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Bearing Mounting and dismounting



BEARING
ASSEMBLY AND DISASSEMBLY



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- Centennial Experience,
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- Professional Techniques,
Lean Manufacture
- Stringent System,
Stable Quality
- Prompt Delivery,
Specialized Service
- East-and-West Merge,
Value Appreciation



1. Bearing mounting environment

Bearing mounting should be in dry and clean places.

Bearing mounting preparations:

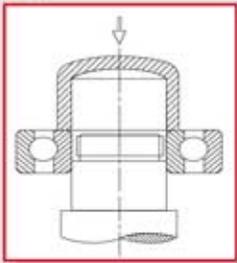
- Prepare all the necessary parts, tools and equipment;
- Inspect the shaft and the bearing housing to make sure that they have good manufacture quality;
- Remove all the scratches and burrs to keep the fitting surface clean;

Attentions: Don't open the package before completing preparation work for preventing bearing pollution.

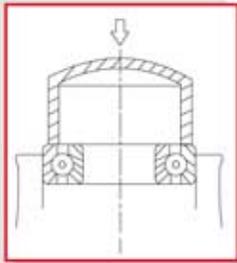
2. Bearing mounting with straight bore

◆ Press method

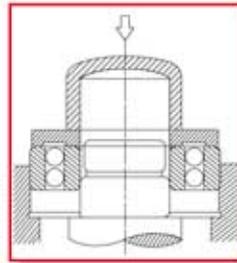
For small bearings with tight fitting, press them on the shaft and into the housing by mechanism or hydraulic equipment.



Tight fitting with shaft



Tight fitting with housing

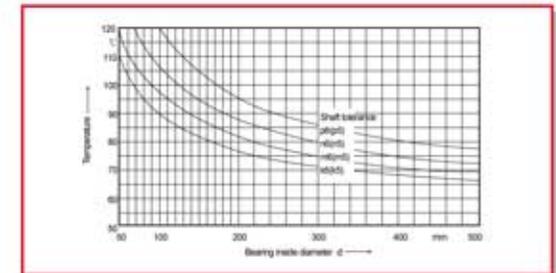
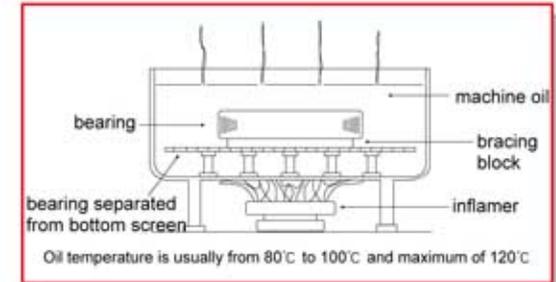


Tight fitting with shaft and housing

◆ Heat method

A popular method of mounting large bearings or a high tight fit is to heat the bearings by oil or inductive device.

◆ Oil-bath heat



◆ Inductive device heat method

Advantages:

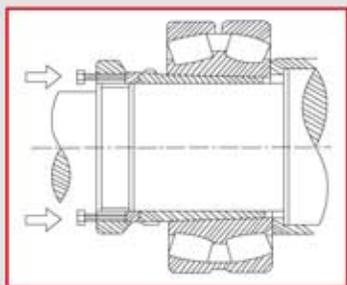
- Clean and has no pollution;
- Constant time and temperature;
- Easy to operate



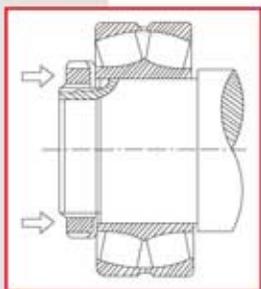


3. Bearing mounting with tapered bore

Bearings with tapered bores always have tight fitting.



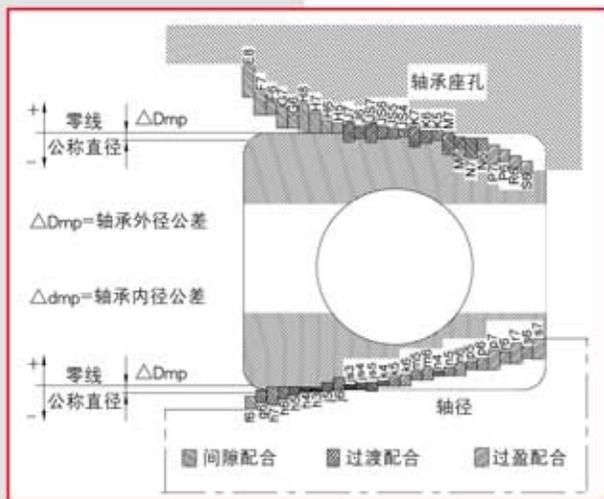
圆柱轴：用退卸套和螺钉（或紧定套和螺母）安装



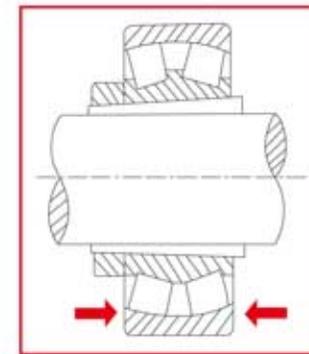
锥形轴：用紧定螺母直接安装

4. Clearance adjustment when mounting the bearing

For the bearings with straight bores, the clearance after mounting is determined by the tolerance of the shaft and housing. The tighter the fitting is, the smaller the clearance becomes. Therefore, it's very important to choose proper tolerance of shaft and housing.



Unlike the bearing with cylindrical bore that fitting interference is determined by shaft tolerance, the magnitude of interference of the bearing with tapered bore is determined by movement of bearing on tapered shaft or adapter.



When a bearing is mounted the clearance is gradually reduced. The axial movement determines the reduction of clearance, so the initial radial clearance should be measured before mounting. During mounting process the radial clearance should be measured continually until demanded clearance is obtained.

Mounting of spherical roller bearing with tapered bore unit(μm)

Bearing bore diameter d(mm)	Radial internal clearance							Reduction in radial clearance		Axial movement Taper 1:12		Axial movement Taper 1:30		Minimum permissible radial clearance		
	C0	C3	C4													
24	30	30	40	40	55	55	75	15	20	300	350	-	-	15	25	40
30	40	35	50	50	65	65	85	20	25	350	400	-	-	15	25	40
40	50	45	60	60	80	80	100	25	30	400	450	-	-	20	30	50
50	65	55	75	75	95	95	120	30	40	450	600	-	-	25	35	55
65	80	70	95	95	120	120	150	40	50	600	750	-	-	25	40	70
80	100	80	110	110	140	140	180	45	60	700	900	1750	2250	35	50	80
100	120	100	135	135	170	170	220	50	70	750	1100	1900	2750	50	65	100
120	140	120	160	160	200	200	260	65	90	1100	1400	2750	3500	55	80	110
140	160	130	180	180	230	230	300	75	100	1200	1600	3000	4000	55	90	130
160	180	140	200	200	260	260	340	80	110	1300	1700	3250	4250	60	100	150
180	200	160	220	220	290	290	370	90	130	1400	2000	3500	5000	70	100	160
200	225	180	250	250	320	320	410	100	140	1600	2200	4000	5500	80	120	180
225	250	200	270	270	350	350	450	110	150	1700	2400	4250	6000	90	130	200
250	280	220	300	300	390	390	490	120	170	1900	2700	4750	6750	100	140	220
280	315	240	330	330	430	430	540	130	190	2000	3000	5000	7500	110	150	240
315	355	270	360	360	470	470	590	150	210	2400	3300	6000	8250	120	170	260
355	400	300	400	400	520	520	650	170	230	2600	3600	6500	9000	130	190	290



The radial clearance measure method can be found in national standard (JB/T3573-93). There are special instruments to measure the radial clearance in manufacture plant.

For spherical roller bearing, we usually use feeler gauge.

Followings are spherical roller bearing clearance measure method using feeler gauge.

A. Set the bearing up and fold

Points:

The end face of inner ring and outer ring should be parallel, and have no gradient. Using thumb to press inner ring and swing 2~3 times to get inner ring and rollers positioned. Position every roller, and let two rollers stand at two sides of the top of inner raceway. Push the two rollers inside to contact inner raceway suitably.



B. Prepare feeler gauge according to the clearance standard

Points:

According to the clearance shows on the standard, the feeler's maximum and minimum should match clearance's maximum and minimum.



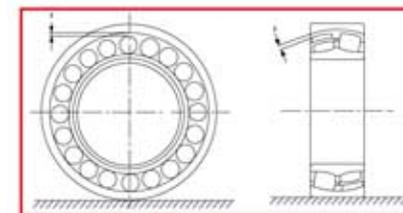
Radial internal clearance in spherical roller bearing Units:(μm)

Bore diameter (mm) d(mm)	Clearance in bearings with cylindrical bores										Clearance in bearings with tapered bores										
	C2		C0		C3		C4		C5		C2		C0		C3		C4		C5		
超过 至	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
24	30	15	25	25	40	40	55	55	75	75	95	20	30	30	40	40	55	55	75	75	95
30	40	15	30	30	45	45	60	60	80	80	100	25	35	35	50	50	65	65	85	85	105
40	50	20	35	35	55	55	75	75	100	100	125	30	45	45	60	60	80	80	100	100	130
50	65	20	40	40	65	65	90	90	120	120	150	40	55	55	75	75	95	95	120	120	160
65	80	30	50	50	80	80	110	110	145	145	180	50	70	70	95	95	120	120	150	150	200
80	100	35	60	60	100	100	135	135	180	180	225	55	80	80	110	110	140	140	180	180	230
100	120	40	75	75	120	120	160	160	210	210	260	65	100	100	135	135	170	170	220	220	280
120	140	50	95	95	145	145	190	190	240	240	300	80	120	120	160	160	200	200	260	260	330
140	160	60	110	110	170	170	220	220	280	280	350	90	130	130	180	180	230	230	300	300	380
160	180	65	120	120	180	180	240	240	310	310	390	100	140	140	200	200	260	260	340	340	430
180	200	70	130	130	200	200	260	260	340	340	430	110	160	160	220	220	290	290	370	370	470
200	225	80	140	140	220	220	290	290	380	380	470	120	180	180	250	250	320	320	410	410	520
225	250	90	150	150	240	240	320	320	420	420	520	140	200	200	270	270	350	350	450	450	570
250	280	100	170	170	260	260	350	350	460	460	570	150	220	220	300	300	390	390	490	490	620
280	315	110	190	190	280	280	370	370	500	500	630	170	240	240	330	330	430	430	540	540	680
315	355	120	200	200	310	310	410	410	550	550	690	190	270	270	360	360	470	470	590	590	740
355	400	130	220	220	340	340	450	450	600	600	750	210	300	300	400	400	520	520	650	650	820

C. Measure the clearance at the maximal position.

Points:

When setting the bearing up, the gap at the top between outer raceway and rollers is the largest radial clearance.



D. Use feeler gauge to measure radial clearance

Points:

Rotate rings, rollers and cage one circle, the feeler can pass three rollers continuously, and can't pass others, it's the maximum clearance. The feeler can't pass three rollers continuously, and can pass others, it's the minimum clearance.



The arithmetic mean value of minimum and maximum is the radial clearance. If the each row's clearance is qualified, get the arithmetic mean value of the two rows as bearing's clearance.

For single angular contact ball bearing, taper roller bearing and thrust bearing, the last step of mounting is to adjust the axial clearance.

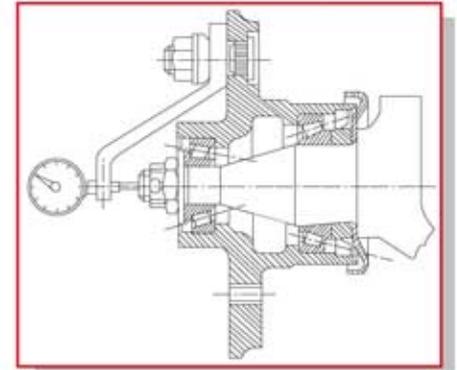
The axial clearance should be adjusted according to mounting configuration, load, work temperature, and bearing performance.



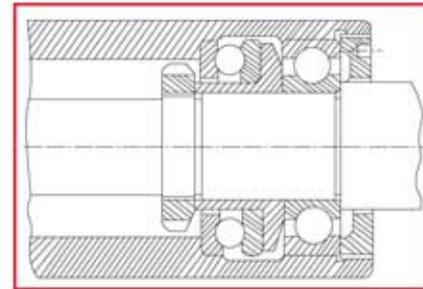
Follows are the axial clearance measure method and the method to adjust axial clearance.

Use micrometer to measure the axial clearance of car hub.

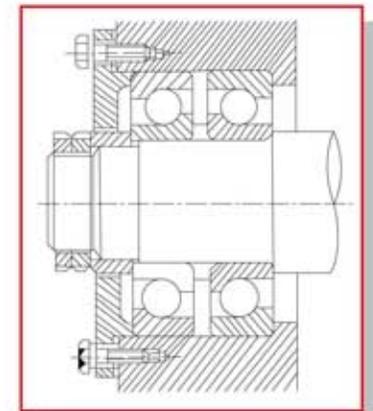
Put the micrometer seat onto machine frame or into the house, and the feeler onto the shaft, push the shaft in the two directions, the range showed by index is the axial clearance.



How to adjust axial clearance?



Use the nut to adjust the axial clearance.



Use the gasket to adjust the axial clearance.

5. Lubrication after bearing mounting

Lubrication is necessary for a bearing to run normally, avoid raceway and rollers from contacting directly, reduce friction and wear, improve its performance, prolong its life.

The purpose of lubrication is to reduce friction and wear, form oil film and take heat away.

The lubrication types mainly are grease and oil.

In special condition where grease and oil can not be used, solid lubricant may be chose.



Principle of choosing lubricant

condition	grease	oil
temperature	Use special grease when temperature is over 120°C; re-lubrication time should be reduce if the temperature were up to 200°C~220°C	Use special lubricating oil when oil temperature is over 90°C or bearing temperature is over 200°C
speed	$Dn < 300000 \sim 350000$	$DN < 450000 \sim 500000$
load	Light-medium	All load conditions
Bearing types	Can't be used in asymmetrical thrust spherical roller bearing	All types
Housing design	easy	Need complicated sealing and supplying devices
Long maintenance period	Available when temperature is considered specially	Not available
Centralized supply (supply to other parts synchronously)	Not available as it can not bring heat away and can not be used as hydraulic medium	Available
Lowest torque loss	If used properly, the loss is lower than oil	For lowest loss, cleanly pump or oil mist instrument should be used
pollution	Available provide proper design	Available provide oil cycle system with filtration instrument was used

Grease and oil performance contrast

Items	Grease	Oil
Lubrication performance	good	Very good
Cool effect	no	have
Allowable rotate speed	Lower than oil	High speed
Allowable load	Medium	heavy
Seal instrument and frame configuration	simple	complex
Dust protection	easy	difficult
Lubricant leak	Less	More
maintenance	easy	difficult
Lubricant replacement	difficult	easy
Equipment cost	low	high
Operate cost	low	high



5.1 Grease

Grease is semi-solid lubricant consisting of base oil, thicker and additives.

Base oil—mineral oils or synthetic oils such as silicone or diester oil are mainly used as the base oil for grease. The lubricant viscosity properties mainly depend on the characteristics of its base oils.

Thickener—the type of thickener is closely related to the grease dropping point, water resistant, oil separation. Thickener has two kinds including metallic soap and non metallic soap.

Additives— grease often contains various additives such as antioxidant, corrosion inhibitors, and extreme pressure additives to give it special properties. It's recommended that extreme pressure additives be used in heavy and compact applications. For long use without replenishment, an antioxidant should be added.

According to different kinds of additives, grease has different kinds as Ca soap, Na soap, Ca-Na soap, Al soap, Li soap, Ba soap and alkyl.

Consistency indicates the "softness" of grease. As numbers increase, grease is softer.

The dropping point is an important index. It determines grease temperature performance. As numbers increase, the work temperature is higher.

Grease types and properties

Grease type	Lithium Grease			Sodium grease (Fiber Grease)	Calcium Grease (Cup Grease)
soap	Li soap			Na Soap	Ca Soap
Base oil	Mineral oil	Diester oil polyatomic Ester oil	Silicone oil	Mineral oil	
Dropping point °C	170~190	170~190	200~250	170~200	70~90
Working Temperature °C	-20~110	-50~120	-50~160	-20~120	-20~60
working speed%	10	100	60	70	40
Mechanical stability	good	good	good	good	poor
Pressure	fair	fair	poor	Good to fair	Poor
Water resistance	good	good	good	Poor	good
corrosion resistance	good	good	good	Good to poor	good
Application arrange	General used on all kinds of bearings	Good low temperature and torque Characteristics Often used for small motors and instrument bearings	Mainly for high temperature High speed, high load	Long and short fiber types are available. Lone fiber grease is unsuitable for high speed, attention to water is required	Extreme pressure containing high viscosity mineral oil and extreme pressure additive has high pressure resistance

Grease types and properties

Grease type	Mixed Base Grease	Complex base Grease	Non-soap base grease	
soap	Na+Ca soap Li+Ca soap Etc.	Ca complex soap Al complex soap Li complex soap Etc.	Urea, Bentonite, Carbon Black, Fluoric, Compounds Heat Resistant Organic, Compound etc	
Base oil	Mineral oil	Mineral oil	Mineral oil	Synthetic oil
Dropping point °C	160~190	240~300	240~250	
Working Temperature °C	-20~80	-20~120	-10~150	
working speed%	70	70	70	40~100
Mechanical stability	good	good	good	
Pressure	Good-fair	Good-fair	Fair	
Water resistance	Poor for Na soap grease	good	good	
corrosion resistance	Good-fair	Good-fair	Fair-poor	
Application arrange	often used for roller bearings and large ball bearing	Suitable for extreme pressures mechanically stable	Mineral oil base grease is middle and high temperature purpose lubricant. Synthetic oil base grease is recommended for low or high temperature	

Bearing lubrication choose points

Bearing temperature	Dn Bore dia X r/min	Dry lubrication position	Water, moisture lubrication position
<0	—	Low dropping point Li soap or 0#, 1# Na soap	Low dropping point Li soap or 0#, 1# Ca and Al soap
0~40	< 80000	1#, 2# Ca or Li soap	1#, 2# Ca or Al soap
	> 80000	2#, 3# Ca or Li soap	2#, 3# Ca or Li soap
40~80	< 80000	2#, 3# Li or Na soap	2#, 3# Ba or Li soap
	> 80000	3#, 4# Li or Na soap	3#, 4# Ba or Li soap
> 80	—	3#, 4# Li soap Dye soap	3#, 4# Li soap or bentonite, silica gel soap

After bearing mounting, grease should be added into the bearings timely, so the bearing can have sufficient lubrication during running.

If the bearing has no enough grease when operating, the oil film can't separate the raceway and roller efficiently, the surface will wear quickly.

If the grease is added too much, more heat will produce, the bearing will easily be broken.

So, adding the grease suitably is very important.



Generally, the formula of the grease quantity G added into bearing is:

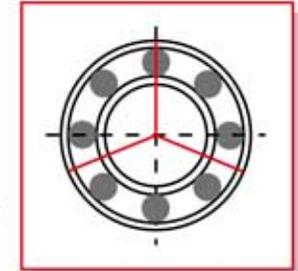
$$G = 0.005DB$$

Where:

G — quantity (g),

D — bearing outside diameter (mm)

B — bearing width (mm)



The formula of the space inside bearing V is:

$$V = WK$$

Where:

V — the room inside bearings (cm³)

W — bearing quality (kg)

K — the coefficient of the room inside bearings

N_g — bearing limiting speed, where grease lubrication (r/min)

N — bearing actual speed (r/min)

If $N_g/N < 1.25$, Lubrication quantity $V=1/3$

If $1.25 < N_g/N < 5$, Lubrication quantity $V=1/3-2/3$

If $N_g/N > 5$, Lubrication quantity $V > 2/3$

The coefficient k of the room inside bearings

Bearing type	Cage type	K
Single cylindrical roller bearing (NU)	Punched cage	50
	Machined cage	36
Single cylindrical roller bearing (N)	Machined cage	37
	Punched cage	55
Taper roller bearing	Punched cage	46
Spherical roller bearing	Punched cage	35
	Machined cage	28
Deep groove ball bearing	Punched cage	61



5.2 Oil lubrication

For the lubrication of rolling bearings, the lubrication type for different mounting should be considered as the bearing can have sufficient lubrication.

Follows are several oil lubrication types : oil bath lubrication; drip-feed lubrication; splash lubrication; circulating lubrication; jet lubrication; oil mist lubrication; oil/air lubrication etc.

❖ Oil bath lubrication

Oil bath lubrication is widely used with low or medium speeds. Part of bearing dips in the oil, oil is brought up and then dropped into oil tank by rotated bearing parts. The oil level should be at the centre of the lowest rolling element.

❖ Drip-feed lubrication

Drip feed lubrication is widely used for small ball bearing operated at relatively high speed. Oil is stored in a visible oil bowl. The oil drip rate is controlled with the screw in the top.

❖ Jet lubrication

The lubricating oil is sprayed into the bearing and feed in the oil groove. In the case of high speed operation of bearing and its parts, the air surrounding the bearing rotates with it causing the oil jet to be deflected. So the normal lubrication method is difficult to get the oil into the bearing, it's necessary to use jet lubrication, and the nozzle should face to the gap of inner ring and cage.

❖ Circulating lubrication

Oil is supplied by the pipe, it travels through the bearing. After being cooled in a reservoir, it returns to the bearing through a pump and filter. Circulating lubrication is commonly used for high speed operation requiring bearing cooling and for bearings used at high temperatures. The filter is needed in the system to filter particles. And it's better to install the constant temperature valve to control oil viscosity.

❖ Splash lubrication

With this lubricating method, oil is splashed onto the bearings by gears or a simple rotating disc installed near bearings without submerging the bearings in oil. It's commonly used in automobile transmissions and final drive gears.

❖ Oil mist lubrication

Oil mist lubrication utilized a mixture of clean air and oil sprayed into a bearing. The sprayed air in the housing can cool the bearing, also it can prevent impurity. Because the quantity of oil can be adjusted accurately, the oil agitation resistance is small, and higher speeds are possible.

❖ Oil-air lubrication

The litter oil is sent to compressed air flow in the pipe at regular interval by using piston-type quantitative distributor, which forms a continuous oil flow to lubricate bearings. New lubricant often flows continuously so that lubricant won't be aging. The compressed air prevents the intrusion of external impurities. Litter oil supply reduces the pollution of the environment, oil air is less stable than oil mist lubrication and with characters of less friction torque, lower temperature rise, especially fit for high-speed bearings.

How select lubricant

Bearing lubricant is generally mineral oil without additive. Only in a special condition, lubricant with additive is used to improve the performance, including resistance to extreme pressure, anti-aging and so on. Synthetic oil is generally used only in special occasions, for instance the very extreme high or low temperature or speed.

Viscosity is an important performance indicator of lubricant, which is the main basis for selecting suitable lubricant. Lubricant viscosity decreases as temperature increases. If viscosity is too low, it can not fully form oil film resulting in abnormal wear and low life. If viscosity is too high, its viscosity resistance may generate heat, expanding the power loss.

In general, high speed bearing should choose low viscosity lubricant, the greater load need the larger bearing and should choose high viscosity lubricant.

Oil replacement intervals

Oil replacement intervals depend on the operating conditions and oil quantity. In those cases where the operating temperature is less than 50°C, and the environmental condition is good with little dust, oil should be replaced approximately once a year. If temperature is high, the intervals should be shorter. In cases where the oil temperature is about 100°C, the oil must be changed once at least every three months. If work condition is not good, the intervals should also be shorted.

The oil replacement intervals of circulating lubrication and jet lubrication depend on circulating speed and the oil is cooled or not. Usually it is determined by actual running and the check status.

When bearing is lubricated by oil mist and oil/air, the oil only goes through bearing one time and doesn't circle.

5.3 Solid lubrication

- ◆ In special conditions where grease and oil lubricant are limited, following solid lubrication may be adopted.
- ◆ Add solid lubricant into grease, usually add 3%~5% 1# MoS₂ into grease.
- ◆ Affix lubricant onto raceway, cage and rollers to form a solid lubricant film.
- ◆ Add solid lubricant into engineering plastic or powder metallurgical material to manufacture self-lubrication bearing parts.
- ◆ Set solid lubricant material into grooves machined on sliding surfaces, or into cage pockets, pilot surfaces or raceways.
- ◆ Form a smooth and compact film of solid lubricant or soft metal (Au, Ag, Pb) on friction surface of by electroplating, high frequency splashing or chemical aggradation.



6. Incorrect mounting causes bearing premature damage

Incorrect mountings often damage bearing early or lead to failure during running time.

Followings are some familiar incorrect mountings:

- ◆ The fitting of shaft to bearing bore is too loose.

The bearing was damaged due to high heat that generated when bearing bore was slid to shaft as their fitting was too loose.



The sliding track between shaft and bearing bore

When the bearing bore slides relative to shaft, the slide friction will generate lots of heat. As the contact area of end face of inner ring and the shoulder is small, the inner ring's temperature is very high that will cause heat crack and then inner ring will split.



Cracks occur due to the heat generated by friction between inner face and shaft shoulder



As the bearing bore slides related to shaft, the slide friction will generate heat and melt metal.



Adhesions occur due to the heat from the surfaces of shaft and bore

- ❖ The fitting between housing diameter and bearing outside ring is too loose, and it usually is said outer ring sliding.
As the fitting of housing to outer ring is too loose, the outer ring will slide relative to housing, so heat will be generated, and then bearing will be damaged.



Trace caused by sliding between housing diameter and bearing outside ring

- ❖ It's forbidden to knock on bearing directly with hammer

When mounting the bearing which the inner ring (outer ring) is tight fitting, it's forbidden to knock on inner ring (outer ring) directly with hammer, as the bearing rib is easy to be broken. A sleeve should be put on the end face of inner ring (outer ring), then use hammer to knock on sleeve to mount bearing.

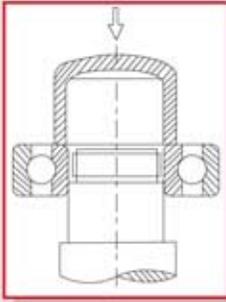


Broken rib knocked by hammer





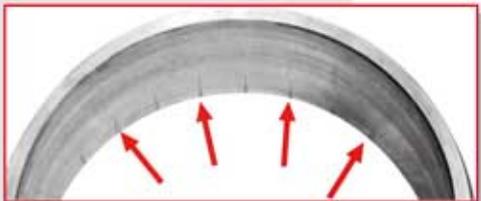
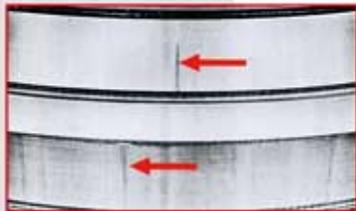
- ❖ It's forbidden to pass force through rolling elements.



正确安装方法

When mounting the bearing where the inner ring with a tight fitting, the mounting force can't be passed through outer ring and rolling elements as it is possible to damage the raceway and the rollers' surface which will produce noise and result in bearing's premature failure. The correct method is to apply a force directly to a ring.

Knocked traces on the raceway of inner ring and outer ring.



- ❖ The heat temperature was too high when mounting the bearing
Some users use acetylene gun to heat bearing, so that the temperature is over 727°C, at which the metallurgical structure of bearing will change. When the bearing is cool down, the dimension of bearing bore can't be back to the previous dimension but usually a larger dimension.



The bearing surface has changed into black after being heated by acetylene gun.

- ❖ Only one row takes load due to faulty mounting position.
Only one row of spherical roller bearing takes load, so one raceway of outer ring and one row of rollers are damaged.





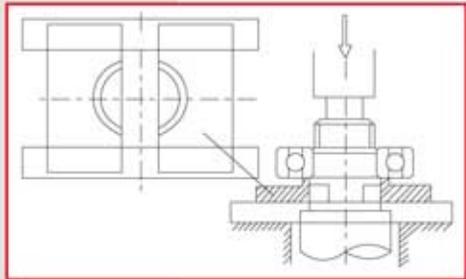
7. Bearing Dismounting Method

When repairing the equipment, the bearing need to be dismounted.

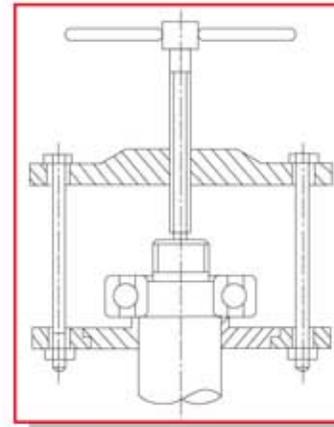
When a bearing was damaged, it also need to be dismounted and replaced with a new bearing. Therefore it's very important to adopt a safe and efficient dismounting method.

If a bearing will be reused after dismounting, it's forbidden to apply a force through rolling elements, otherwise the rolling element and raceway would be damaged.

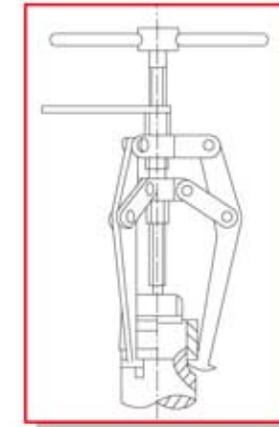
For non-separable bearing, the ring with looser fit should be dismounted first and then remove the ring with tighter fit by a press machine.



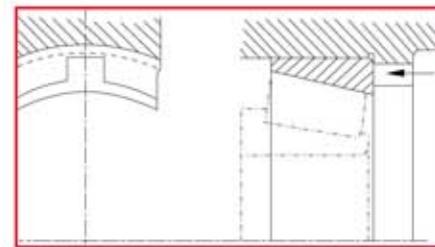
For non-separable bearing, special dismounting devices can be used



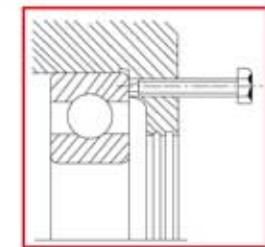
A dismounting tool with two adjustable paws



A dismounting tool with three adjustable paws



Design several cuts on housing shoulder

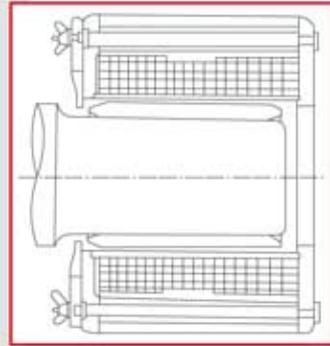


design screwed holes for ejector screw

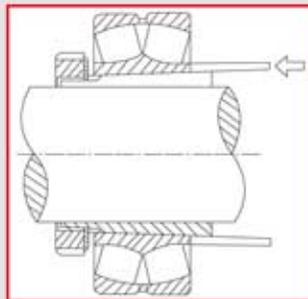
For non-separable bearing, it would easy to dismount outer ring with a tight fit if dismounting plan were considered during design phase



For separable bearing, e.g. single cylindrical roller bearing (NU, NJ type), the outer ring, cage and rolling elements as an unit can be separated with inner ring. Usually it need large force to dismount inner ring as the inner ring is tight fitting with shaft. Sometimes it may damage the surface of the inner ring and shaft. If an induction heating device was used to heat the inner ring, the dismounting would become easy.



Induction heating device for dismounting of inner ring of cylindrical roller bearing

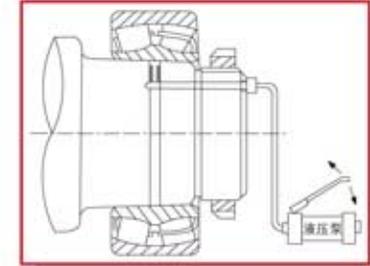
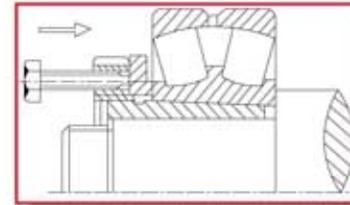


It's easy to dismount the bearing with small tapered bore.

When bearings are mounted on an adapter sleeve, the nut should be unscrewed first and then use hammer to knock on sleeve to dismount.



Bearings located using extraction sleeves are dismounted with the aid of the extraction nut.



In the case of difficult to dismount, locknuts with additional pressure screws can be used.

The dismounting of large bearing can become easier if use a hydraulic tool, where oil is pressed trough appropriate oil slots in the tapered shafts to expand the inner ring for dismounting. In actual operation some loose-proof means, e.g. locknut or cover should be used to fix bearing axially.

The problems in mounting and dismounting of bearing often face customers. Only use proper mounting and dismounting methods can the bearing be running normally and be longer life.