What Lubrication Method Should I Use?

Analyzing Oil Versus Grease in Bearing Applications

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Lubricants are a critical factor in the performance and life of a rolling element bearing. Less than 10 percent of bearings reach their theoretical L10 life, and poor lubrication can be attributed to 80 percent of those that fall short. Ideally, a lubricant forms a film layer between moving components in a bearing, separating moving parts, minimizing friction and preventing wear between balls or rollers, raceways and retainers. Lubricants also protect metal surfaces from corrosion and moisture, dissipate heat and can even prevent the ingress of contaminants.

Poor lubrication is attributed to a large percentage of bearing failures in a wide range of manufacturing applications.

There are two common ways to lubricate rolling bearings. Grease is the most common method and is used in most bearing applications. Another option is oil, which is typically used in more demanding applications.

Grease is comprised of a base oil and a thickener. The ratio is approximately 85 percent oil to 15 percent thickener. The thickener acts as a sponge and contains the base oil. It can also have other additives used for anticorroision and extreme pressure agents for high loads. The oil can be a conventional mineral oil or a synthetic. It is important that the oil component has the appropriate viscosity for the application. Viscosity is the thickness of the oil. As oil heats up, it gets thinner. If it gets too thin at operating temperature, it will not provide the needed lubrication. The thickener is usually a metal soap (lithium, sodium, aluminum or calcium). The stiffness of the thickener is graded using a National Lubricating Grease Institute (NLGI) class with 0 being very soft to 6 being very thick. Rolling bearings typically use a NLGI class from 1 to 2.

Grease is commonly used for several reasons. It is easy to lubricate a bearing with grease. Grease can be easily added by manually pumping it through a zerk fitting located on the bearing housing. The grease fitting is positioned so that an appropriate amount can be pumped directly into the space between the internal rollers of the bearing. Automatic greasers may also be used to deliver a specific grease charge at specific time intervals. Where bearings are operating at low speeds, the bearing and the internal cavity of the housing can be completely filled with grease, where the grease acts a barrier to prevent the ingress of contaminants into the bearing. For higher speeds, bearing housings are typically filled to ⅓ capacity.

Grease also simplifies the housing design. Standard bearing housings bought off the shelf do not require any special modifications for grease lubrication. Grease can even be used to create a housing seal. Labyrinth seals can be designed where grease is pumped into the labyrinth passages of the seal, providing a barrier against contamination. These types of seals are made so that they fit loosely with the housing, which allows for misalignment, and they can be made where they do not wear or damage the shaft. Some manufacturers produce sealed bearing designs where the grease purges through the bearing and fills the complex labyrinth passages of the seals. Grease becomes a critical element of the seal. These factors make grease inexpensive, and convenient for customers to use.

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When the lubrication requirements exceed the capabilities of grease, oil is used. Oil lubrication provides more oil directly to the bearing than grease, which can help dissipate heat. Oils used for lubrication can be mineral or synthetic. Mineral oils are extracted from crude oil and contain natural occurring molecules. Synthetic oils are manmade, where all of the molecules are the same size and shape. This can provide better lubrication properties and more stability at higher temperatures. There are various types of oil lubrication, including oil bath, oil mist and oil circulation.

An oil bath is a system where oil is added to a bearing housing so that the oil level comes to the center of the lowest roller or ball. As the bearing rotates, the oil is picked by the rollers and distributed throughout the internal components of the bearings. In this system the volume of oil is significantly greater than when grease is used. The oil washes through the bearing and falls back into the sump. This type of system provides a significant volume of oil, reducing friction and operating temperatures.

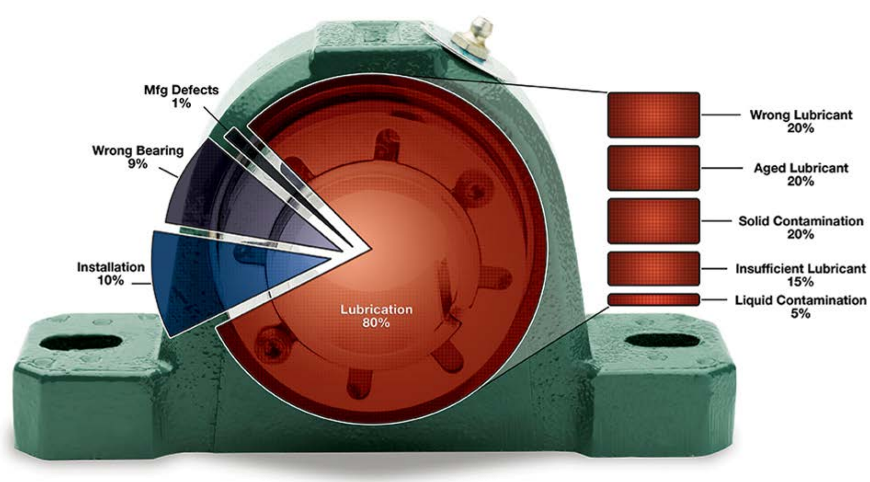
Another way to provide oil is by injecting it under pressure. This is called an oil mist system. Oil is injected directly into the center of bearing, coating the moving elements. It requires a pump, but it uses very little oil compared to static oil where the entire lower sump is filled to a prescribed level. With static oil, the oil is churned by the rotating bearing and may froth and cause heat due to fluid friction. These issues do not exist with oil misting.

For severe applications where external heat may be present, an oil circulation system may be needed. In this type of system, a stream of oil is pumped into the housing, preferably through the center of the bearing, and flows out of the bearing housing through large drains. The oil may also pass through filters and heat exchangers to cool the oil before being returned to the bearing housing.

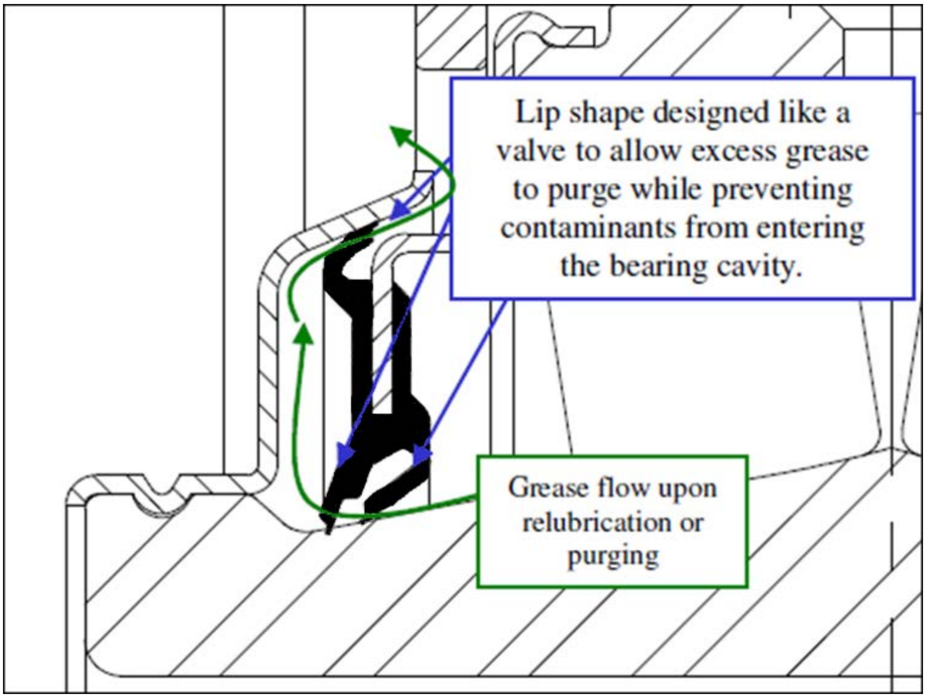
Oil is used when grease cannot handle the demands created by heat and high shaft speeds. There are, however, additional costs and challenges when using oil. To use oil, the bearing housing will have to accommodate the liquid lubricant. Seals used for grease may not be sufficient for oil lubrication. A more intricate seal will have to be used. Often contact seals are used. These type of seals are less forgiving regarding misalignment, and in time, will wear the shaft. For static oil, in addition to improved sealing, a sight gage will also be needed. Circulating systems require additional components such as pumps, heat exchangers, and filters. Housings will have to be modified for large inlets and drains, crossover holes and thermal sensor devices. Maintenance of static and oil circulating systems may require sampling and testing of the oil. Oil temperatures can be continually monitored so that equipment can be shut down in the event of an equipment failure, saving valuable machinery and repair costs.

Grease and oil can be used for different reasons. In the following paragraphs, several examples are given, detailing the lubrication system used, and the reasons why those systems were chosen.

Large hammer mills used on car shredders typically use large radial bearings turning several hundred rpm. One customer was operating successfully using grease, but later changed to a circulating oil system, which allowed the rotor bearings to operate at higher speeds, increasing output from the shredder. The circulating system not only accommodated higher speeds, but the operating temperature of the shredder was reduced.



Common modes of mounted bearing failure.



The benefits of properly designed grease paths and purgeable seals .

Large facilities such as mines or cement pants that use long stretches of conveying equipment usually choose to use grease. The bearings used for this type of equipment are operating at slow speeds and work well with grease. It is more economical to individually grease each unit than it would be to provide the necessary equipment required for oil systems where many bearings are used over a very large area.

Another application requiring oil circulation are bearings used dryer sections of a paper mill. Superheated steam at 400°F is blown through hollow shafts, creating extremely high temperatures for bearings. Circulating oil allows bearings to survive in this type of environment, by constantly removing the oil and cooling it before it is pumped back into the bearing.

Fans run at extremely high speeds. Grease is used in many of these applications, but sometimes the fans turn faster than a grease lubricated bearing can handle. On one such application, a 4$\frac{7}{16}$ spherical roller bearing on a fan was turning 2,000 rpm using grease lubrication. Bearing temperatures exceeded 200°F. The customer switched to an oil circulating system and the operating temperatures came down to 145°F.

Another scenario where a circulation system could be used is where the bearing housing is inaccessible. The housing could be buried in a machine or located on top of a high structure. Oil lines could be plumbed to the housing, and the oil system could be located externally, easily accessible by maintenance personnel.

Deciding on which lubrication method to use can be based on several factors. It can be driven by cost, ease of maintenance, improved bearing life or higher performance of equipment. When choosing a lubrication method, several factors need to be examined. Using application data such as loading and speeds, bearing manufacturers provide data for their product that enables customers to determine if grease or oil should be used. Bearing and lubrication manufacturers can also provide critical information regarding viscosity and lubrication intervals required for a specific application. Poor lubrication is attributed to a large percentage of bearing failures. Choosing an appropriate method will maximize the life of a bearing. **PTE**

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For more information
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