4. Bearing internal clearance

Table 4.1 Radial internal clearance of needle roller bearings (Unit: μm)

Nominal bore diameter d (mm)		C2		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.
-	10	0	30	10	40	25	55	35	65
10	18	0	30	10	40	25	55	35	65
18	24	0	30	10	40	25	55	35	65
24	30	0	30	10	45	30	65	40	70
30	40	0	35	15	50	35	70	45	80
40	50	5	40	20	55	40	75	55	90
50	65	5	45	20	65	45	90	65	105
65	80	5	55	25	75	55	105	75	125
80	100	10	60	30	80	65	115	90	140
100	120	10	65	35	90	80	135	105	160
120	140	10	75	40	105	90	155	115	180
140	160	15	80	50	115	100	165	130	195
160	180	20	85	60	125	110	175	150	215
180	200	25	95	65	135	125	195	165	235
200	225	30	105	75	150	140	215	180	255
225	250	40	115	90	165	155	230	205	280
250	280	45	125	100	180	175	255	230	310
280	315	50	135	110	195	195	280	255	340
315	355	55	145	125	215	215	305	280	370
355	400	65	160	140	235	245	340	320	415
400	450	70	190	155	275	270	390	355	465

5. Lubrication

5.1 Lubrication of rolling bearings

The purpose of bearing lubrication is to prevent direct metallic contact between the various rolling and sliding elements. This is accomplished through the formation of a thin oil (or grease) film on the contact surfaces. However, for rolling bearings, lubrication has the following advantages:

(1) Friction and wear reduction
(2) Friction heat dissipation
(3) Prolonged bearing life
(4) Prevention of rust
(5) Protection against harmful elements

In order to achieve the above effects, the most effective lubrication method for the operating conditions must be selected. Also, a good quality, reliable lubricant must be selected. In addition, an effectively d&sign&d seating system that prevents the intrusion of damaging elements (Dust, water, etc.) into the bearing interior, removes dust and other impurities from the lubricant, and prevents the lubricant from leaking to the outside, is also a requirement. Almost all rolling bearings use either grease or oil lubrication methods, but in some special applications, a solid lubricant such as molybdenum disulfide or graphite may be used.

5.2 Lubrication methods and characteristics

The lubrication methods come in two general methods: grease or oil, each with their own characteristics. These characteristics are shown in table 5.1

Table 5.1 Comparison of grease lubrication and oil lubrication characteristics

Method / Concern	Grease lubrication	Oil lubrication
Handling	Very good	Fair
Reliability	Good	Very good
Cooling effect	Poor	Good (circulation necessary)
Seal's structure	Good	Fair
Power loss	Good	Good
Environment contamination	Good	Fair
High speed rotation	Poor	Good

5.2 Grease lubrication

Grease type lubricants are relatively easy to handle and require only the simplest sealing devices. For these reasons, grease is the most widely used lubricant for rolling bearings.

5.2.1 Types and characteristics of grease

Lubricating grease are composed of either a mineral oil base or a synthetic oil base. To this base a thickener and other additives are added. The properties of all greases are mainly determined by the kind of base oil used and by the combination of thickening agent and various additives.

Standard greases and their characteristics are listed in Table 5.2 as performance characteristics of even the same type of grease will vary widely from brand to brand, it is best to check the manufacturers' data when selecting a grease.

Also, greases of different brands should not be mixed because of the different additives they contain.

However, if different greases must be mixed, at least greases with the same base oil and thickening agent should be selected. But even when greases of the samel base oil and thickening agent are mixed, the quality of U grease may still change due to the difference in additives. For this reason, changes in consistency and other qualities should be checked before being applied.

Table 5.2 Grease varieties and characteristics

Grease name	Lithium grease			Sodium grease (Fiber grease)	Calcium compound base grease
Thickener	Li soap			Na soap	Ca+Na soap Ca+Li soap
Base oil	Mineral oil	Diester oil	Silicone oil	Mineral oil	Mineral oil
Dropping point	170 ~ 190	170 ~ 190	200 ~ 250	150 ~ 180	150 ~ 180
Operating temperature range °C	-30 ~ +130	-50 ~ +130	-50 ~ +160	-20 ~ +130	-20 ~ +120
Mechanical stability	Excellent	Good	Good	Excellent ~ Good	Excellent ~ Good
Pressure resistance	Good	Good	poor	Good	Excellent ~ Good
Water resistance	Good	Good	Good	Good ~ poor	Good ~ poor
Applications	Widest range of applications. Grease used in all types of rolling bearings.	Excellent low temperature and wear characteristics. Suitable for small sized and miniature bearings.	Suitable for high and low temperatures. Unsuitable for heavy load applications due to low oil film strength.	Some emulsification when water is introduced. Excellent characteristics at relatively high temperatures.	Excellent pressure resistance and mechanical stability. Suitable for bearings receiving shock loads.

Grease name	Aluminum grease	Non-soap base grease Thickener	
Thickener	Al soap	Bentone, silica gel, urea, carbon black, fluorine compounds, etc.	
Base oil	Mineral oil	Mineral oil	Synthetic oil
Dropping point	70 ~ 90	250 or above	250 or above
Operating temperature range °C	-10 ~ +80	-10 ~ +130	-50 ~ +200
Mechanical stability	Good ~ poor	Good	Good
Pressure resistance	Good	Good	Good
Water resistance	Good	Good	Good
Applications	Excellent viscosity characteristics. Suitable for bearings subject to vibrations.	Can be used in a wide range of low to high temperatures. Shows excellent heat resistance, cold resistance, chemical resistance, and other characteristics when matched with a suitable base oil and thickener. Grease used in all types of rolling bearings.	

Note: The figures given for operating temperature range are standard characteristic values, and are not guaranteed.

5.2.2 Amount of grease

The amount of grease used in any given situation will depend on many factors relating to the size and shaped the housing, space limitations, bearing's rotating speed and type of grease used.

As a general rule, housings and bearings should be only filled from 50% to 80% of their capacities.

Where speeds are high and temperature rises need to be kept to a minimum, a reduced amount of grease should be used. Excessive amounts of grease cause temperature rise which in turn causes the grease to soften and may allow leakage. With excessive grease fills oxidation and deterioration may cause lubricating efficiency to be lowered.

Moreover, the standard bearing space can be found by below formula (5.1)

$V = K \cdot W$ ..... Formula (5.1)

where,

V : Quantity of bearing space open type (approx.) cm^3

K : Bearing space factor (Table 5.3)

W : Mass of bearing kg (See bearing tables)

Table 5.3 Bearings space ratio K

Bearing type	Retainer type	K
Needle roller bearings	Pressed or Machined retainer	35