14. Handling of Bearings

Bearings are heavy-duty machine elements with high precision, so care has to be taken for them to serve their functions to the fullest degree.

To last up to their life span, following points especially have to be observed.

(1) Always keep bearings and working environment clean and tidy.

When a bearing is mounted on shaft and housing while working environment is polluted with dust or other foreign particles, or while bearing itself is dirty due to unclean storage, dust or minute foreign particles can induce indentation or scratches on bearing rolling element surface, resulting in fatigue rupture at the time below rated fatigue life.

Therefore surrounding working environment needs to be kept clean and tidy all the time, and also tools and hands need to be clean and dry while working on bearings.

Also, spare bearings need to be stored in well-ventilated, dry space, and they need to be checked for appropriateness before mounting.

(2) Handle the Bearings with care.

Sudden impacts to or dropping of a bearing while handling them, or mounting of a bearing with excessive force while using hammer or others, can cause indentation or scratches on bearing rolling element surfaces, resulting in its early rupture.

Care has to be taken while handling the bearings, because abnormal or excessive damage to bearing rolling element surface can induce breakage of rings or separation of rings of non-separable type bearings.

(3) Use only clean lubricants and greases.

When dismounting and checking the bearings for abnormality, surroundings around housing should be cleaned first before dismounting starts, and then after dismounting, foreign materials on and around outside and inner surface of bearing and others should be wiped off thoroughly by using dry cloth.

In case of open type bearings, it is recommended to clean them with kerosene oil or equivalents before re-mounting them.

Also, only clean lubricants or greases not contaminated with dust or any other solid foreign materials should be used.

(4) Be sure to prevent bearing corrosion from developing

When bearing comes in contact with hand sweat, water-soluble lubricants or cleansers, rust can be developed later on.

Therefore when it is necessary to work on a bearing with bare hands, hands should be washed thoroughly first to get rid of sweat and then high-quality mineral oil should be applied to hands before working on a bearing.

Specially during rainy seasons or summer, care should be taken to prevent corrosion.

(5) Use appropriate tools.

Use of inappropriate tools, which just happen to be around, for example, while working on bearings, should be avoided at all cost. Use only appropriate tools suitable for the tasks involved.

Also, when using the cloth for cleaning, one needs to make it sure it' s not a kind that produces shag, which contaminate a bearing.

14-1 Storage Precautions

Preservation medium and packaging of KBC bearings are designed to retain the bearing properties as long as possible.

Certain requirements must, therefore, be met for storage and handling. During storage, the bearings must not be exposed to the effects of aggressive media such as gases, mists or aerosols of acids, alkaline solutions or salts. Direct sunlight should also be avoided because it can cause large temperature variations in the package, apart from the harmful effects of UV radiation. The formation of condensation water is avoided under the following conditions.

- Temperature range : 6~25℃ (30℃ for short period)
- Max. temperature difference, day/night: 8K
- Max. relative air humidity: 65%
- Location should be free of excessive vibration.

With standard preservation, bearings can be stored safely up to 5 years, if the said conditions are met. If this is not the case, shorter storage periods must be taken into consideration.

If the permissible storage period is exceeded, it is recommended to check the bearing for its preservation state and corrosion prior to use. In case of sealed type bearings filled with grease, their permissible storage periods tend to be shorter, because the lubricating grease contained in the bearings may change their chemico-physical behavior due to aging.

Bearings completed inspection or ones with damaged packages contaminating the inside, should be washed by using appropriate washing oil. While washing with oil, turn either inner or outer ring little by little.

Ones with seal or shield on one side should be handled same as open type bearings. And the others with them on both sides should not be washed at all, but, instead, anti-corrosion agent should be applied thinly prior to use, or they should be wrapped with oil paper before being stored.

14-2 Mounting of Bearings

The shop drawings should be studied prior to mounting to become familiar with the design. The order of the individual work steps is schematically laid down including the required heating temperatures, mounting forces and grease quantities. The anti-corrosion agent of the packed KBC bearing has no effect on the standard greases which are most commonly used(Lithium soap mineral grease), and does not have to be washed out prior to mounting. It is only wiped off the seats and mating surfaces.

When anti-corrosion agent is washed off from KBC bearings, rust can be developed easily, so they should not be stored for long before being used.

Rolling bearings must be protected from dirt and humidity under all circumstances so as to avoid damage to the running areas. The work area must, therefore, be clean and free of dust.

When mounting the bearings, loads of rings and rolling elements should not be applied to them, and mounting forces should be applied uniformly to all points around rings. Blows with the hammer applied directly to the bearings, which can damage them, should be avoided completely.

14-2-1 Mounting of Tapered Bore Bearings

In the case of mounting the non-separable bearings by using press or hammer, the mounting forces are applied to the ring which is to have a tight fit by using a unrelieved mounting disk on ring's to be mounted, or by using mounting disk that touches both outer and inner rings, as shown in Fig. 14-1.

However, in bearings where the cage or balls project laterally(e. g. Some self-aligning ball bearings), a relieved disk should be used so as not to damage cage or balls during mounting, as shown on Fig 14-2. But, separable bearings can be mounted independently.

Bearings with a maximum bore of approximately 80 mm can be mounted cold. The use of mechanical or hydraulic press is recommended.

Should no press be available, the bearing can be driven on with hammer and mounting sleeve. Bearings with a cylindrical bore for which tight fits on a shaft are specified and which cannot be pressed mechanically onto the shaft without great effort, are heated before mounting. Fig. 14-3 shows the heat-up temperatures required for easy mounting as a function of the bearings bore d.

The data applies to the maximum interference, a room temperature of 20℃ plus 30 K to be on the safe side. At this time, bearings should be heated up higher than 120℃.

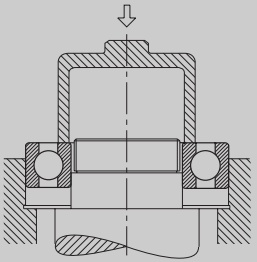

Fig. 14-1 Pressing of a Bearing when Tight-Fitting a Inner Ring

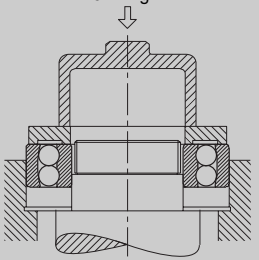

Fig. 14-2 Simultaneous Pushing In of Both Inner and Outer Rings

Induction heating devices are particularly suitable for fast, safe and clean heating, and the device should be selected considering the size and weight of a bearing.

Individual bearings can be heated provisionally on an electric heating plate, and the bearing can be covered with a metal sheet and turned several times.

A safe and clean method of heating bearings it to use a thermostatically controlled hot air or heating cabinet.

It is used mainly for small and medium-sized bearings, but the heat-up times are relatively long.

Bearing of all sizes and types can be heated in an oil bath except for sealed and greased bearings as well as precision bearings.

A thermostat control is advisable(Temperature 80 to 100℃). The bearings are placed on a grate or hung up for them to heat uniformly. This method has some disadvantages, such as accident hazard, pollution of the environment by oil vapours, inflammability of hot oil, danger of bearing contamination.

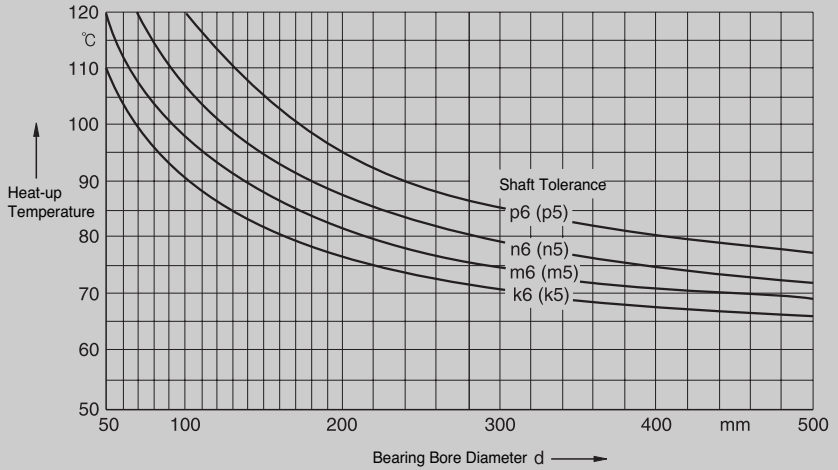

Fig. 14-3 Diagram for Determining the Heat-up Temperature

14-2-2 Mounting of Tapered Bore Bearings

Rolling bearings with a tapered bore are either fitted directly onto the tapered shaft seat or onto a cylindrical shaft with an adapter sleeve or a withdrawal sleeve(Refer to Fig. 14-4, 14-5, 14-6).

In general, tapered bore bearings require tight fits whose interference is a little bigger than that of cylindrical bore bearings. The bigger the applied load is, the stronger tight fit is required.

And this makes inner ring expand, and which, in return, makes bearing's inner clearance smaller. Therefore, the inner clearance of a tapered roller bearing prior to mounting should be bigger than that of a cylindrical bore bearing. The resulting tight fit of the inner ring is measured by checking the radial clearance reduction due to the expansion of the inner ring or by measuring the axial drive-up distance.

Small bearings(up to approx. 80mm bore) can be pressed with a locknut onto the tapered seat of the shaft or the adapter sleeve. A hook spanner is used to tighten the nut.

Small withdrawal sleeves are also pressed with a locknut into the gap between the shaft and inner ring bore.

Considerable forces are required to tighten the nut with medium-sized bearings. Locknuts with thrust bolts facilitate mounting in such cases.

It is advisable to use a hydraulic press for driving up larger bearings or pressing them onto the sleeve.

Hydraulic nuts are available for all popular sleeve and shaft threads. For bearings with a bore of approximately 160mm and upwards mounting and especially dismounting are greatly facilitated by the hydraulic method.

An oil with a viscosity of about 75mm²/s at 20℃ (Nominal viscosity at 40℃ : 32mm²/s) is recommended for mounting.

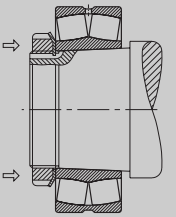

Fig. 14-4 Direct Mounting on a Tapered Shaft

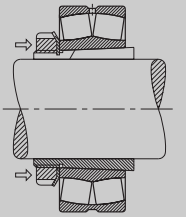

Fig. 14-5 Mounting on an Adapter Sleeve

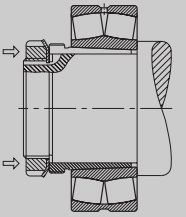

Fig. 14-6 Mounting on a Withdrawal Sleeve

14-3 Bearing Performance Test

14-3-1 Manual Operation Test

Small bearings can be turned around manually, and for large bearings, power is turned on momentarily without applying any load at all, then turned off, and then their performance is checked whether they run smoothly.

Followings and others need to be checked; Excessive torque or noise or vibration, or interfere-

nce in the revolving parts, caused by imbalance revolution torque caused by inserted foreign materials or dust, groove or indentation mark, or improper mounting, inappropriate amount of clearance, or seal friction.

14-3-2 Operation Test with Power On

If no abnormality is found during manual test, then the bearing's performance is tested again with power on.

The test is carried on by starting the machine in low speed without applying any load, and then accelerating it in accordance with specified

condition until rated operation is achieved. Its performance is checked during whole operation for noise, abnormal sound, bearing temperature variation, temperature rise due to friction, color changes and leakage of lubricant, etc.

It's possible to directly measure the temperature of bearing outer ring through oil hole, but, in general, it is estimated by measuring the temperature of housing's outer surface. Bearing temperature rises as running time passes, but after certain time, it reaches constant normal running temperature. But, if there exists some bearing mounting error, excessive inner clearance, or excessive friction in sealing device, etc., then temperature rises rapidly, which calls for inspection.

14-4 Dismounting of Bearings

When it is required to inspect or replace the bearings, the mounted bearings have to be dismounted first.

Dismounting of bearings require careful handling just like its mounting, and bearings need to be designed from the beginning with dismounting safety and convenience in mind, so as not to damage the bearing, shaft, housing, or any other surrounding parts during dismounting, and proper dismounting tools should also be provided.

If the bearings are to be used again, the extraction force should be applied only to the tightly fitted bearing ring with interference.

14-4-1 Dismounting of Cylindrical Bore Bearings

It is efficient enough to use, in case of small bearings, a rubber hammer, or an extracting tools as shown on Fig. 14-7 or 14-8, or a press as shown on Fig.14-9. And with non-separable bearings, such as deep groove ball bearings, if the inner ring is tightly fitted, then care should be taken to apply all extraction forces only to the inner ring.

When extraction tools are used to dismount the bearings, inner ring supporting parts of them should be sufficiently fixed onto the side of inner ring. This is why the size of shaft lip dimension as well as the location of groove for holding extraction tool have to be considered from the initial design stage.

When a tightly-fitted large bearing is mounted onto the shaft, large extraction force is required. In this case, oil injection method, which utilizes oil pressure on the tightly fitted surface, is widely used. This method works because inner ring gets expanded as wide as the thickness of oil film formed by forced injection, which makes bearing dismounting that much easier.

In case of dismounting cylindrical roller bearings of NU or NJ types, or others, which has no lip, or just one integral lip, the induction heating device that rapidly heats up and expands the inner ring locally is used.

When dismounting non-separable bearings, a loosely fitted side should be separated first, and then the tightly fitted side is dismounted. And when dismounting separable bearings, inner and outer rings can get dismounted independent of each other.

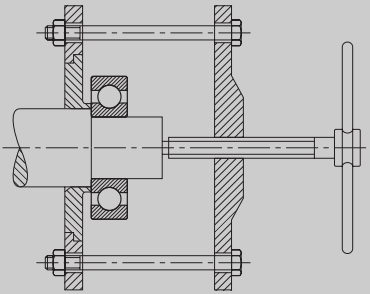

Fig. 14-7 Dismounting of Ball Bearing by using a Extraction Tool

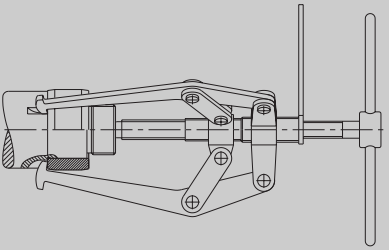

Fig. 14-8 Dismounting of Inner Ring of Cylindrical Roller Bearing by using a Extraction Tool

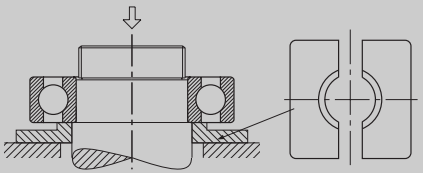

Fig. 14-9 Dismounting of Inner Ring by using Hydraulic Press

14-4-2 Dismounting of Tapered Bore Bearings

When the bearings are directly on the tapered seat or an adapter sleeve, the lock nut is loosened first, and then mounting disk is placed before it is driven off by means of a hammer(Refer to Fig. 14-10, 14-11).

Withdrawal sleeve mounted bearings are removed by means of the extraction nut. If difficulty is expected to remove them, bolt holes may be drilled in advance on the circumference, so that bearing can be removed by fastening the bolts(Refer to Fig. 14-12).

The hydraulic nut is applied to facilitate the dismounting of large-size bearings(Refer to Fig. 14-13)

In case that oil grooves and supply holes have been drilled on tapered shaft in advance, or that the sleeve with oil groove and supply hole is used, bearings can be easily removed without damaging the surfaces by using the oil pump, because forcefully injected protects the rubbing surfaces.(Refer to Fig. 14-4, 14-5). However, since the press fit is released abruptly, a stop such as a nut should be provided to control the movement of the bearing.

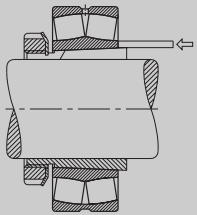

Fig. 14-10 Dismounting of Adapter Sleeve by using Metal Drift

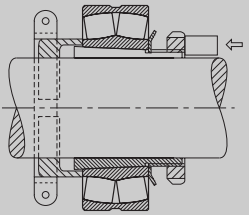

Fig. 14-11 Dismounting of Adapter Sleeve by using Stop Nuts

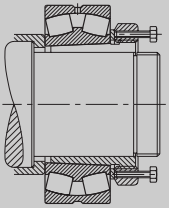

Fig. 14-12 Dismounting of Withdrawal Sleeve by using Bolts

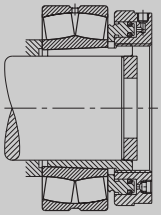

Fig. 14-13 Dismounting of Withdrawal Sleeve by using Hydraulic Nuts

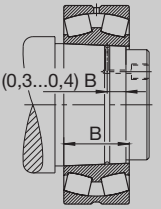

Fig. 14-14 Dismounting of Tapered Shaft by using Hydraulic Pressure

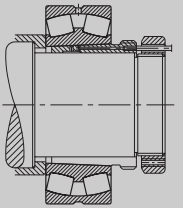

Fig. 14-15 Dismounting of Withdrawal Sleeve by using Hydraulic Pressure

14-4-3 Dismounting of Outer Rings

Two methods are widely used to dismount a tightly-fitted bearing outer rings.

First, one can drill several holes for outer ring extraction bolts on the circumference of bearing housing in advance, so as to fasten the bolts uniformly to dismount a ring, as shown on Fig. 14-16. Second, one can make some grooves for dismounting metal piece on the housing lip, and then use hydraulic press or hammer to dismount the ring, as shown on Fig. 14-17.

The other method of cold extraction effect by using dry ice or liquified nitrogen gas is quite efficient in that it requires light extraction force and extraction can be done easily.

However its extraction cost is comparatively expensive than other methods, so this method is employed only in some special cases.

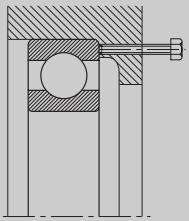

Fig. 14-16 Dismounting of Outer Ring by using Dismounting Bolt

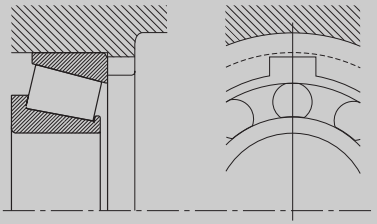

Fig. 14-17 Dismounting Groove

14-5 Compression and Extraction Forces

Amount of compression or extraction forces required to be applied to tightly fit or extract the bearings by giving the interferences is calculated as follows.

$$F_p = \mu \cdot P_m \cdot \pi \cdot d(\text{or } D) \cdot B \quad \cdots\cdots \text{(Equation14-1)}$$

Where,

F_p	: Compression or extraction force	[N]
P_m	: Pressure on tightly fitted surface	[N/mm^2]
d	: Bearing bore diameter	[mm]
D	: Bearing outer diameter	[mm]
B	: Width of inner or outer ring	[mm]
μ	: Sliding friction coefficient	

Actual forces required to mount or dismount bearings on the job are much bigger than the figures theoretically obtained by using above equation.

Therefore, the above equation should be used just as a reference, and mounting or dismounting tools should be designed to withstand much stronger forces.

Table 14-1 Sliding Friction Coefficient

Condition	Coefficient(μ)
When mounting inner ring on cylinder shaft	0.12
When dismounting inner ring from cylinder shaft	0.18
When mounting inner ring on tapered shaft or sleeve	0.165
When dismounting inner ring from tapered shaft	0.135
When mounting sleeve on shaft or bearing	0.3
When dismounting sleeve from shaft or bearing	0.33