Shigley's Mechanical Engineering Design | (10th Edition)

Chapter 8, Problem 6P | 13 Bookmarks | Show all steps: ON

Problem

The press shown for Prob. 8-5 has a rated load of 5000 lbf. The twin screws have Acme threads, a diameter of 2 in, and a pitch of $\frac{1}{4}$ in Coefficients of friction are 0.05 for the threads and 0.08 for the collar bearings. Collar diameters are 3.5 in. The gears have an efficiency of 95 percent and a speed ratio of 60:1. A slip clutch, on the motor shaft, prevents overloading. The full- load motor speed is 1720 rev/min.

(*a*) When the motor is turned on, how fast will the press head move?

(*b*) What should be the horsepower rating of the motor?

Step-by-step solution

Step 1 of 6

Given data:

Diameter of the power screw, $d = 2$ in

Pitch of the screw, $P = 0.25$ in

Load acting on the screw, $F = 5000$ lbf

Coefficient of friction of collar, $f_c = 0.08$

Coefficient of friction of thread, $f_t = 0.05$

Diameter of collar, $d_c = 3.5$ in

Speed ratio of the gears is $60:1$

Speed of the load motor, $N = 1720$ rev/min

Efficiency of the gears is, $95\ \%$

Comment

Step 2 of 6

a)

Given that speed ratio, $\left(\dfrac{\text{Speed of Motor}}{\text{Speed of Press Head}}\right) = 60:1$

Therefore, Speed of press head is,

$$N = \frac{\text{Speed of Motor}}{\text{Speed Ratio}}$$

$$N = \frac{1720}{60}$$

$$\boxed{N = 28.67 \text{ rev/min}}$$

Linear speed of press head is given by,

$$v = N \times l$$

$$v = 28.66 \times 0.25 \qquad (l = P \text{ for single threaded screws})$$

$$v = 7.167 \text{ in/min}$$

Comment

Step 3 of 6

b)

The rated load is given for twin screws.

Therefore, the rated load for single screw is,

$$F = \frac{5000}{2}$$

$$F = 2500 \text{ lbf/screw}$$

Major diameter $(d_m) = d - \frac{P}{2}$

$$= 2 - \frac{0.25}{2}$$

$$= 1.875 \text{ in}$$

Comment

Step 4 of 6

The angle between acme threads, $2\alpha = 29°$

Therefore, $\sec\alpha = 1.033$

For raising the load or for tightening a screw or bolt

$$T_R = \frac{Fd_m}{2}\left(\frac{l + \pi f_t d_m \sec\alpha}{\pi d_m - f_t l \sec\alpha}\right)$$

$$T_R = \left(\frac{(2500 \text{ lbf}) \times (1.875 \text{ in})}{2}\right)\left(\frac{(0.25 \text{ in}) + \pi \times 0.05 \times (1875 \text{ in}) \times 1.033}{\pi \times (1.875 \text{ in}) - 0.05 \times (0.25 \text{ in}) \times 1.033}\right)$$

$$T_R = 2343.75 \times \left(\frac{0.5542}{5.8776}\right) \text{ lbf-in}$$

$$T_R = 220.99 \text{ lbf-in}$$

$$T_R = 221 \text{ lbf-in}$$

Comments (3)

Step 5 of 6

Torque due to collar friction is given by,

$$T_C = \frac{Ff_c d_c}{2}$$

$$T_C = \frac{2500 \times 0.08 \times 3.5}{2}$$

$$T_C = 350 \text{ lbf-in}$$

Comment

Step 6 of 6

Total torque $(T_{total}) = T_R + T_C$

$$= 221 + 350$$

speed ratio×e

$$= \frac{571 \times 2}{60 \times 0.95}$$

$$= 20.035 \text{ lbf-in}$$

Power rating of the motor is given by,

$$H = TN$$

$$H = \frac{\left(\frac{20.035}{12} \text{ lbf-ft}\right) \times 2\pi \times (1720 \text{ rpm})}{33000}$$

$$H = 0.5467\, HP$$

$$\boxed{H = 0.55\, HP}$$