

13 Performance

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13.1 Bearing Friction Torque

Bearing friction torque is the conglomeration of the rolling friction between the balls with the inner and outer rings, the sliding friction between the balls and the cage, the agitating resistance of lubricants, and the friction resistance of the seals.

The specific amount of friction torque is influenced by the particular bearing model, dimensions, bearing load, rotating speed, and lubricating conditions.

Bearings with triple-lip seals and open cover seals will have greater friction torque and overall greater friction resistance.

Friction torque for bearings can be found by the formulas below.

$$M = M_p + M_k \quad (13.1)$$

$$M_p = \mu \cdot P \cdot \frac{d}{2} \quad (13.2)$$

Whereas,

- M : Friction torque of bearing, $mN \cdot m$
- M_p : Friction torque of sections changed by load, $mN \cdot m$
- M_k : Friction torque of sections changed by rotating speed, $mN \cdot m$
- μ : Friction coefficient (0.0015 to 0.002)
- P : Load applied to bearings, N
- d : Nominal bearing bore dia., mm

Note that the agitating resistance of lubricants and the friction resistance of the seals are difficult to calculate since the resistance fluctuates with speed.

Fig. 13.1 shows the result of measurement of friction torque of the typical ball bearing unit.

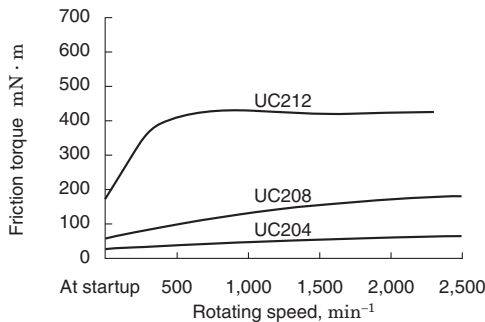


Fig. 13.1 Example of measurement result of ball bearing units

13.2 Bearing Temperature Increase

The increase in temperature of the bearing is represented as heat energy created from friction torque in the bearing during operation. The temperature of the bearing during operation increases in proportion to the amount of friction torque, and friction torque increases in proportion to the increase in bearing load.

The increase in temperature of the bearing depends on the heating value generated by friction in the bearing and the amount of heat discharged from the bearing and housing in which it is mounted. Therefore, the temperature level of the bearing is influenced by the environmental conditions of the location in which the bearing unit is installed (quality of heat radiation environment).

The operating temperature of the bearing unit increases gradually after startup of operation and reaches the maximum level after one or two hours if no abnormalities occur. Then it decreases slightly and enters a steady state (see Fig. 13.2).

If the operating conditions are not changed, bearing temperature will remain virtually constant, and measurement of the temperature and assumption of the bearing status are enabled.

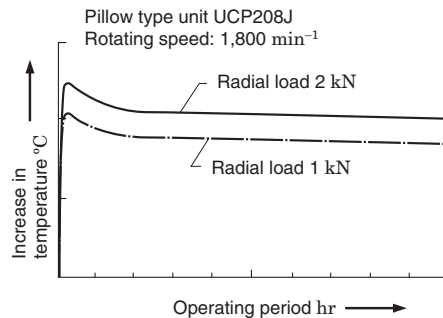


Fig. 13.2 Example of temperature measurement during operation of pillow type units

Increase in temperature during operation of the bearing depends on the type of seal used in the bearing as well as friction torque.

Increase in temperature of triple-lip bearings (suffix code: L3) is greater than that of the standard single lip model, and that of the non-contact seal (suffix code: K3, S5) is lower than the standard single lip model. Bearings for blowers and other high-speed applications are equipped with non-contact seals, with grease or oil, for high-speed operation as well as reduction of heat, vibration, and noise.