Bearing Life

The total number of revolutions, or the number or hours at a given constant speed, of bearing operation required for failure criteria to develop

failure criteria vary from vendor to vendor
Timken criterion—spalling or pitting of an area of 0.01 in^2

Rating life

The number of revolutions, or hours at some given constant speed, that 90% of a group of bearings will complete or exceed before failure.

Sometimes called the L_{10} life.

Bearing Load

$(L_1/L_2) = (F_2/F_1)^a$

L1 is the life of a bearing subjected to load, F1
L2 is the life of a bearing subjected to load, F2

L1 and L2 are given in either millions of revolutions, or hours at a given constant speed, in RPM

a = 3 for ball bearings
a = 10/3 for roller bearings

Average life –median lives of groups of bearings are averaged--somewhere between 4 and 5 times the L10 life.

Basic Load Rating

The constant radial load which a group of bearings can endure for a rating life of 1 million revolutions of the inner ring (stationary load and stationary outer ring).

The basic load road is used for reference only—the load required for a basic load rating is so high that plastic deformation would occur.

$C = FL^{(1/a)}$

Most vendors had rather publish ratings of bearings corresponding to a certain number of hours of life at a specified speed.

Example:

Bearing is rated at 3000 hours at 500 RPM.

Say the radial load on a bearing is 2140 lb.

L_{10} = (3000 h)(60 min/h)(550 rev /min) = 90 E6 revolutions

The basic load rating would be:

$C = F_r L^{(1/a)}$

$C = 2140\ (90)^{(3/10)} = 8263$ lb.

Suppose a designer has the following conditions:

Load = F_d, lb.
Design life = L_d, in hours
nd = required speed, RPM

How should she or he use vendor information to find a suitable bearing?

$Nd = 60\ L_d * n_d$ (the total number of design revolutions)

$Nr = 60\ L_r * n_r$ (the total number of revolutions the vendor's bearing)

$(Nd/Nr) = (Fr/Fd)^a$

or

$Fr = Fd(Nd/Nr)^{(1/a)}$

The engineer must find a bearing that has a rated load of at least this much.

Reliability

$$R = \exp\left[-\left(\frac{L/L_{10} - .02}{4.439}\right)^{1.483}\right]$$

How can we select a bearing for a specified reliability?

L = desired life
R = desired reliability

$$L_{10} = \frac{L}{.02 + 4.439\left[\ln(1/R)\right]^{1/1.483}}$$

$$F_R = F_d \left\{ \frac{\left(L_d n_d / L_r n_r \right)}{.02 + 4.439\left[\ln(1/R)\right]^{1/1.483}} \right\}^{1/a}$$

Fr = catalog radial load corresponding to Lr hours of life at a rate speed of nr RPM
Fd = design load, with required life of Ld, at a speed of nd RPM

$$F_R = F_d \left\{ \frac{\left(L_d n_d / L_r n_r \right)}{4.8\left[\ln(1/R)\right]^{1/1.5}} \right\}^{3/10}$$

Tapered Roller Bearings.

Equivalent radial load, Fe

Compute the following:

Fe = V* Fr
Fe = XVFr + Y Fa

Choose the larger of the two

Fe = equivalent radial load
Fr = applied radial load
Fa = applied thrust load
V = rotation factor
    rotating inner ring V = 1
    rotating outer ring V = 1.2
    Self aligning bearings, V = 1, regardless of which ring rotates
X and Y are geometry factors
X is a radial factor
Y is a thrust factor

To find X and Y

compute Fa/Co (thrust load/basic static load rating)
relate to reference value e
Compute Fa/Fr
Compare Fa/Fr to e and choose X and Y accordingly.

(Table 11-2—page 460)

Sample problems:

A certain application requires a bearing to last for 1800 hours with a reliability of 96%. What should be the rated life for this application?

A certain ball bearing manufacturer's catalog ratings are based not on L10 life , but on average life. A certain bearing in this catalog has a rated load of 1570 lb. at a speed of 1800 RPM, and an average life of 3800 h. What is the basic load rating?

An 02 series ball bearing is to be selected to carry a radial load of 8 kN and a thrust load of 4 kN. The L10 life is to be 5000 h with the inner ring rotation of 900 RPM. What basic load rating should be used to select the bearing