Table 7.3 Preload of matched pair angular contact ball bearing(continuation) Unit:N

Bearing series / preload value: / d mm	7200 B			7300 B		
	GA	GB	GC	GA	GB	GC
20	175	350	700	—	—	—
25	195	390	780	320	640	1, 280
30	250	500	1, 000	400	800	1, 600
35	335	670	1, 340	470	940	1, 880
40	400	800	1, 600	580	1, 160	2, 320
45	445	890	1, 780	735	1, 470	2, 940
50	480	960	1, 920	840	1, 680	3, 360
55	570	1, 140	2, 280	970	1, 940	3, 880
60	690	1, 380	2, 760	1, 010	2, 020	4, 040
65	780	1, 560	3, 120	1, 270	2, 540	5, 080
70	865	1, 730	3, 460	1, 410	2, 820	5, 640
75	900	1, 800	3, 600	1, 620	3, 240	6, 480
80	990	1, 980	3, 960	1, 660	3, 320	6, 640
85	1, 150	2, 300	4, 600	1, 820	3, 640	7, 280
90	1, 310	2, 620	5, 240	1, 950	3, 900	7, 800
95	1, 485	2, 970	5, 940	2, 120	4, 240	8, 480
100	1, 600	3, 200	6, 400	2, 340	4, 680	9, 360
105	1, 765	3, 530	7, 060	2, 485	4, 970	9, 940
110	1, 895	3, 790	7, 580	2, 660	5, 320	10, 640

Note: The preload of bearing with bore diameter >100mm is not listed in the table.
Series 7000C: Light, medium and heavy preload should be 0.009, 0.018, and 0.036 of bearing dynamic load rating respectively
Series 7200C: Light, medium and medium preload should be 0.010, 0.020, and 0.040 of bearing dynamic load rating respectively
Series 7000AC: Light, medium and heavy preload should be 0.015, 0.030, and 0.060 of bearing dynamic load rating respectively
Series 7200 AC, 7200 B and 7300 B: Light, medium and heavy preload should be 0.016, 0.032 and 0.064.of bearing dynamic load rating respectively.

Table 7.4 Protruding amount with preload Unit: μm

△δ1+△δ2 (Face-to-face or back-to-back)、△δ1—△δ2 (Tandem)

Bearing series / preload value: / d mm		7000 C				7200 C				7000 AC 7200 B				7200 AC 7300 B					
		GA、GB		GC		GA、GB		GC		GA、GB		GC		GA		GB		GC	
Over	Up to	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
—	18	−0.5	+0.5	−1	+1	−0.5	+0.5	−1	+1	−0.5	+0.5	−0.5	+0.5	−0.5	+0.5	−0.5	+0.5	−0.5	+0.5
18	30	−1	+1	−1	+1	−1	+1	−1	+1	−0.5	+0.5	−1	+1	−0.5	+0.5	−0.5	+0.5	−1	+1
30	50	−1	+1	−1	+1	−1	+1	−1.5	+1.5	−0.5	+0.5	−1	+1	−0.5	+0.5	−1	+1	−1	+1
50	80	−1	+1	−1.5	+1.5	−1.5	+1.5	−2	−2	−1	+1	−1.5	+1.5	−1	+1	−1	+1	−1.5	+1.5
80	120	−2	+2	−2	+2	−2	+2	−2.5	+2.5	−1	+1	−1.5	+1.5	−1	+1	−2	+2	−2	+2
120	150	−2	+2	−2	+2	−2.5	+2.5	−3	+3	−1	+1	−2	+2	−1.5	+1.5	−2	+2	−3	+3

7.2 Lubrication

7.2.1 Lubrication of bearing

The purpose of bearing lubrication is to separate rollers from rolling surface by a thin oil film during running, thereby reduce the internal friction of bearing and friction between components and prevent heat. Its primary functions are as follows:

1 To lubricate every component of bearings, prevent metallic contact, and reduce friction, abrasion etc.

2 Keep the appropriate oil film on the rolling contact surface of bearing, and prolong bearing life.

3 Carry away heat either generated by friction or outside.

4 Prevent dirt or other carry away foreign matter from penetrating into the interior of bearing and occurrence of rust and corrosion.

7.2.2 Lubricating method

The lubricating method of bearing is divided into grease lubrication and oil lubrication. In order to maximize the use function of bearing, first we should choose lubricating method that meets working conditions. If only considering the lubricating effect, oil lubrication is more advantageous. Yet grease lubrication is also widely used as it has the advantage of simplifying working conditions. In recent years, sealed structure that use lubricating grease is increasingly adopted. Table 7.5 makes a comparison of the advantages and disadvantages of oil lubrication and grease lubrication.

Table 7.5 Comparision of oil lubrication and grease lubrication

Item	Oil lubrication	Grease lubrication	
		Open type bearing	Sheiled/Sealed type bearing
Shell mechanism device	Maintenance trouble	Can be simplified	Simplified
Rotational velocity	Be applicable to high speed rotation	The speed limit is 65%-80% of oil lubrication	
Cooling effect	Could carry away heat	None	None
Replacement of lubricating grease	Relatively simple	More difficult	No need for replacement
Control of dust impurity	Easier	Difficult	Professional control effect
Leakage	Easier	Easy	Not easy

7.2.3 Lubricating grease

Lubricating grease is the semisolid lubricant which use lubricating oil as its base oil and incorporate solid lipophilic thickener . Sometimes various additives are mixed into the grease to promote grease characteristics.

See p.80 for details for typical lubricating grease of bearing.

1) Base oil

The base oil of lubricating grease mostly use mineral oil, yet when special performances like low-temperature fluidity or high temperature stability are required, we also use synthetic oil such as diester oil, silicone oil, polyethylene diester oil and fluorocarbon oil etc.

Generally speaking, lubricating grease made of low viscosity base oil applies to high-speed bearing and low temperature conditions while that made of high viscosity base oil applies to heavy loading bearing and high temperature conditions.

2) Thickener

The thickener agent of lubricating grease mostly comprises of metallic soap base like lithium, calcium and sodium etc. Yet according to different purposes, we also use thickener with non-metallic soap base (inorganic substance such as silica gel, bernton etc.)

Generally, the characteristic of lubricating grease are determined by thickener such as stability of mechanical property, scope of service temperature, water resistance etc.

Lithium based grease: Superior in heat resistance, water resistance and mechanical stability.

Sadium grease: Superior in water resistance, inferior in heat resistance.

Calcium grease: Good water resistance, superior in heat resistance, inferior in water resistance.

Nonmetal soap grease: Good thermo-tolerance.

3) Additive

According to different application purpose, lubricant is also added with all kinds of additives.

Extreme-pressure agents: When bearing take heavy load or impact load.

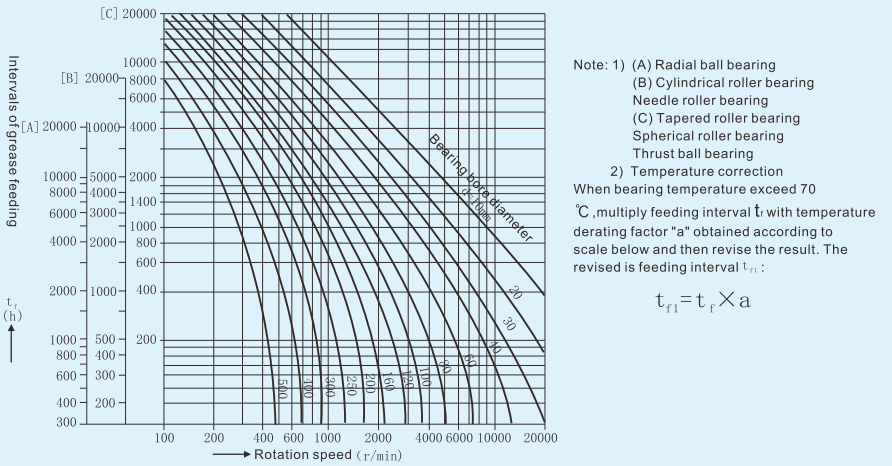
Antioxidation inhibitors: Not supply lubricant for long period other additives include structure stabilization agent, rust preventive and corrosion inhibitors etc.

4) Consistency

The hardness of lubricating grease is describes by consistency, which is calculated by multiplication by 10 the depth (in mm) to which the cone shaped metallic plunger penetrates into the grease by dead weight in 5seconds.Therefore the softer the grease , the higher the figure.

5) Mixing of different grease

The mixing use of different grease could change It's properties. Thus normally grease of different brands should not be mixed. If we have to use mixing grease, we can only choose those of same thickener. Yet it should be noticed that even in this way effects may be taken due to the difference of additives. Therefore, we must check the effects of a mixture in advance through testing or other methods.



Note: 1) (A) Radial ball bearing
(B) Cylindrical roller bearing
Needle roller bearing
(C) Tapered roller bearing
Spherical roller bearing
Thrust ball bearing
2) Temperature correction
When bearing temperature exceed 70 ℃ ,multiply feeding interval t_f with temperature derating factor "a" obtained according to scale below and then revise the result. The revised is feeding interval t_{f1} :

$$t_{f1} = t_f \times a$$

Fig. 7.8 Intervals of grease feeding

7.2.4 Grease lubrication

The grease lubrication has the advantage that no need for replenishment over a long period once grease is filled. Besides, the seal structure is relatively simple. Therefore the grsese is extensively applied.

Grease can be repacked in sealed/shield type bearing beforehand. Alternatively, we can also fill in right amount of grease in housing, and refilled at a regular intervals via replenishment or replacement .

Moreover, for machinery that have many bearings to be lubricated, we could also adopt the grease-feeding devices in which connected by piping and supplied with grease collectively.

1) Amount of grease

The Amount of grease in the housing varies with differences in bearing rotation speed, shell mechanism, space cubage, trademark of grease and working temperature etc. Generally the standards are as follows:

First of all, fill grease into inside space of bearing and make sure it is flows into the guide surface of cage. Then we should fill in grease according to available inside space of housing.

1/2 – 2/3 grease(below 50% of limit rotation speed)

1/3 – 1/2 grease(above 50% of limit rotation speed)

2) Replenishment of grease

Generally it is unnecessary to refill once grease filled. Yet sometimes we need for replenishment. Therefore the design of housing should be convenience of grease refilling. The time interval is shown in Figure 7.8.

On condition that supply intervals are short, we need to design supply inlets and outlets on proper location of the housing so as to replace the degraded grease with new grease. For example, the inside of the housing is devided by grease sectors. As long as one part is filled up, the lubricating grease can flow into inside space of bearing. The grease forced out of bearing could flow back from inside housing by grease valve.On occasions that lubricating valve is not used, we design a larger housing space on the discharge side to store old grease. We only need to take out the old grease by removing the housing cover regularly.

3) Grease life in sealed/shieled ball bearing

The grease life of single-row deep groove ball bearing sealed/shieled with seals can be calculated approximately by the following two equation:

Universal grease (1)

$$\mathrm{Log}\,t = 6.54 - 2.6n/N_{max} - (0.025 - 0.012n/N_{max})T$$

High quality grease (2)

$$\mathrm{Log}\,t = 6.12 - 1.4n/N_{max} - (0.018 - 0.006n/N_{max})T$$

Among the equation:
t: Mean grease life h
n: Rotation speed of bearing r/min
T: Working temperature of bearing ℃
N_{max}: Limit rotation speed of Grease r/min
(Value of ZZ type and 2RZ type listed in bearing specification table)

Explanation:

A) When n/Nmax<0.25, n/Nmax should be 0.25.
B): Working temperature of bearing
Universal grease: 70℃ ⩽T⩽ 110 ℃
High quality grease: 70℃ ⩽T⩽130 ℃
When<T 70℃, we adopt T=70℃.
C) Bearing load

Bearing load for basic dynamic load rating is around 0.1 or less than 0.1.

Remarks:

Universal grease (1): is applicable to grease of mineral oil type between -10℃ and -110℃.

High quality lubricating grease (2): is applicable to grease of synthetic oil type between -40℃ and -130℃.

7.2.5 Lubricating oil

Generally the oil lubrication of bearing adopts the refined mineral oil which has good oxidation stability, antirust and high oil film strength. Yet different kinds of synthetic oil are often used and sometimes all types of additive, rust preventives, and antifoaming agents are added in order to promote some characteristics. The characteristics of normal type lubricant are shown in Table 7.6.

7.2.6 Oil lubrication

Generally the oil lubrication of rolling bearing adopts mineral oil which is free of additives. Only in special conditions lubricating oil with additives is used to promote its performance, such as extreme pressure resistance and age resistance. Synthetic oil is only used in case that temperature and rotation speed is too high or too low.

Viscosity is one of the important characteristic of lubricating oil and is the main principle for selecting proper lubricating oil. The viscosity of lubricating oil is related to temperature and it drops in response to temperature rise. Lubricating oil must maintain certain viscosity at work temperature in order that sufficient lubricating oil film forms between rollers and raceway contact surface. If viscosity is too low, no adequate oil film could form, will cause abrasion or lower life. While if viscosity is too high, will cause heat up by viscosity resistance and enlarge power waste.

Generally speaking, low viscosity oil should be chosen if working speed is high; while high viscosity lubricating oil should be used when bearing dimension and load is large. Lubricating oil adopted by different types of bearing should possess the viscosity illustrated in Table 7.7 under its working temperature.

Table 7.7 Viscosity required by different bearings

Bearing type	Lubricant viscosity
Ball bearing	⩾13mm/s
Roller bearing, spherical roller bearing	⩾20 mm/s
Spherical trust roller bearing	⩾32 mm/s

Fig. 7.9 is the graph of relation between lubricating oil viscosity and temperature, which is designed to select lubricating oil viscosity in accordance with its running temperature. Table 7.8 lists the selection of lubricating oil viscosity for all types of bearings under different working conditions

Table 7.6 Characteristics lubricating oil

Variety of lubricating oil	Refined mineral oil	synthetic oil				
		Diester oil	Silicone oil	Polyethylene diester oil	Polyethylene aether oil	Fluorocarbon oil
Service temperature scope	−40～+220	−50～+150	−70～+350	−30～+330	0～+330	−20～+300
Lubricity	Excellent	Excellent	OK	Good	Good	Excellent
Oxidation stability	Good	Good	Acceptable	Acceptable	Excellent	Excellent
Proof Radioactivity	Unacceptable	Unacceptable	Unacceptable	Unacceptable	Excellent	_

7.2.7 Oil change period

Oil change period depends on running conditions and oil amount. When working temperature does not exceed 50℃ and there is not much dust, it can be changed once a year. The higher the working temperature is, the more frequency the oil shall be changed. For example: When working temperature reaches 100℃, it shall be changed every three months. In severe running conditions, the frequency of oil change shall be increased.

For circulation oil lubrication and splash oil lubrication, oil change period depends on oil circulation speed and whether the lubricating oil has been cooled, which will be determined through the oil status of experimental runs and regular inspections. In case of any special cases, please contact the technical center of C&U Group.

Table 7.8 Selection of suitable viscosity of lubricating oil

Bearing running temperature ℃	Value dn	Lubricating oil ISO Viscosity class (VG)		Applicable bearing
		Norml load	Heavy load or impact load	
−30～0	To permitted rotation speed	22 32	46	All types
0～60	To 15000	46 68	100	All types
	15000～80000	32 46	68	All types
	80000～150000	22 32	32	Except thrust ball bearing
	150000～500000	10	22 32	Single-row radial ball bearing, cylindrical roller bearing
60～100	To15000	150	220	All types
	15000～80000	100	150	All types
	80000～150000	68	100 150	Except thrust ball bearing
	150000～500000	32	68	Single-row radial ball bearing, cylindrical roller bearing
100～150	To permitted rotation speed	320		All types
0～60	To permitted rotation speed	46 68		Spherical roller bearing
60～100	To permitted rotation speed	150		

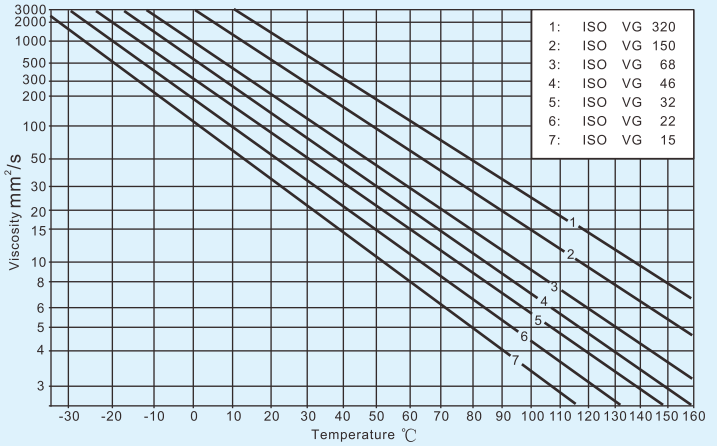


Fig. 7.9 Corresponding relational graph between lubricating oil viscosity and temperature

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Brands and performance of lubricating grease for rolling bearing

Lubricating grease Name	Manufacturers	Base oil	Thickener	Consistency	Dropping point		Service temperature range	Colour	Features				
									Resistance water	High-speed running	Tone	Low temperature torque	Load
molykoteG-0102	MOLYKOTE	Mineral oil	Compound calcium	275～295	>300		-25～140	Brown		√			
molykoteG-0100	MOLYKOTE	Mineral oil	Polyurea	265～296	>251		-40～170	Cinnamon	√	√	√	√	
molykoteBR2+	MOLYKOTE	Mineral oil	Lithium soap	265～295	>175		-30～130	Black		√			√
molykoteG-6000	MOLYKOTE	Synthetic oil	Polyurea	280	>260		-40～200	Ecru	√				√
GHY-133	KLUBER	Mineral oil, hydrocarbon oil	Polyurea	265～295	>250		-30～160	Brown	√	√	√		
ALVANIA-WR2	Shell	Mineral oil	Compound calcium lithium	265～295	>180		-25～130	Cinnamon	√		√		
ALVANIA-RLQ2	Shell	Mineral oil	Lithium	285	185		-25～120	Cinnamon	√		√		
ALVANIA-EP2	Shell	Mineral oil	Lithium	280	170		-15～110	Reddish brown		√			√
ALVANIA-2	Shell	Mineral oil	Lithium	266	185		-25～120	Milk yellow	√		√		
ALVANIA-R2	Shell	Mineral oil	Lithium	265～295	185		-35～100	Reddish					
Multemp-PS2	Kyodo	Diester+ Petrolatum	Polyurea (lithium)	275	195		-40～130	Brown Milk white		√	√	√	
Multemp-SRL	Kyodo	Diester	Polyurea (lithium)	244	210		-50～150	Straw yellow	√		√	√	
Multemp-ET-K	Kyodo	Diester	Polyurea (lithium)	300	230		-40～160	Milk white			√		
Multemp-SB-M	Kyodo	Diester	Polyurea (lithium)	220	260		-40～170	Maple				√	
MAXSUPER	Kyodo	Paraffin mineral oil	Polyurea	260	253		-40～160	Hazel	√		√		
NIGLUBE MP-DX	Kyodo	Synthetic oil	Polyurea	278	199		-40～130	Brownish Green				√	
WR-L	Nippon grease	Synthetic oil	Polyurea	240	270		-40～150	Maple		√	√		
WR-S	Nippon grease	Synthetic oil	Polyurea	230	270		-30～150	Maple			√		
Chevron SRI-2	Cheveron	Paraffin base oil	Polyurea (lithium)	280	243		-30～150	Green	√	√	√		√
Chevron SRI-OEM	Cheveron	Paraffin base oil	Polyurea (lithium)	280	243		-30～150	Green	√	√		√	
Moonshine 2000	Chongqing Yiping	Saponification (lithium key)	Mineral oil	220～295	>180		-20～120	Buff			√		
BLE	Jin Zhi	Polyurea	Mineral oil	280	>260		-20～177	Straw yellow			√		

Remarks:
1.Bearing internal lubricating grease feeding amount strictly controlled according to design requirements;
2.Different lubricating grease types are not allowed to be mixed. The mixture property of same type does not change much;
3.Mineral oil grease will cause damage to plastic material and esters ,oil acrylate and ABS. Be precautions while using;
4.In case of extraordinarily high temperature, high speed or other special operating ambience, please contact the technical center of C&U Group.