Torsion in Shafts. Question 5-36 Solution

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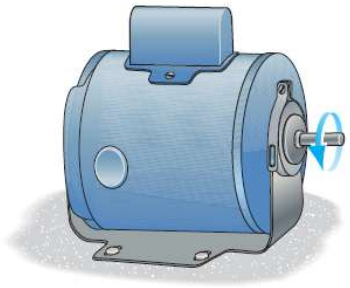
*5-36. The drive shaft of the motor is made of a material having an allowable shear stress of T_{allow} 75 MPa. If the outer diameter of the tubular shaft is 20 mm and the wall thickness is 2.5 mm, determine the maximum allowable power that can be supplied to the motor when the shaft is operating at an angular velocity of 1500 rev/min.

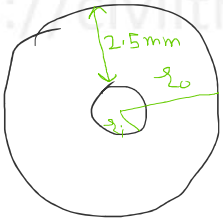
***5–36.** The drive shaft of the motor is made of a material having an allowable shear stress of $\tau_{allow} = 75$ MPa. If the outer diameter of the tubular shaft is 20 mm and the wall thickness is 2.5 mm, determine the maximum allowable power that can be supplied to the motor when the shaft is operating at an angular velocity of 1500 rev/min.



Given Data :

$\tau_{allow} = 75 MPa = 75 \times 10^6 N/m^2$

$N = 1500 RPM$



$r_o = \frac{d_o}{2} = \frac{20mm}{2} = 10mm$

$r_i = r_o - 2.5mm$

$= 7.5mm$

To find :

$P = ?$

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

$\Rightarrow P = T \times \omega$

T = internal torque

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

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

$\tau = 75 \times 10^6 N/m^2$ [given]

$R = 10mm = 0.01 m$

$J = \frac{\pi}{2}(r_o^4 - r_i^4) = \frac{\pi}{2}\left[(0.01\,m)^4 - (0.0075\,m)^4\right] = 3.4\pi \times 10^{-9} m^4$

$\Rightarrow T = \frac{3.4\pi \times 10^{-9} m^4}{0.01 m} \times 75 \times 10^6 N/m^2 = 80.11 N.m$

$\omega = 2\pi N = 2\pi \times 1500/ = 157.08 rad/s$

$\omega = 2\pi N = 2\pi \times 1500/60 = 157.08$ m/s

$\Rightarrow$ Power, $P = 80.11$ N.m $\times$ 157.08 m/s $= 12583.65$ watt $\simeq 12.6$ KW

~~ANS.~~

Solved by Civil Thinking