

TECHNICAL INSIGHT

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Lubrication – Reducing friction and bearing wear

Lubricating a bearing with greases or oils stops direct metallic contact between the bearing components and the cage. A sufficient film of lubricant prevents friction and potential overheating of the bearing, which can stop premature wear and extend fatigue life. Lubrication also means that foreign particles cannot penetrate the bearing and protects against corrosion.

Grease and oil lubrication

Either grease or oil lubrication can be used to ensure bearings run optimally and to reduce wear. The application and operating conditions have to be taken into account when choosing the type of lubrication. Different parameters and the recommended method of lubrication are listed in the table below.

Comparison of grease and oil lubrication

| Item | Grease Lubrication | Oil Lubrication |
|---------------------------------------|--|--|
| housing structure and sealing method | simple | may be complex, careful maintenance required |
| speed | limiting spirit is 65% to 80% of that with oil lubrication | higher limiting speed |
| cooling effect | poor | heat transfer is possible using forced oil circulation |
| fluidity | poor | good |
| full lubricant replacement | sometimes difficult | easy |
| removal of foreign matter | removal of particles from grease is impossible | easy |
| external contamination due to leakage | surroundings seldom contaminated by leakage | Often leaks without proper countermeasures. Not suitable if external contamination must be avoided. |

Composition of lubricants

| Greases consist of: | Oils consist of: |
|---------------------|------------------|
| 70-90% base oils | 95-99% base oils |
| 5-30% thickeners | – |
| 1-5% additives | 1-5% additives |

Base oils provide the lubricating power, thickeners give base oils a semi-solid consistency, and additives improve various characteristics which are required.

1. Grease lubrication

Increasingly high-performance machines need rolling bearings which fulfil the most exacting output and quality requirements. Grease lubrication plays an important role in extending service life, keeping torque low, ensuring quiet running and guarding against corrosion.

NSK offers a range of specially developed greases, e.g. for high temperatures and high speeds.

Requirements for greases

- › High level of resistance to oxidation and heat; low evaporation losses
- › Good lubricating power over extended periods of use
- › Mechanical strength and resistance to softening and leakage
- › First-rate lubricating and wear-reducing properties
- › Minimal torque and temperature increase in the bearing
- › Outstanding properties at low temperatures
- › Minimal torque at low temperatures
- › Quiet on start-up
- › Water-repellent; very good protection against corrosion
- › Prevention of contamination; quiet running
- › Neutral to plastic and rubber
- › Consistent quality and maximum shelf life without any changes

Quantity of grease

The amount of necessary grease within a housing depends on the following factors:

- › Housing design
- › Available space
- › Grease properties
- › Ambient temperature

The amount of available space inside the bearing which should be packed with grease is based on the speed:

- › 1/2 to 2/3 of the space if the speed of rotation is less than 50% of the limiting speed.
- › 1/3 to 1/2 of the space if the speed of rotation is more than 50% of the limiting speed.

Replenishing grease

Usually, grease does not need replenishing for a long time. In demanding operating conditions, such as high bearing temperatures or loads, grease has to be replenished or changed regularly. If lubrication is needed at short intervals, filling and draining nozzles must be set in suitable positions so that used grease can be replaced with fresh lubricant.

Types and properties of NSK greases

See separate table "Brands and properties of lubricating greases - TI/E/0100".

2. Oil lubrication

Oil lubrication is most suitable for high limiting speeds. Generally speaking, oil lubrication systems are more complex and need careful maintenance.

The lubricating oils used for rolling bearings are normally highly refined mineral and synthetic oils with high levels of oil film strength plus excellent resistance to oxidation and corrosion. When choosing a lubricating oil, it is important to consider its viscosity in the relevant operating conditions. If the viscosity is too low, a proper oil film will not be able to form, which can cause abnormal wear and smearing. However, if the viscosity is too high, the lubricant can cause excessive friction, leading to an increase in bearing temperature and a considerable loss of energy.

Bearing types and proper viscosity of lubricating oils

| Bearing Type | Proper Viscosity at Operating Temperature |
|---|---|
| ball bearings and cylindrical roller bearings | higher than 13 mm ² /s |
| tapered roller bearings and spherical roller bearings | higher than 20 mm ² /s |
| spherical trust roller bearings | higher than 32 mm ² /s |

Remarks 1 mm²/s = 1 cSt (centistokes)

Different types of oil lubrication

1) Oil bath lubrication

Oil bath lubrication is often used for low and medium speeds. The oil level should be in the middle of the lowest rolling element. It is wise to install an oil gauge glass, so that you can ensure you maintain the correct oil level.

2) Oil splash lubrication

With this method, gear wheels or a flinger splash oil onto the bearings, without the latter being dipped in oil. It is primarily used in automotive gears and axle drives.

3) Oil circulating lubrication

Oil circulating lubrication is mainly used for high-speed applications where bearings need to be cooled and used at high temperatures. With this method, oil is delivered through a guide on one side, it runs through the bearing and is then fed out again through a pipe on the other side. Once it has been cooled in a storage tank, it passes through a pump and a filter, back into the bearing. The outlet for the oil should be larger than the supply pipe so that surplus oil cannot back up.

4) Oil injection lubrication

Oil injection lubrication is often used for bearings with extremely high speeds, such as bearings in jet engines where the $n \times dm$ factor (dm : pitch circle diameter of the rolling element set in mm; n : speed in rpm) exceeds one million. With this system, pressurised lubricating oil is injected directly into the bearing by one or several nozzles. Using several nozzles enables more uniform cooling and a better temperature distribution for a minimal amount of oil.

5) Oil-air lubrication

With oil-air lubrication, a metering device periodically injects very small, consistent quantities of oil into pipes with a continuous flow of compressed air. The oil flows along the walls of the pipes at a constant speed. This type of lubrication is used in the main spindles of machine tools and other high-speed applications.

The main advantages of oil-air lubrication are:

- › A minimum amount of oil is used, making this method suitable for high speeds because less heat is generated.
- › The minimum amount of oil is always available, so the bearing temperature remains stable. Also, as little oil is used, there is virtually no air pollution.
- › Only fresh oil is fed into the bearings so the oil does not deteriorate.
- › The addition of compressed air generates a certain amount of overpressure. Dust and cutting oil cannot penetrate the system.

Types and properties of NSK lubricating oils

| Operating Temperature | Speed | Light or normal Load | Heavy or Shock Load |
|-----------------------|---------------------------------|---|--|
| -30 to 0°C | less than limiting speed | ISO VG 15, 22, 32 (refrigerating machine oil) | - |
| 0 to 50°C | less than 50% of limiting speed | ISO VG 32, 46, 68 (bearing oil, turbine oil) | ISO VG 46, 68, 100 (bearing oil, turbine oil) |
| | 50 to 100% of limiting speed | ISO VG 15, 22, 32 (bearing oil, turbine oil) | ISO VG 22, 32, 46 (bearing oil, turbine oil) |
| | more than limiting speed | ISO VG 10, 15, 22 (bearing oil) | - |
| 50 to 80°C | less than 50% of limiting speed | ISO VG 100, 150, 220 (bearing oil) | ISO VG 150, 220, 320 (bearing oil) |
| | 50 to 100% of limiting speed | ISO VG 46, 68, 100 (bearing oil, turbine oil) | ISO VG 68, 100, 150 (bearing oil, turbine oil) |
| | more than limiting speed | ISO VG 32, 46, 68 (bearing oil, turbine oil) | - |
| 80 to 110°C | less than 50% of limiting speed | ISO VG, 320, 460 (bearing oil) | ISO VG 460, 680 (bearing oil, gear oil) |
| | 50 to 100% of limiting speed | ISO VG, 150, 220 (bearing oil) | ISO VG, 220, 320 (bearing oil) |
| | more than limiting speed | ISO VG 68, 100 (bearing oil, turbine oil) | - |

- Remarks**
1. For the limiting speed, use the values listed in the bearing tables.
 2. Refer to Refrigerating Machine Oils (JIS K 2211), Bearing Oils (JIS K 2239), Turbine Oils (JIS K2213), Gear Oils (JIS K 2219).
 3. If the operating temperature is near the high end of the temperature range listed in the left column, select a high viscosity oil.
 4. If the operating temperature is lower than -30°C or higher than 110°C, it is advisable to consult NSK.