

## 10. Friction and Temperature Rise

### 10.1 Friction

One of the main functions required of a bearing is that it must have low friction. Under normal operating conditions rolling bearings have a much smaller friction coefficient than the slide bearings, especially starting friction.

The friction coefficient for rolling bearings is calculated on the basis of the bearing bore diameters and is expressed by formula (10.1).

$$\mu = \frac{2M}{Pd} \dots \dots \dots (10.1)$$

where,

- $\mu$  : Friction coefficient
- $M$  : Friction moment, N•mm
- $P$  : Load, N
- $d$  : Bearing bore diameter, mm

Although the dynamic friction coefficient for rolling bearings varies with the type of bearings, load, lubrication, speed and other factors; for normal operating conditions, the approximate friction coefficients for various bearing types are listed in Table 10.1.

Table 10.1 Friction coefficient for bearings

Bearing type	Coefficient $\times 10^{-3}$
Deep groove ball bearings	1.0~1.5
Angular contact ball bearings	1.2~1.8
Self-aligning ball bearings	0.8~1.2
Cylindrical roller bearings	1.0~1.5
Needle roller bearings	2.0~3.0
Tapered roller bearings	1.7~2.5
Spherical roller bearings	2.0~2.5
Thrust ball bearings	1.0~1.5
Thrust roller bearings	2.0~3.0

### 10.2 Temperature rise

Almost all friction loss in a bearing is transformed into heat within the bearing itself and causes the temperature of the bearing to rise. The amount of thermal generation caused by friction moment can be calculated using formula (10.2).

$$Q = 0.105 \times 10^{-6} M \bullet n \dots \dots \dots (10.2)$$

where,

- $Q$  : Thermal value kW
- $M$  : Friction moment N•mm
- $n$  : Rotational speed r/min

Bearing operating temperature is determined by the equilibrium or balance between the amount of heat generated by the bearing and the amount of heat conducted away from the bearing. In most cases the temperature rises sharply during initial operation, then increases slowly until it reaches a stable condition and then remains constant. The time it takes to reach this stable state will vary according to the amount of heat generated, the heat absorbing capacity of the housing and surrounding parts, the amount of cooling surface, amount of lubricating oil, and the surrounding ambient temperature. If the temperature continues to rise and does not become constant, it must be assumed that there is some improper function.

Excessive bearing heat can be caused by: moment load, insufficient internal clearance, excessive preload, too little or too much lubricant, foreign matter in the bearing, or by heat generated at the sealing device.