**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**

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

$L_1$ is the life of a bearing subjected to load, $F_1$

$L_2$ is the life of a bearing subjected to load, $F_2$

$L_1$ and $L_2$ 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 $L_{10}$ 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.

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

The basic load rating would be:

$C = F_r L^{(1/3)}$

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

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?

$N_d = 60 L_d \times n_d$ (the total number of design revolutions)

$N_r = 60 L_r \times n_r$ (the total number of revolutions the vendor’s bearing)

$(N_d/N_r) = (F_r/F_d)^a$

or

$F_r = F_d (N_d/N_r)^{(1/a)}$

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

Reliability

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

How can we select a bearing for a specified reliability?

$L = \text{desired life}$

$R = \text{desired reliability}$
\[ L_{10} = \frac{L}{0.02 + 4.439\left[ \ln\left( \frac{1}{R} \right) \right]^{1/483}} \]

\[ F_R = F_d \left\{ \frac{\left( \frac{L_d n_d}{L_r n_r} \right)}{0.02 + 4.439\left[ \ln\left( \frac{1}{R} \right) \right]^{1/483}} \right\}^{1/a} \]

\[ F_R = F_d \left\{ \frac{\left( \frac{L_d n_d}{L_r n_r} \right)}{4.8\left[ \ln\left( \frac{1}{R} \right) \right]^{1/5}} \right\}^{3/10} \]

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

Tapered Roller Bearings.

**Equivalent radial load, \( F_e \)**

Compute the following:

\[ F_e = V^* F_r \]

\[ F_e = XVFr + Y Fa \]

Choose the larger of the two

\( F_e \) = equivalent radial load
\( F_r \) = 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?