10 Rotation speed limit of bearing

The rotation speed limit of bearing refers to the limit value which no friction heat generated in bearing and bearing can continuously operate.

Every rolling bearing has its specified rotation speed limit .When bearings rotate from lower speed to higher speed, the temperature inside bearings generated by friction heat will raise up. Rotation speed limit is an allowable value in which no sintering, no over heat , and bearing can keep continuous rotating. The speed limit of bearing varies with the difference of bearing structure, dimension, cage structure, material, load, lubrication method, and also cooling conditions around bearing.

The rotation speed limit of bearing determined under grease lubrication and oil lubrication is specified in bearing specification table. These values are allowable rotation speed which standard design bearings are rotated under normal load conditions with grease lubrication or oil lubrication .Oil lubrication refers to oil bath lubrication.

Some lubricant has very good quality ,but not suitable for high speed rotation. So when bearing Rotation speed exceeds speed limit by 70 %, high-speed lubricating grease or lubricating oil of good quality must be chosen.

10.1 The correction of rotation speed limit

When bearing dynamic equivalent load exceeds 8% of basic dynamic load rating , or axial load exceeds 25% of radial loading. The rotation speed limit should be corrected by multiplying correction coefficient listed in Fig.10.1 and 10.2.Using the following equation to get the correction rotation speed.

$$n_a = f_1 \cdot f_2 \cdot n$$

Where ,

n_a : Limit speed after correction r/min

f_1 : Correction coefficient determined from load condition (fig. 10.1)

f_2 : Correction determined from combined coefficient load ((fig. 10.2)

n : Speed limit r/min
(refer to bearing specification table)

If bearing rotation speed goes over working conditions of speed limit, we must do sufficient research on bearing' s degree of precision , (inside) internal clearance, cage ' s structure and material , and also , we must adopt all kinds of lubrication methods including oil circulation forced lubrication , jet lubrication , mist lubrication or oil air lubrication and so on .

The rotation speed limit can be approached by adopting above methods.I.e: approximately, we can reach the value calculated by multiplying oil lubrication rotation value in bearing dimension table by correction coefficient in table 10.1 .

Table 10.1 Rotation speed limit correction determined under high speed.

Bearing type	correction value
Cylindrical roller bearing (single row)	2
Needle roller bearing (excluding large width)	2
Tapered roller bearing	2
Spherical roller bearing	1.5
Deep groove ball bearing	2.5
Radial-thrust ball bearing (excluding matched pair bearing)	1.5

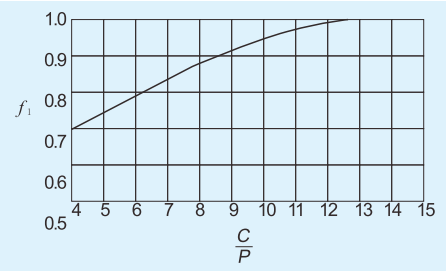

Fig. 10.1 Values of correction coefficient of load condition.

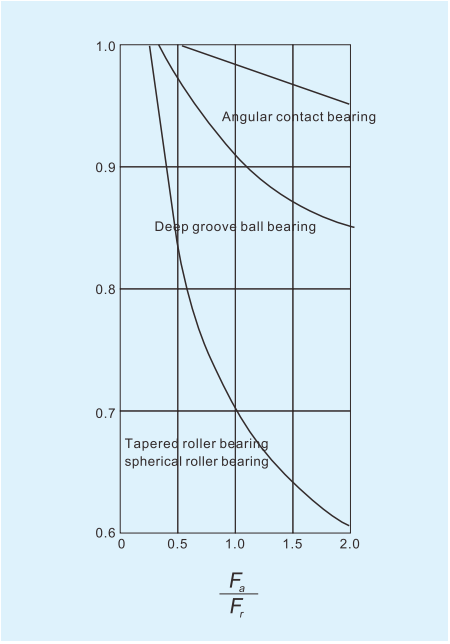

Fig. 10.2 Values of correction coefficient of combined load

10.2 Rotation speed limit fo sealed ball bearing.

The speed limit of ball bearing with contact seals （RS type ）restricted by rubbing speed of seals contact surface, rubbing speed depends on seel rubber material.

10.3 Considerations for high-speed rotation

When bearing is in high speed rotation, especially when the rotation speed approaches or exceeds the mentioned speed limit , we must pay attention to following items:

(1) use precision bearing ;

(2) Study bearing internal clearance (consider inside clearance decrease caused by temperature rise) ;

(3) Study material type of cage (with regard to high-speed rotation , it is better to adopt copper alloy or phenolic resin machined cage. And also molded cage of synthetic resin suitable for high speed rotation).

(4) Study lubrication method (adopt lubrication method suitable for high-speed rotation such as forced oil circulation lubrication , splash lubrication , oil mist lubrication and oil air lubrication etc.).

10.4 Friction coefficient of bearing (for reference)

In order to make it easy to compare with plain bearing, friction moment of rolling bearing can be calculated according to bearing bore with the following formula:

$$M = \mu P d / 2$$

There into

M : Friction moment N • m

μ : Friction coefficient see Table 10.2

P : Bearing load N

d : Nominal bore diameter mm

Friction coefficient influenced greatly by bearing type , bearing load , rotation speed , lubrication method etc. In general situations, the reference value of friction coefficient under rotation as follows:

As to plain bearing , normal μ= 0.01 ~ 0.02 , occasionally 0.1 ~ 0.2 .

Table 10.2 Friction coefficient of all kinds of bearing

Bearing type	Friction coefficient μ
Deep groove ball bearing	0.0010～0.0015
Angular Contact Ball Bearing	0.0012～0.0020
Self-aligning ball bearing	0.0008～0.0012
Cylindrical roller bearing	0.0008～0.0012
Full complement type needle roller bearing	0.0025～0.0035
Needle roller and cage assembly	0.0020～0.0030
Tapered roller bearing	0.0017～0.0025
Spherical roller bearing	0.0020～0.0025
Thrust ball bearing	0.0010～0.0015
Spherical thrust roller bearing	0.0020～0.0025