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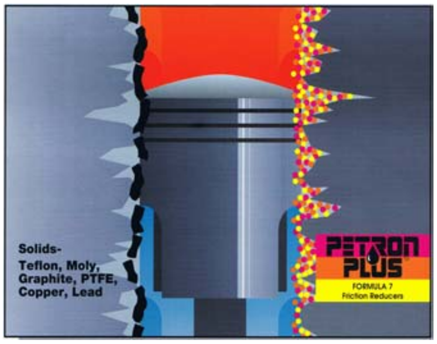

TEN (10) THREATS to BEARING RELIABILITY

► 10 THREATS TO BEARINGS

TECHNICAL SERVICE BULLETIN

When a failed bearing causes a critical piece of manufacturing equipment to go down, it is more than a nuisance. It is a loss to your company's productivity.

Although bearing performance has improved markedly over the past decade, many maintenance managers still feel they are replacing bearings too often. And they are right.

Factors that influence the operating performance of a bearing include load magnitude and load direction (radial, axial [thrust], or a combination of both); shaft speed; operating environment (temperature and contamination); lubrication (type and method); type and condition of seal; shaft alignment; mounting and dismounting technique; shaft and housing fits; running accuracy.

The same factors should be considered when troubleshooting an apparent problem. Is the equipment operating beyond its original design parameters, affecting load conditions? Is the bearing better suited to support radial load than axial load? Or is the operating environment adversely affecting bearing life? Ingress of solid contaminants dents raceways, disrupts lubricant film, and induces high stress. Extreme temperature conditions can make it virtually impossible to develop adequate lubrication.

At SKF, bearing performance data have been compiled and analyzed for more than 80 years. Guidelines have been developed on the most common causes of bearing failure. The following 10 trouble-shooting tips should be helpful in extending bearing life. Once you know the problem, it is much easier to prevent it from happening again.

1. Wrong Lubricant for Bearing

Lubrication should be one of the first points considered in troubleshooting a bearing failure. Bearings can be lubricated with an oil bath, circulating system, oil mist, or grease. Some applications, because of high speed, high temperatures or both, warrant oil lubrication systems. However, this decision may be compromised because of the cost involved. The result is often periodic bearing replacement.

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Greases are available with varying base oils, thickeners, additives, and consistencies. Because many options are available, lubricants are often misapplied.

Lubricants should separate the working surfaces, which prevents metal-to-metal contact, reduces friction, and helps prevent wear. They should protect against corrosion, exclude contaminants, and dissipate heat. The most important property of oil is viscosity, a measure of the oil's strength, or ability to develop a film that separates the working surfaces. Working surfaces in rolling bearings include the contacts between the rolling elements and the raceways, the rolling elements and guiding surfaces (cage pockets, flanges, guide rings), and cage piloting surfaces.

For proper lubrication of rolling element bearings, adequate viscosity at operating temperature is required. Examine the surface of the bearing raceway and rolling elements. Highly polished, glazed appearances or frosty, matted appearances indicate that working surfaces are and inadequate viscosity at operating temperature. Surface roughening in contact, the result of insufficient of film, which gives surface a leathery appearance or orange peel effect, is another indication of metal-to-metal contact wear conditions. To avoid such problems, use both the type and quantity of lubricant specified by the manufacturer, not only at the time of installation, but also during maintenance procedures.

2. Mixing Incompatible Lubricants

If two incompatible greases are mixed, lubrication failure is inevitable. Polyurea and lithium-based greases, for example, break down rapidly when mixed. A soupy or runny grease is an indication of the problem. A grease that is much thicker than its original consistency may indicate incompatible mixing. Grease color also should be observed. For example, if the original lubricant was green but has turned brown by the time of inspection, incompatible greases may have been mixed. Incompatible greases are a factor in many bearing failures.

3. Too Much or too Little Lubricant

A common misconception among maintenance personnel is that it is better to over-lubricate than to under lubricate bearings. Both methods are undesirable. Under-lubrication risk metal-to-metal contact, and over-lubrication (pushing excessive grease into the cavity) causes heat build-up and friction as the rolling elements continuously try to push extra grease out of the way. To assure that bearings are not over or under-lubricated, follow the manufacturer's instructions. This recommendation applies not only to grease lubrication, but also to oil bath. In addition to maintaining the correct oil levels, be certain to check for faulty bearing seals. Faulty seals often allow oil to escape, which results in premature wear and the need for frequent replacement.

4. Contaminants or Corrosives in Lubricant

Although contaminants are sometimes difficult to detect, they are a common cause of lubrication failure. Dirt, sand, and water are the most common contaminants, but acid and other corrosives also can deteriorate the bearing lubricant. They can dilute the oil film, reducing viscosity, and they can corrode the bearing surfaces, disrupting the oil film and causing erosion, creating thousands of abrasive particles.

Solid-particle contaminants introduce the most damage and are a factor from the moment they come into contact with the internal workings of a bearing. Depending on particle size, they may be seen or felt as grittiness in the lubricant. It is best to perform a lubricant sample analysis, which may be available from the lubricant supplier or an independent laboratory. The service will determine concentration levels of solid particles, identify the material, and indicate the source.

The best safeguard against contaminants is a clean, dry operating environment. If operating circumstances do not permit this environment, select bearings with seals or shields to keep contaminants out. In addition, replace worn housing seals. If humidity is a problem, consider selecting a lubricant with a good rust inhibitor. Harsh environments can sometimes be overcome by increasing the frequency of relubrication or oil changes. These procedures, however, add to the risk of over-lubrication. Proper grease levels can be maintained by opening purge plugs to allow excess grease to escape or by periodically removing the existing grease and repacking with the appropriate fresh clean grease. Oil systems lubrication provides a continuous supply of cool, clean oil that flushes away contaminants.

5. Misalignment of Components

One of the great causes of premature bearing failure is misalignment between the equipment shaft and bearing housing bore. Some, but not all, bearings can tolerate minor misalignment. Serious misalignments introduce excessive vibration and loads.

In the case of belt-driven motors or equipment, never over-tighten belts, because over-tightening introduces unnecessary loads. Use just enough tension to prevent belt slippage.

To Correct bearing alignment problems, shim the housings as necessary. Shafts should be coupled in a straight line, especially when three or more bearings operate on a shaft.

6. Distorted Housing Bore

If a housing bore is out-of-round or if it is not the right geometric shape, excessive loads and wear result. This problem arises when the housing is mounted to a pedestal that is not flat. For example, if the housing is bolted to a crowned surface, the housing will become distorted, which in turn elongated the bore. If an out-of-round housing bore is suspected, correct the mounting surface before installing a new bearing.

The same principle also applies when aligning pillow block bearings. When adjusting height, even a fraction of an inch, fully support the complete pillow block base with shims. If the center portion of the block is unsupported, the housing bore can become distorted, leading to another failure.

7. Inadequate Internal Clearance

Internally, there is a small clearance to accommodate the thermal expansion of the bearing components. With the bearing in a radial position, subjected to a load acting radically downward, the internal clearance is the total distance between the outer raceway and the topmost rolling element. Rolling bearings are manufactured to specified clearance categories and marked accordingly, for example, suffix C3. If the internal clearance is inadequate, excessive heat buildup results. Temperature affects viscosity, leading to a lubrication problem. Or worse, internal friction becomes so great that the bearing locks up. Replacement bearings must satisfy the internal clearance specification the same as the original bearing.

Shaft interference directly influences bearing internal clearance. If the bearing shaft seat is oversized, the internal clearance may be completely removed before the equipment operates.

8. Bearing Arrangement

The bearing arrangement usually consists of a two-bearing systems that provides radial support. The bearings are supported in housings, one provided with shoulders to axially locate or position the shaft assembly, and the other designed so the bearing is unrestrained, or axially free, to accommodate thermal shaft expansion.

Terms associated with the two bearings in this arrangement are held and free, fixed and floating, locating and expansion, and thrust and radial. If the arrangement does not provide for adequate shaft expansion, parasitic thrust loads and increased operating temperatures can result. The held bearing carries both radial and axial load capabilities vary among bearing types and may also be influenced by operating speed and lubrication method.

9. Distorted Seals and Shields

Integral bearing seals and shields are sometimes inadvertently pushed in and damaged as bearings are mounted. Distorted seals or shields can interfere with the functioning of the bearing cage or rolling elements and will permit contaminants to enter the bearing. To prevent seal damage, always follow the prescribed mounting techniques when installing bearings.

Sealed or shielded bearings are not intended to be modified. Normally, sealed and shielded bearings are considered sealed for life and do not require lubrication. To satisfy particular conditions, seals or shields are sometimes removed from bearings, presenting the risk of physical damage to the bearing components, especially the cage, during the removal process. If the removal is successful, the bearing should be treated as an open bearing, which requires a greater amount of grease. If grease is not added, or if an incompatible grease is added, the bearing will fail early because of lubrication failure. The best practice is to use the correct bearing, as specified.

10. Undersized Shaft Diameter

In most applications, the shaft rotates while the housing is stationary. The bearing inner ring normally has an interference fir on the shaft, and the outer ring has a loose fir in the housing.

A tight fit forms a bond between the bearing and shaft so they operate as an integral assembly. Dimensional interference develops a fit pressure, or a gripping action of the inner ring on the shaft. The holding power of the fit depends on the amount of interference, the surface area in contact, and the friction between the mating parts.

The bearing needs to be fitted to an accurately sized shaft. If the shaft is oversized, the internal clearance is reduced. If the shaft is undersized, the bearing creeps on the shaft, promoting wear of the shaft and the bearing bore. Friction and heat are then created, increasing the operating temperature and generating particle debris that acts as a contaminant. This condition can be corrected only by restoring the shaft diameter to the correct size and shape.

In the case of an adapter sleeve mounting or a tapered bore bearing on a tapered shaft, looseness might indicate that the bearing was not properly mounted. Do not arbitrarily retighten the bearing. If the shaft is worn, restore the shaft to the specified size and shape, and properly mount the replacement bearing with adequate holding power.

Other Causes of Bearing Failure

These 10 troubleshooting tips cover most failures, but there are literally hundreds of reasons bearings go bad. For example, a technician might have inadvertently installed a held bearing when a floating bearing was needed on a shaft.

Other common errors include installing bearings with inadequate load capacity, or using rigid bearings in place of-self-aligning bearings.

Although most of these problems can be spotted quickly, others are quite bewildering. For example, if a technician installs a bearing in or near a high-velocity fan, airflow over the bearing creates a pressure imbalance and may pull oil from the housing. To prevent a failure, install a baffle which will divert air away from the affected bearing.

The majority of bearing problems can be solved by focusing on the 10 trouble spots discussed here. At SKF, we recommend an ongoing multi-parameter condition monitoring program, which includes periodic measurement of temperature, machine vibration, bearing condition, and lubricant oil sample analysis. The extra effort of a monitoring program pays off dramatically in reducing equipment downtime and production losses.

The above information was supplied by the SKF USA, Inc. The SKF Bearing Maintenance Institute recommends the above bearing maintenance tips to maximize bearing performance. SKF USA, Inc. may be contacted at www.skfusa.com.