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The "infinite life" theory for rolling bearings holds that under good operating conditions and provided the fatigue load limit is not exceeded, bearing life will not be limited by fatigue and, in fact, can exceed the life of the machine. But in real-world operations, vast differences will exist in bearing life expectancy due to a variety of influences.

Handling and contamination damage can dramatically reduce bearing life by adding unaccounted-for material stresses. Bearings should be properly stored, mounted/dismounted, monitored, and inspected. The degree of cleanliness in a bearing arrangement will especially make or break service life. Optimized performance and life further will depend on whether bearings receive appropriate lubrication and adequate protection from corrosion and foreign matter.

While particular applications will present particular challenges impacting on bearing service life, users can be guided by some general rules of thumb in their quest to help prevent premature failure.

Proper storage

If originally packaged properly, rolling bearings can be stored effectively for several years in a cool, clean, low-humidity environment free of dust, shocks, and vibrations. (Storing bearings directly on the floor should be avoided. If stocks of bearings are kept, stock rotation is advised.)

Large rolling bearings should be stored lying down only and, preferably, with support for the side faces of the rings. If kept in a standing position, the weight of the rings and rolling elements may cause permanent distortions because the rings are relatively thin-walled.

The importance of cleanliness cannot be over-emphasized. All rolling bearings should be kept clean. Contamination and corrosion will tend to shorten the life of any bearing.

Users should be cautious when storing sealed or shielded types over long periods. The lubricating properties of the grease used to fill these bearings may deteriorate, resulting in associated potential problems down the road.

Handling and mounting

Because they are precision components, rolling bearings should be handled carefully and mounted with the proper equipment. They must be installed correctly to realize maximum bearing service life.

An estimated 16 percent of all premature bearing failures are caused by poor fitting, frequently using brute force, and being unaware of the availability of the correct mounting tools and methods. Individual installations may require mechanical, thermal, or hydraulic methods for correct and efficient mounting, depending on the bearing type and size. In all cases the bearing rings, cages, and rolling elements or seals should not receive direct blows and the mounting force must never be directed through the rolling elements.

Professional fitting, using specialized tools and techniques, can further help in achieving maximum machine uptime. Other suggestions when mounting a bearing to promote desired performance:

- Be sure housing and shaft in the arrangement are clean and undamaged.
- Do not remove the bearing from its wrapping until ready to mount.
- Do not wash the bearing.
- Apply mounting forces only to the bearing ring with the interference fit.
- Use minimum force with a maximum control method.

Dismounting

One reason for dismounting a bearing is to replace it with a new one. When proceeding, care must be taken not to damage the shaft in the process, which can result in compromising a machine's efficiency. Shaft condition can greatly influence the service life of the new bearing.

Another reason to dismount bearings is for maintenance or replacement of other machine components. Proper dismounting methods and tools should be enlisted because these dismounted bearings will be mounted again (unless they are damaged during dismounting). Choice of tools will depend on bearing type, size, and fit.

Lubrication

For rolling bearings to operate reliably when carrying heavy loads at high speeds they must be adequately lubricated to prevent metal-to-metal contact (and resulting friction) between the rolling elements, raceways, and cages. The lubricant also serves to inhibit wear and protect bearing surfaces against corrosion.

A wide selection of greases and oils is available for lubricating rolling bearings, and solid lubricants have been developed especially for extreme temperature conditions. The actual choice of a lubricant depends primarily on the operating conditions, such as the temperature range, speeds, and surrounding influences.

Over time, the lubricant in a bearing arrangement gradually loses its lubricating properties as a result of mechanical work, aging, and the buildup of contamination. This underscores a necessity for grease to be replenished or renewed and for oil to be filtered and changed at regular intervals to help promote maximum bearing service life.

Condition monitoring

To gain long bearing life it is imperative to monitor the condition of machinery and bearings while in operation so that problematic components can be addressed prior to failure. This approach not only reduces the possibility of catastrophic failure, but also allows plant personnel to order parts in advance, schedule manpower, and plan unrelated repairs during downtime.

The most significant machine-condition parameters to monitor include noise, temperature, speed, vibration, alignment, oil condition, and bearing condition. A variety of measuring instruments will enable users to analyze all factors.

Alignment issues

Shaft misalignment is known to be responsible for up to 50 percent of breakdowns in rotating machinery. Such breakdowns increase machine downtime, lost productivity, and associated costs. Incorrect alignment further places a greater load on machine components, increasing wear and tear and putting additional stresses on supporting bearings.

Misalignment occurs when the center lines of rotation of two machinery shafts are not in line with one another. There are two types of misalignment (parallel and angular) and, in most cases, machine misalignment is caused by a combination of both.

Shaft misalignment adversely affects bearing performance. Misaligned shafts generate a frictional moment, which creates a reaction force in the shaft bearings of the driven and drive units. (As a safeguard, users should confirm that the degree of misalignment between the shafts is within the coupling manufacturer's tolerances and the machinery manufacturer's recommendations.)

In some bearings a 20 percent increase in load caused by misalignment will reduce the calculated bearing life by almost 50 percent. Proper shaft alignment can reward users with important advantages, including longer bearing life; minimal stress on couplings, reducing the risk of overheating and breakdowns; minimal wear of seals, lowering risk of contamination and lubricant leakage; lower energy consumption; minimal vibration and noise; and increased uptime.

Inspection and cleaning

As with all other important machine components, ball and roller bearings should be cleaned and examined on a timely basis. The intervals between examinations depend entirely on the operating conditions. Where the load is heavy, frequency of inspections should be increased. When there is an effective condition monitoring program in place, visual inspection and cleaning frequency can often be lengthened.

When bearing components must be cleaned (using a suitable solvent), they should be oiled or greased immediately to prevent corrosion. This is particularly important for bearings in machines left standing for considerable periods.

Initial selection

In designing a rolling bearing arrangement for an application, users first must identify a suitable bearing type and determine suitable bearing size. Other aspects, too, must be considered. These include suitable form and design of other components of an arrangement, appropriate fit and bearing internal clearance or preload, holding devices, adequate seals, type and quantity of lubricant, and installation and removal methods.

Each decision ultimately will affect the performance, reliability, economy, and service life of a bearing arrangement. For this reason such decisions can best be made in partnership with an experienced bearing manufacturer offering practical design and engineering support. This

process also allows use of the most recent bearing technology and taps the application knowledge of the manufacturer. Users then can maximize opportunities for realizing optimized bearing service life. **MT**

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