

Lubrication Strategies for Electric Motor Bearings

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The proprietary in-house statistics of a number of petrochemical plants in the United States indicate that approximately 60 percent of all motor difficulties originate with bearing troubles. If a bearing defect is allowed to progress to the point of failure, far more costly motor rewinding and extensive downtime will often result. Improvements in bearing life should not be difficult to justify, especially if it can be readily established that most incidents of bearing distress are caused by lubrication deficiencies.

There is some disagreement among electric motor manufacturers as to the best bearing arrangement for horizontal-type, grease-lubricated, ball bearing motors. There is also disagreement on the best technique for replenishing the grease supply in the bearing cartridge. If the user of these motors wishes to follow the recommendations of all these manufacturers for their respective motors, he must stock or have available ball bearings in a given size with no shield, single-shield and double-shield. He should also train personnel in the relubrication techniques for each make of motor. The confusion thus created in the minds of maintenance personnel may indeed bring about a less-than-satisfactory method of maintaining expensive, important equipment.

This discussion will focus on grease lubrication methods for electric motor bearings. All too often, an industrial user will employ less-than-ideal lubrication strategies, or vulnerable bearing housing configurations. These are the issues addressed first.

How Grease-lubricated Bearings Function in Electric Motors

A shielded, grease-lubricated ball bearing (Figure 1) can be compared to a centrifugal pump having the ball-and-cage assembly as its impeller and having the annulus between the stationary shield and the rotating inner race as the eye of the pump. Shielded bearings are not sealed bearings.

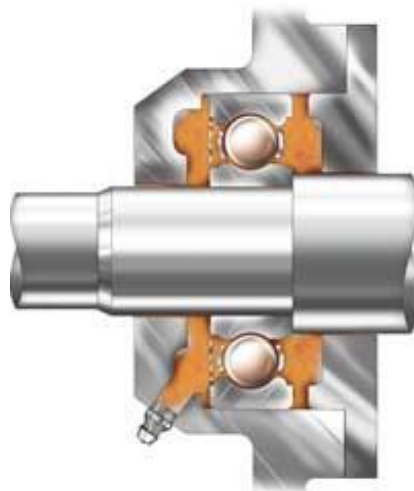


Figure 1. Shielded, Grease-lubricated Bearing

With the shielded bearing, grease may readily enter the bearing, but dirt is restricted by the close-fitting shields. Conversely, bearings of the sealed design will not permit entry of new grease, whereas with shielded bearings, grease will be drawn in by capillary action as the bearing cage assembly rotates. The grease will then be discharged by centrifugal force into the ball track of the outer race. If there is no shield on the back side of this bearing, the excess grease can escape into the inner bearing cap of the motor bearing housing.

Single-shielded Bearings

Many bearing users consider the regular single-shielded bearing with the shield facing the grease supply (Figure 2) to be the best arrangement.

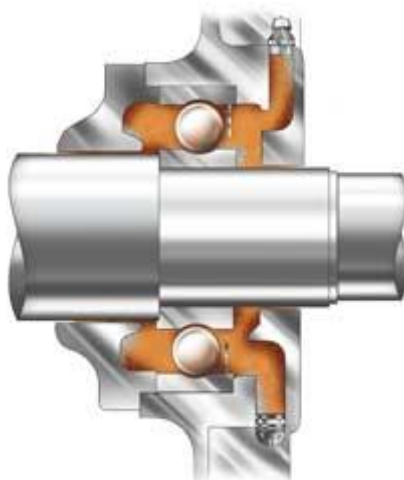


Figure 2. Single-shielded Motor Bearing with Shield Facing the Grease Cavity

Table 1. Influence of Lubrication on Service Life (Source: FAG Bearing Corporation)

| | Oil | Oil | Grease | Dry Lubricant |
|-------------------------------------------|------------------------------------------|------------------------------------------------------|---------------------------------------|-----------------------|
| | Rolling bearing alone | Rolling bearing with gearing and other wearing parts | Rolling bearing alone | Rolling bearing alone |
| Decreasing service life ² ↓ | Circulation with filter, automatic oiler | Circulation with filter | Automatic feed | |
| | Oil-air spray | Oil-air spray | | |
| | Oil-mist | Oil-mist | | |
| | Circulation without filter ¹ | Circulation without filter ¹ | | |
| | Sump (bath), regular renewal | Sump (bath), regular renewal ¹ | Regular regreasing of cleaned bearing | |
| | Sump (bath), occasional renewal | Rolling bearing | Regular grease replenishment | |
| | | Sump (bath), occasional renewal | Occasional renewal | Regular renewal |
| | Rolling bearing | Occasional replenishment | | |
| | | Lubrication for life | Lubrication for life | |

¹ By feed cones, bevel wheels, asymmetric rolling bearings.

² Condition: Lubricant service life less than fatigue life.

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Experience indicates this simple arrangement will extend bearing life. This arrangement will also permit an extremely simple lubrication and relubrication technique. The shield serves as a baffle against agitation. The shield-to-inner-race annulus serves as a metering device to control grease flow. These features prevent premature ball bearing failures caused by contaminated grease and heat buildup due to excess grease. For other services where an open bearing is necessary, as in some flush-through arrangements, the shield can be removed in the field.

TECHNICAL INFORMATION

Double-shielded Bearings

Some motor manufacturers subscribe to a different approach, favoring double-shielded bearings. These are usually arranged as shown in Figure 3.

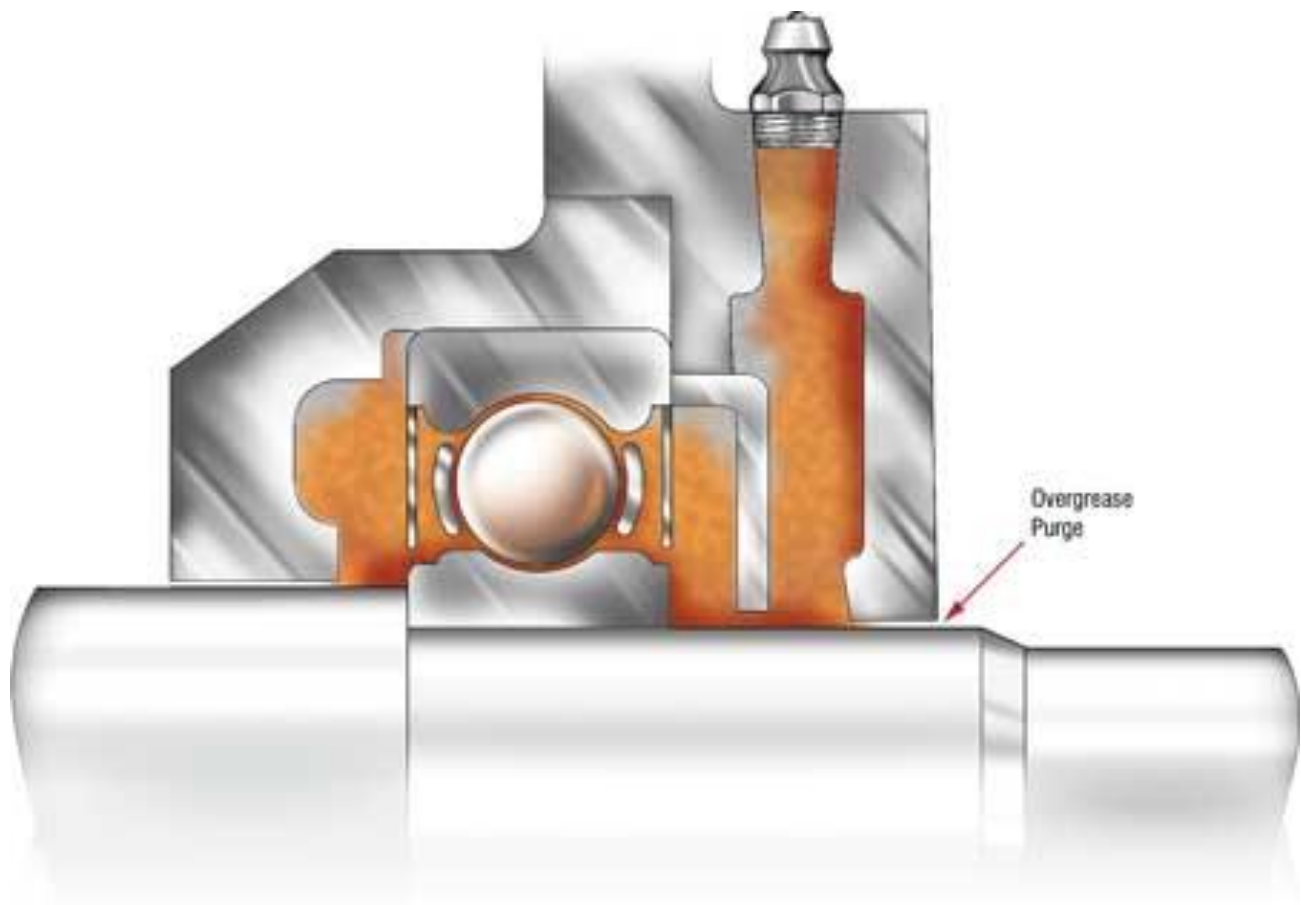


Figure 3. Double-shielded Bearing with Grease-metering Plate Facing Grease Reservoir

The housings serve as a lubricant reservoir and are filled with grease. By regulating the flow of grease into the bearing, the shields act to prevent excessive amounts from being forced into the bearing. A grease retainer labyrinth is designed to prevent grease from reaching the motor windings on the inner side of the bearing.

On motors with this bearing configuration and mounting arrangement, it is not necessary to pack the housing next to the bearing full of grease for proper bearing lubrication. However, packing with grease helps prevent dirt and moisture from entering. Over a long period, oil from this grease reservoir enters the bearing to revitalize the grease within the shields. Grease in the housing outside the stationary shields is not agitated or churned by the rotation of the bearing and consequently, is less subject to oxidation. Furthermore, if foreign matter is present, the fact that the grease in the chamber is not being churned reduces the probability of the debris contacting the rolling elements of the bearing.

On many motors with grease-lubricated double-shielded bearings, the bearing housings are not usually equipped with a drain plug. When grease is added and the housing becomes filled, some grease will be forced into the bearing, and any surplus grease will be squeezed out along the close clearance between the shaft and the outer cap. This happens because the resistance of this path is less than the resistance presented by the bearing shields, metering plate and the labyrinth seal.

Open Bearings

High-load and/or high-speed bearings are often supplied without shields to allow cooler operating temperature and longer life. One such bearing is illustrated in Figure 4.

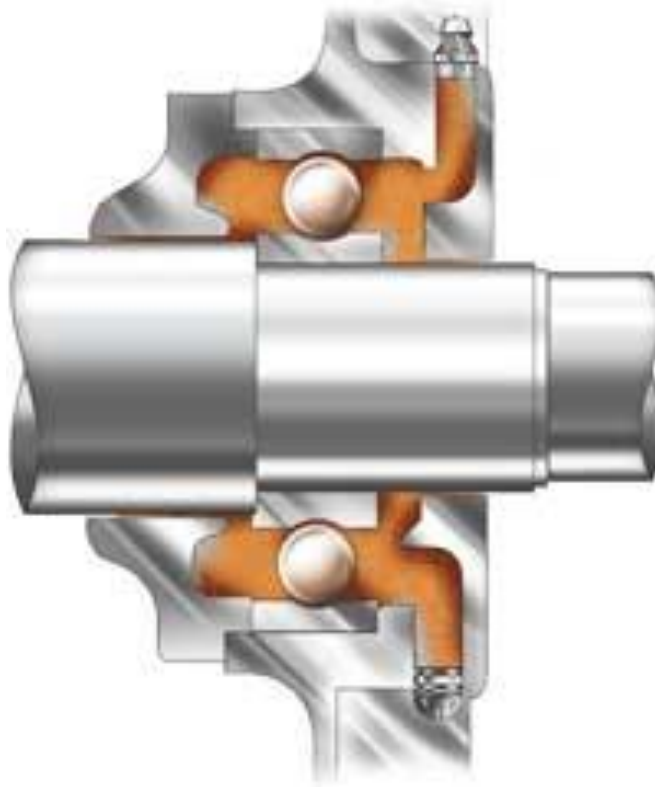


Figure 4. High-load and/or High-speed Bearings are Often Supplied without Shields

If grease inlet and outlet ports are located on the same side, this bearing is commonly referred to as “conventionally grease-lubricated.” If grease inlet and outlet ports are located at opposite sides, it is referred to as cross-flow, or cross-lubrication.

Lifetime-lubricated, Sealed Bearings

Lubed-for-life bearings incorporate close-fitting seals in place of, or in addition to shields. These bearings are customarily found on low-horsepower motors or on appliances that operate intermittently. Although it has been claimed that sealed ball bearings in electric motors will survive as long as bearing operating temperatures remained below 150°C (302°F) and speed factors DN (mm bearing bore times revolutions per minute) did not exceed 300,000. Other studies showed that close-fitting seals can cause high frictional heat and that loose-fitting seals cannot effectively exclude atmospheric air and moisture which will cause grease deterioration. These facts preclude the use of lubed-for-life bearings in installations where expected life in the typical plant environment is more than three years. Moreover, some experts believe this is the reason bearing manufacturers advise against the use of sealed bearings larger than size 306 (30 mm shaft size) at speeds exceeding 3,600 rpm.

A 1989 guideline issued by a major bearing manufacturer gives a DN value of 108,000 as the economic, although not technically required, limit for lifetime-lubrication.

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