Chapter 10, Problem 2

A journal bearing has a 4-in. length, a 3-in. diameter, a *c/r* ratio of 0.002, carries a 500-lb

radial load at 24,000 rpm, and is supplied with an oil having a viscosity of 0.6 μreyns. Using the Petroff approach, estimate

(*a*) The frictional torque developed.

(*b*) The frictional horsepower.

(*c*) The coefficient of friction.

Chapter 10, Solution 2

(a) $T_f = \frac{4\pi^2 \eta L r^3 n}{c} = \frac{4\pi^2 (0.6\times10^{-6})(4)(1.5)^3 (24000/60)}{0.003} = 42.64\ lb \cdot in.$

(b) $hp = \frac{T_f n}{1050} = \frac{42.64(400)}{1050} = 16.24$

(c) $f = \frac{T_f}{Wr} = \frac{42.64}{500(1.5)} = 0.057$

Chapter 10, Solution 9

$\frac{h_0}{c} = \frac{0.001}{0.0025} = 0.4$, Figure 10.13: $S = 0.13, \quad L/D = 1$

$$S = (\tfrac{r}{c})^2 \tfrac{\eta n}{P} = (\tfrac{2}{0.0025})^2 \tfrac{\eta(900/60)}{100}, \quad \eta = 1.35\ \mu reyn$$

(a) Fig.10.7: $t = 172^o\ \ F$ ◂

(b) Fig.10.14: $\tfrac{r}{c} f = 3, \quad f = 3(\tfrac{0.0025}{2}) = 0.00375$ ◂

(c) $T_f = fWr = 0.00375(100 \times 4 \times 4)(2) = 12\ lb \cdot in.$

$hp = \tfrac{T_f n}{1050} = \tfrac{12(15)}{1050} = 0.171$ ◂

Chapter 10, Solution 13

$$c = 0.0015(50) = 0.075\ mm, \qquad \tfrac{h_0}{c} = \tfrac{0.025}{0.075} = \tfrac{1}{3}, \quad L/D = 1/2$$

Figure 10.13: S=0.022

$$P = \tfrac{W}{DL} = \tfrac{8000}{(0.1)(0.05)} = 1.6\ MPa \qquad n = 900/60 = 15\ rps$$

(a) Equation (10.17):

$$\eta = \tfrac{SP}{n}(\tfrac{c}{r})^2 = \tfrac{0.22(1.6 \times 10^6)}{15}(0.0015)^2 = 52.8\ mPa \cdot s$$ ◂

(b) Figure 10.14: $\tfrac{r}{c} f = 6.5, \quad f = 6.5(0.0015) = 0.01$

$$F = fW = 0.01(8000) = 80\ N$$

$$kW = \tfrac{T_f n}{159} = \tfrac{(80 \times 0.050)15}{159} = 0.377$$ ◂

Chapter 10, Problem 16

A 25-mm (02-series) deep-groove ball bearing carries a combined load of 2 kN radially and 3 kN axially at 1500 rpm. The outer ring rotates and the load is steady. Determine the rating life in hours.

Chapter 10, Solution 16

Table 10.3: $C = 14\ kN \qquad C_s = 6.95\ kN \qquad n = 1500$

Table 10.5: $\frac{F_a}{VF_r} = \frac{3}{1.2(2)} = 1.25 > e \qquad \frac{F_a}{C_s} = \frac{3}{6.95} = 0.432$

$X = 0.56 \qquad Y = 1.037$ (by interpolation)

Thus, we obtain

$$P = XVF_r + YF_a = 0.56(1.2)(2) + 1.037(3) = 4.455\ kN$$ ◂

or

$$P = VF_r = 1.2(2) = 2.4\ kN$$

Hence

$$L_{10} = \frac{10^6}{60n}\left(\frac{C}{P}\right)^a = \frac{10^6}{60(1500)}\left(\frac{14}{4.455}\right)^3 = 344.8\ \ hr$$ ◂

Chapter 10, Problem 17

Resolve Problem 10.16, for a single-row, angular-contact ball bearing having 35° contact angle.

Chapter 10, Problem 16

A 25-mm (02-series) deep-groove ball bearing carries a combined load of 2 kN radially and 3 kN axially at 1500 rpm. The outer ring rotates and the load is steady. Determine the rating life in hours.

Chapter 10, Solution 17

Table 10.3: $C = 14.8\ kN \qquad C_s = 7.65$

Table 10.6: $\frac{F_a}{VF_r} = 1.25 > e = 0.95; \quad X = 0.37, \quad Y = 0.66$

We have then

$$P = XVF_r + YF_a = 0.37(1.2)(2) + 0.66(3) = 2.868\ kN$$

or

$$P = VF_r = 1.2(2) = 2.4\ kN$$

Thus

$$L_{10} = \frac{10^6}{60n}\left(\frac{C}{P}\right)^a = \frac{10^6}{60(1500)}\left(\frac{14.8}{2.868}\right)^3 = 1526.8\ \ hr$$

Chapter 10, Solution 21

Table 10.3: $C = 55.9\ kN, \qquad C_s = 35.5\ kN$

Table 10.6: $\frac{F_a}{VF_r} = \frac{1.5}{1.2(5)} = 0.25 < e, \qquad \frac{iF_a}{C_s} = \frac{2(1.5)}{35.5} = 0.085$

and

$$X = 1, \quad Y = 1.386 \text{ (by interpolation)}$$

Then we obtain

$$P = XVF_r + YF_a = 1(1.2)(5) + 1.386(1.5) = 8.079\ kN$$

or

$$P = VF_r = 1.2(5) = 6\ \ kN$$

Thus

$$L_{10} = \frac{10^6}{60n}\left(\frac{C}{P}\right)^a = \frac{10^6}{60(1000)}\left(\frac{55.9}{8.079}\right)^3 = 5521\ \ hr$$

and

$$5L_{10} = 5(5521) = 27{,}605\ hr$$