9. Bearing Clearance

The internal clearance of bearing is the measurement by which one ring can be displaced in relation to the other one either in the radial direction or in the axial direction from one end position to the other, and these clearances are specified in the KS B 2102. The internal clearances of bearing are the relative amount of displacement of either inner or outer ring, and they can be divided into two groups, namely axial or radial clearances, depending on their directions, as shown in Table 9-1.

A bearing in operation with an inappropriate internal clearance reduces its life, and generates excessive vibration and heat.

Theoretically, the operating clearances of small minus values allows the life to be extended, but it is practically difficuit to achieve such values. In other words, because the internal clearances vary depending on mounting methods, different heat expansion due to temperature gradient, or deformation by loads, etc., it is imperative to precisely analyze the operating conditions to select appropriate amount of clearance for the bearings.

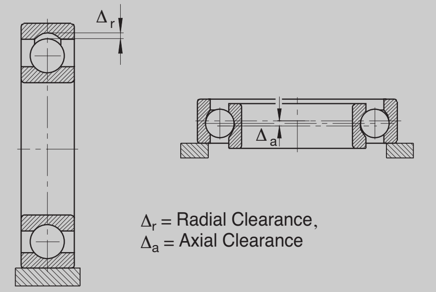

Fig 9-1 Bearing Clearance

9-1 Selection of Bearing Internal Clearance

Bearing clearances can be classified into the Normal Clearance Group appropriate for regular operating conditions, smaller Group C2, and larger Groups, C3, C4, and C5. Also, there is a Group CM, which has been specially and empirically created

Table 9-1 Radial Internal Clearance Specifications of Deep Groove Ball Bearings

Unit : mm

Nominal Bore Diameter	Over / up to	6 / 10	10 / 18	18 / 24	24 / 30	30 / 40	40 / 50	50 / 65	65 / 80	80 / 100	100 / 120	120 / 140	140 / 160	160 / 180	180 / 200	200 / 225	225 / 250
		Bearing Clearance : μm (0.001mm)															
C2	Min	0	0	0	1	1	1	1	1	1	2	2	2	2	2	4	4
	Max	7	9	10	11	11	11	15	15	18	20	23	23	25	30	32	35
CM (For electric motors)	Min	4	4	5	5	9	9	12	12	18	18	24	24	-	-	-	-
	Max	11	11	12	12	17	17	22	22	30	30	38	38	-	-	-	-
Normal Group	Min	2	3	5	5	6	6	8	10	12	15	18	18	20	25	25	30
	Max	13	18	20	20	20	23	28	30	36	41	48	53	61	71	80	90
C3	Min	8	11	13	13	15	18	23	25	30	36	41	46	53	63	74	84
	Max	23	25	28	28	33	36	43	51	58	66	81	91	102	117	134	149
C4	Min	14	18	20	23	28	30	38	46	53	61	71	81	91	107	124	144
	Max	29	33	36	41	46	51	61	71	84	97	114	130	147	163	189	214
C5	Min	20	25	28	30	40	45	55	65	75	90	105	120	135	150	-	-
	Max	37	45	48	53	64	73	90	105	120	140	160	180	200	230	-	-

Table 9-2 Radial Inner Clearance Specifications of Extra Small Bore Deep Groove Ball Bearings(With bore diameters smaller than 10mm)

Unit : mm

Clearance Groups		MC1	MC2	MC3	MC4	MC5	MC6
		Bearing Clearance : μm(0.001mm)					
Clearance	Min	0	3	5	8	13	20
	Max	7	8	10	13	20	28

by KBC for motor application that require noise control, and this Group CM has a very small range of radial clearances as well as the small clearance values.

For the miniature bearings, the Clearance Groups of MC1 to MC6 are provided, and the larger the suffix number is, the bigger the clearances are. And MC3 is the Normal Clearance Group for them.

The radial clearance of deep groove ball bearings are shown in Table 9-1 and 9-2.

9-2 Bearing Clearance Variations

A distinction can be drawn between the bearing clearance before mounting and the clearance of mounted bearing under operating temperature (Operating clearance). In order to guide the shaft properly, the operating clearance should be as small as possible.

The clearance of the unmounted bearing gets reduced when mounted due to tight fits of the bearing rings. Furthermore, the radial clearance is also reduced during operation, as inner ring becomes warmer than outer ring, which is usually the case. Therefore, in general, the clearance of unmounted bearing should be larger than the operating clearance.

9-2-1 Reduction of the Radial Clearance by Means of Temperature Differences

$$\Delta_{Grt} = \Delta_t \cdot \alpha \cdot (d+D)/2 \quad \text{(Equation 9-1)}$$

Where,

Δ_{Grt} : Reduction of radial clearance [mm]

Δ_t : Temperature difference between inner and outer rings [°C]

α : Linear thermal expansion coefficient of bearing steel [1/°C]

d : Bearing bore diameter [mm]

D : Bearing outside diameter [mm]

The radial clearance can vary a great deal, if the bearing is exposed to input or dissipation of heat. A smaller radial clearance results from heat transfer through the shaft or heat dissipation through the housing. On the other hand, a larger radial clearance results from heat transfer through the housing or heat dissipation through the shaft. Rapid run-up of bearings to operating speed results in greater temperature gradient between the bearing rings than is the case in a steady state. So, either the bearings should be run up slowly or a larger radial clearance than theoretically necessary for the bearings when under operating temperatures should be selected in order to prevent detrimental preload and bearing deformation.

9-2-2 Reduction of Radial Clearance by Means of Tight Fits

Although the radial clearances vary depending on the materials of bearing seat, temperature, or wall thickness, etc., the expansion of the inner ring raceway and the contraction of the outer ring raceway can be assumed to be approximately 80% and 70% of the interference, respectively, provided that solid steel shaft and steel housing with normal wall thickness are used.

Contact KBC for more exact calculations under various conditions, which can be obtained by using KBC's advanced computer software.

$$\Delta_{fit} = (0.7 \sim 0.8) \cdot \Delta d_{eff} \quad \text{(Equation 9-2)}$$

Where,

Δ_{fit} : Reduction of radial clearance [mm]

Δd_{eff} : Effective interference [mm]