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SMOOTH OPERATIONS

David Larson, A.W. Chesterton Co., US, outlines a simple approach to improving bearing reliability.

The coal industry is constantly striving to improve plant reliability and lower operating costs. One particularly good place to make savings is in bearing maintenance. Bearing failure can cause unplanned shutdowns, lost production and increased costs for parts and labour. Most maintenance personnel are aware of the primary reasons for shortened bearing life, but do not have the time, budget or solutions available to extend the mean time between failure (MTBF). By addressing the primary causes of premature failure, it is possible to significantly improve bearing life and reliability, while lowering operating costs.

Improving bearing reliability is a subject that is much discussed and documented. This article considers what can be done to reduce common bearing failures when the tools, time or budget for an in-depth analysis and solution implementation are limited or unavailable. This paper discusses one example, of how simple changes for the re-greasing of pillow block bearings on a coal conveyor reduced bearing failure by 90%. The specific example was improving bearing reliability of coal conveyors at a coal preparation plant; however, the approach would apply to a broad range of applications.

Some basics on bearing reliability may be helpful. A frequently asked question is: "How long should bearings last?" The simple answer is that they should last a lot longer than most do. A more specific answer is that most bearings are typically designed to last at least 50,000 operating hours, or about 6 years of continuous operation.

The bearing design, installation and operating conditions will, of course, directly impact bearing life, sometimes severely.

Most bearing manufacturers provide a list of reasons for premature bearing failure. They usually conclude that less than 10% of bearings reach their L_{10} design life.[1] In other words, more than 90% of bearings fail prematurely.

Significant improvements in bearing reliability can be achieved if the root cause(s) of bearing failure can be identified and addressed. There are many causes of early bearing failure and these are well documented. Bearing manufacturers and their troubleshooting guides can be a great tool for failure analysis. While some causes are quite difficult to identify, the primary reasons are usually basic, easy to determine and resolve.

One study by a bearing manufacturer grouped failure causes into two categories:

- Mechanical problems (20%).
- Lubricant failure or contamination (80%).

The lubricant-related causes were further expanded, providing an interesting insight and clear opportunities for improvement (Figure 1).

Aged lubricant (20%)

This is often caused by a failure to periodically re-lubricate, limited oxidative stability of the grease and/or environmental conditions. The solution is to chose a grease with suitable thermal stability and re-lubricate at correct intervals.

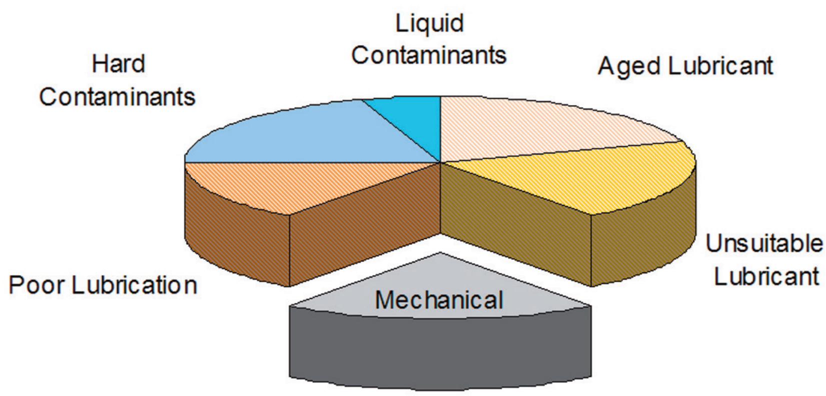

Figure 1. Lubricants cause up to 80% of bearing failures, broken down into: aged lubricant (20%); unsuitable lubricant (20%); poor lubrication (15%); hard contaminants (20%); liquid contaminants (5%).

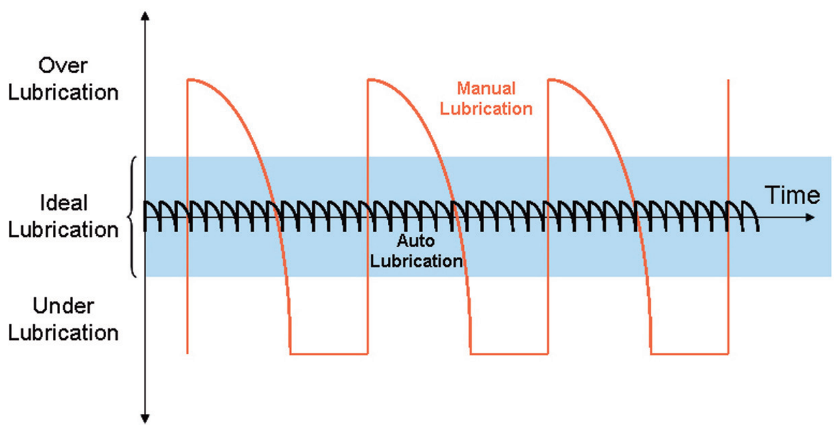

Figure 2. Comparison of manual vs automatic re-lubrication.

Unsuitable lubricant (20%)

The lubricant does not have the properties needed to maintain a lubricating film under the operating conditions of the bearing. The approach in this case is to choose a grease with performance that better matches the operating conditions and environment.

Poor lubrication (15%)

Too much or too little grease generally results in reduced bearing life. The re-lubrication time and amount needs to match the recommendations for the specific bearing.

Hard contaminants (20%)

Failure of the bearing protection to prevent ingress of dirt or dust, or failure to clean the grease nipple before manual re-greasing. In the coal handling industries, coal dust presents a continuous challenge to bearing life. Hard particles, such as coal dust, mix with the grease forming an abrasive paste. In addition, the coal often brings with it corrosive elements such as sulfur or chlorides. The most common bearing protection is a spring loaded rubber lip seal. The standard rubber lip seal has a design life of 3000 hours or less. Bearing protection can be upgraded, and/or more frequent re-lubrication can be employed to help expel contaminants.

Liquid contaminants (5%)

Water contamination from rain or moisture condensing will thin most greases. The result is a poor lubricating film causing corrosion, increased wear and potentially allowing the lubricant to flow out of the bearing. The direct solution is to improve the bearing protection, or upgrade to a grease that provides superior corrosion protection and is designed to accept water without thinning out.

Once the specific causes of reduced bearing life are identified, the most common issues are straightforward to minimise. Goals include:

- Extending bearing life.
- Increasing productivity.
- Reducing grease consumption.
- Reducing operational costs.

Bearing protection

In general, "permanent" environmental bearing protection in general is thought to be a myth. With regards to bearing protection, it is commonly believed that if no lubricant can be seen leaking out, the seal is effective. This is not true, because it does not consider the ingress of moisture, corrosive chemicals or abrasive particles.

Conventional rubber lip seals are commonly used to protect bearings from environmental contaminants. Studies indicate that a normal lip seal protects for less than 3000 hours (< 4 months), even though bearings are designed for 50,000 hours of operation. The gap is more than considerable.

There are many alternative designs for improved bearing protection. A simple replacement upgrade would be lip seal types that use newer designs and materials technologies. They have been shown to provide up to 10 times longer life. Some designs are split, allowing easy installation without disassembly.

Grease choice

Grease technology has dramatically improved since the development of basic lithium grease. The industry now has a wide spectrum of performance to address specific operating conditions. With the normal lip seal potentially providing limited life, the grease is effectively the last line of bearing protection.

With the correct base oil viscosity, and grease hardness specified, the primary properties to consider might include:

- Load bearing capability, EP.
- Anti-wear ability.
- Water washout resistance.
- Corrosion protection.
- Temperature range.
- Tolerance to contamination with water.

Figure 3. Coal conveyors.

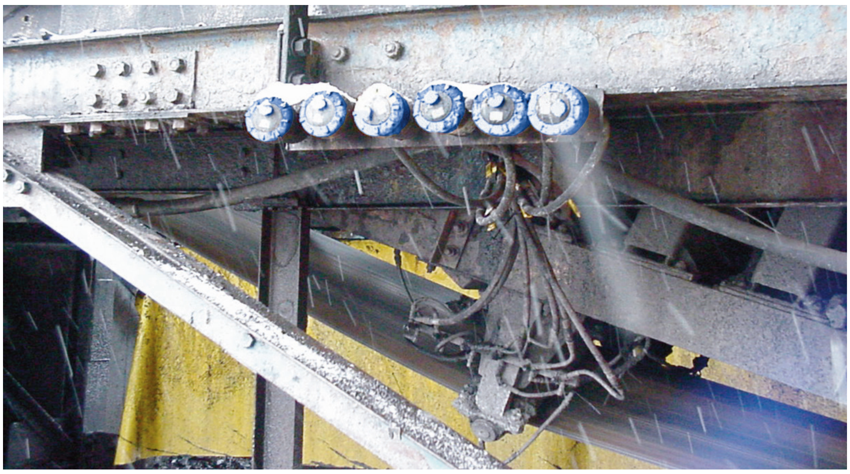

Figure 4. Single point grease lubricators feeding primary bearings.

Lubrication frequency and quantity

Ideally, the correct amount of grease should be maintained in the bearing at all times. Equipment such as ultrasonic bearing monitoring offers an excellent tool to determine when the bearing has the correct amount of grease. The most common approach is to re-lubricate the bearings at a predetermined interval. Re-lubrication can be done manually or automatically. Common net differences between these two approaches are represented in Figure 2.

The benefit of automatic re-lubrication is clear. It is designed to frequently supply a small amount of grease to maintain a consistent quantity in the bearing. A central system is ideal, but not always practical. Increasingly common are single point lubricators. The advantage is that they can be cost effectively used to upgrade from manual lubrication of bearings in remote, dangerous locations. Not only do they improve the lubrication quality, but significantly reduce the labour. In addition, they often reduce the amount of grease used by a factor of two, confirming that over-lubrication was occurring before. They can be actuated by a spring, gas pressure or electro-mechanical mechanism.

Case study

The challenge

At a coal preparation plant, frequent bearing failures on the tail roller conveyor system were due to inconsistent lubrication practices, average quality greases and poor bearing seal protection. The typical challenges were what type of grease should be used, concerns of over- or under-lubrication, the volume of grease needed, the frequency of lubrication, the dangerous location of grease points and limited manpower. All these factors contributed to inconsistent bearing lubrication, resulting in premature bearing failures and costly downtime.

The solution

A high performance calcium sulfonate grease with extremely low water washout, high EP and corrosion protection was combined with a gas-operated, single point lubricator. Standardising on one lubricant eliminated the need for multiple types of greases for different applications. The single point lubricators solved the other issues by being user friendly and simple to operate, having a variable dispensing rate, a sealed microprocessor/logic circuit for dependable operation and, most importantly, provided an affordable system approach to lubrication maintenance.

The replaceable lubricators were located between 5 – 10 ft from the bearings where they were removed from rotating parts, making it easy to inspect and maintain the units without interrupting the operation of the conveyor line. A single lubricator was used for each bearing to maximise the intervals between replacement. The unit chosen could also be turned off during extended line shutdowns.

The grease feed rate depends on the bearing diameter and revolutions per minute (RPM). The dispenser suppliers normally provide charts to determine the feed rate setting. In this case, 250 cc of grease provided lubrication for each bearing for 6 months. At this point, the units would be shut off and replaced without interrupting production.

Annual savings

Materials

- Tail drive pulley – (4), 4 $^{7}/_{16}$ in. "HD" pillow blocks bearings.
- Take-up pulley (4), 3 in. pillow blocks bearings.
- Snubber pulley (4), 3 in. pillow blocks bearings.

Labour

Three mechanics for a minimum of 6 hours each.

The results

The cost for bearing replacement on this conveyor alone was US$ 10,800/year, while the cost of lubricators with grease is US$ 2200/year. This represents annual savings of US$ 8600. This does not include eliminating the time and labour previously required to manually re-lubricate the bearings. In four years, bearing failure has been reduced 90%, with bearing life so far exceeding four years.

Bearings often fail prematurely, causing excessive replacement costs and production losses. Simple goals to improve bearing life can be summarised as:

- Keep contaminants such as dirt and water out.
- Re-lubricate with the appropriate grease.
- Re-lubricate with the correct amount and frequency.

Notes

1. L_{10}, as defined by ISO 281:2007 'Roller bearings - Dynamic load ratings and rating life', is the life expectancy of 90% of a large group of apparently identical bearings.