdot \text{ft} \times 12 = 1260.5 \text{ lb} \cdot \text{in}$$



$$T_{\text{max, abs}} = 1260.5 \text{ lb} \cdot \text{in}$$

Shaft is always designed for absolute maximum torque

We know

$$\frac{\tau}{R} = \frac{T}{J}$$

$$\tau = 12 \text{ ksi [Given]} = 12 \times 10^3 \text{ lb/in}^2$$

$$R = \frac{d}{2} ; J = \frac{\pi}{2} \left(\frac{d}{2}\right)^4 ; T = T_{\max, \text{abs}} = 1260.5 \text{ lb.in}$$

$$\Rightarrow \frac{12 \times 10^3}{(\cancel{d/2})} = \frac{1260.5 \text{ lb.in}}{\frac{\pi}{2} (\cancel{d/2})^4 \cdot 3}$$

$$\text{Solving for } d, \text{ yields, } d = 0.8118 \text{ inch} = \frac{7}{8} \text{ inches}$$



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