White Paper

Friction in Bearings

Rolling bearings are called anti-friction bearing. They have high loading capacity and exhibit very low rolling friction torques. The friction torques are similar or lower than ideally designed plain bearing operating under conditions of thick film lubrication. Rolling bearing has low starting torques.

- **Friction component and influence factor**

Frictional component	Influence factor
Rolling friction	Magnitude of load
Sliding friction of rolling elements sliding friction of cage	Magnitude and direction of load. Speed and lubricant condition, running-in condition
Fluid friction (flow resistance)	Type and speed Type, quantity and operating viscosity of lubricant
Seal friction	Type and preload of seal

The idling friction is depends on the quantity of lubricant, operating speed, viscosity of lubricant during operation, seal and operating conditions in which bearing is running.

The bearing friction torque $M_r = F \cdot f \cdot (d/2)$ or

The bearing friction torque $M_r = F \cdot f_m \cdot (D_m/2)$

- Mr = Friction torque (N mm)
- F = Radial (or axial load) (N)
- f = coefficient of friction of rolling bearing.
- fm = coefficient of friction of rolling bearing based on mean diameter
- d = Diameter of the bore of the bearing (Shaft diameter)(mm)
- D = Outside diameter of the bearing (mm)
- Dm = (d+D)/2 (mm)

- **Heat dissipation**

Friction is converted into heat. This must be dissipated from the bearing. The fig 3.1 shows the temperature distribution between shaft, bearing and housing

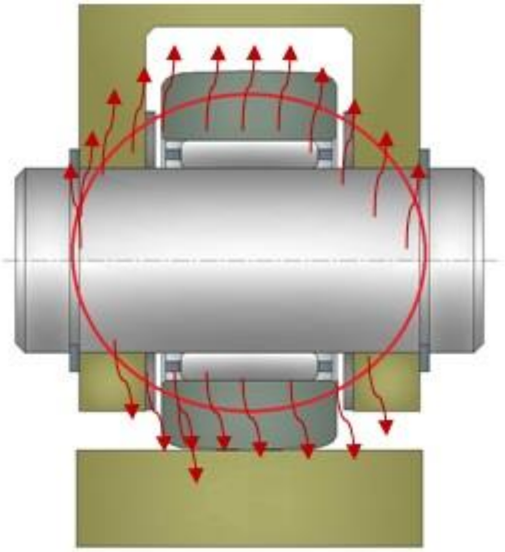


Fig 3.1 the temperature distribution between shaft, bearing and housing

- **Friction values**

These values relate to running bearings without seals and with optimimum lubrication. The start-up friction values will be higher -up to twice the values quoted below.

Single row ball bearing (radial Load)	f = 0.0015
Angular contact ball bearing (single row)	f = 0.0020
Angular contact ball bearing (double row)	f = 0.0024
Self aligning ball bearing (radial load)	f = 0.0010
Cylindrical roller bearings with cage	f = 0.0011
Cylindrical roller bearings full complement	f = 0.0020
Thrust ball bearing (axial load)	f = 0.0013
Spherical roller bearing (radial Load)	f = 0.0018
Taper roller bearings	f = 0.0018
Needle roller bearings-with cage	fm = 0.003
Needle roller ball bearings-full Complement	fm = 0.005

- **Reference heat flow density**

The reference heat flow density, q_r, is defined as:

$$q_r = \frac{Ø}{Ar}$$

For normal applications the following values for the heat flow density qr may be assumed, when the temperature difference $\theta_r - \theta_{Ar}$ equals 50 °C:

- Radial bearing

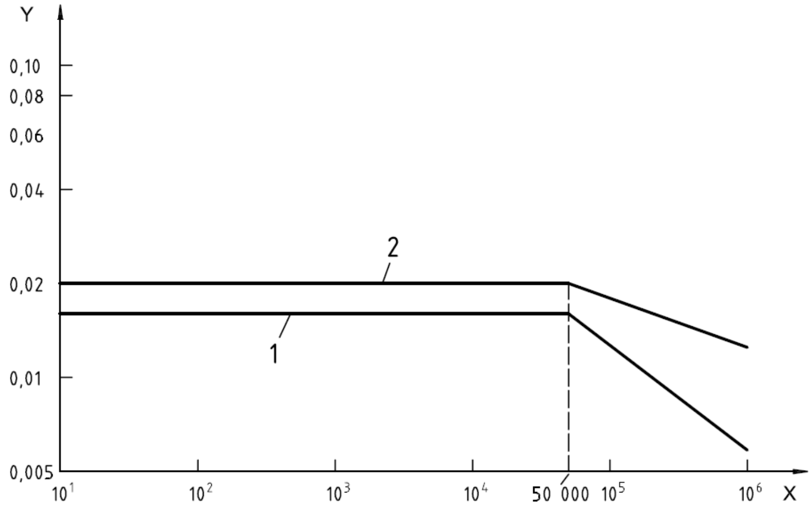
For Ar ≤ 50000 mm^2
qr = 0.016 W/mm^2

For Ar > 50000 mm^2
$qr = 0.016 \times \left(\frac{Ar}{50000}\right)^{-0.34}$ W/mm^2

- Thrust bearings

For Ar ≤ 50000 mm^2
qr = 0.020 W/mm^2

For Ar > 50000 mm^2
$qr = 0.020 \times \left(\frac{Ar}{50000}\right)^{-0.16}$ W/mm^2



1- Radial bearings
2- Thrust bearings
X -Heat emitting reference surface, Ar, mm2
Y- Reference heat flow density, qr, W/mm2