Roll neck bearings are subject to high loads, high temperatures, as well as water ingress and other contaminates. Due to these challenging operating conditions, standard industrial greases typically will not provide suitable performance in these applications. Special lubricant properties are required to improve bearing performance under these conditions. This paper will cover the proper selection of lubricant properties, lubrication replenishment interval, as well as application features that aid in water and contaminate exclusion, such that roll neck bearing performance can be optimized.

Discussion

Grease Selection — Grease selection is typically made based on evaluation of the lubricant data sheet, a compatibility test to evaluate mixing with existing grease used and an evaluation of cost. What is missed in this kind of a cost-for-feature analysis is the evaluation of how the grease will work in an application. Quite often, a limited trial in the mill is done to gain confidence in a new grease selection.

General selection guidelines are to use a grease with: extreme pressure (EP) additives for high load capability; good water resistance because of water and steam that enters past the chock seals; and a minimum base oil viscosity for lubricating film formation in the roller bearing. While computer modeling by bearing manufacturers can validate minimum base oil viscosity, some critical performance features of the grease are not necessarily available in data sheets and are difficult to model.

Grease evaluation prior to operation in a mill reduces the risk of premature damage to machinery. Evaluation of wear protection, water resistance, corrosion resistance and grease mobility is crucial for long service life of roller bearings and is dependent on the grease formulation. The following topics covering evaluation of grease in a laboratory environment and some straightforward guidance for roller bearing maintenance will provide improved performance of greased roll neck bearings.

Grease Evaluation — An important item to consider is the process water or rolling solution chemistry. This article is available online at AIST.org for 30 days following publication.
There are many applications in the steel industry where high-pressure water spray is adjacent to seals and water are placed in a sealed bearing and housing and may react differently with bearing grease versus standard reagents. The following tests are covered for their value in evaluating roller bearing grease performance, with a modification to the tests proposed to more accurately gauge lubricant performance.

**Corrosion Prevention Properties:** Quite often, when chocks are removed from rolls, they are staged for preventive maintenance. Often process water can be trapped inside the chock when it is staged. This standing process water often leads to etching of the bearing and causes premature bearing damage when placed back into service. To compare two different greases under this condition, corrosion testing may be completed. ASTM D1743 or ASTM D6138 are both tests that may be used to compare the corrosion prevention capability of the grease, while DIN 51819 provides insight for wear resistance.

**Static Corrosion Test:** ASTM D1743 places water on a greased bearing in a jar that is then sealed and placed in an oven for a pre-determined amount of time. After testing, the bearing is cleaned and inspected for corrosion. Any corrosion spot 1 mm or larger is considered a failure of the test. For the purposes of grease evaluation in roll necks, the water may be replaced by the process water used in a mill.

This test provides insight on grease absorption of water and how well it protects the bearing surface from corrosion.

**Dynamic Corrosion Test:** The overall goal is to evaluate the selection of grease based on the effect of water. There are many applications in the steel industry where high-pressure water spray is adjacent to seals and water ingress may result. For older mills, a consistent issue of process water ingress is something that is tolerated as normal.

ASTM D6138 is a dynamic test where grease and water are placed in a sealed bearing and housing and spun under no load, promoting mixing of the two different types of fluid. The test utilizes a run-stop cycle that repeats three times. After three cycles of running, the bearings are removed and immediately cleaned and the outer ring inspected for corrosion. The result of this test is ranked on a scale provided in the test standard.

The challenge with this test is that it is run under no load, so the impact of entrainment of water into the bearing roller-race contact is not captured. The performance of grease under this test may be indicative of how well the grease will perform when a chock is removed from the mill and staged for teardown with a mixture of grease and process water inside. To enhance the value of this test, replacing the reagent with mill process water can provide a more reasonable comparison.

**Dynamic Wear Test:** DIN 51819 or FE-8 test examines the interaction of the lubricant at the roller bearing roller-race contact region or the bearing tribological system. The test is versatile in that it may be conducted under a variety of operating and ambient conditions and allows for lubricant to be tested under a specific operating condition. The basic test setup uses a test pair of bearings pre-loaded by Belleville or spring washers and run at a set speed and temperature with a test lubricant condition (such as contaminated with process water) to allow for a more representative test of the mill environment. Multiple rolling element bearing types may be used in the test, so grease usage throughout the mill may be reviewed.

The test provides the wear behavior of the lubricant based on wear results, or difference in the pre- and post-test bearing weight. Working with a bearing supplier to ensure that the ratio of lubricant film thickness to bearing surface finish, or lambda ratio, is comparable to what is occurring in the subject application, providing for a controlled real-world test.

**Grease Replenishment —** The regreasing cycle for a mill is dependent on the load-to-capacity relationship, amount of water ingress being dealt with and operating temperature. There are many publicly available calculation tools for determining grease replenishment cycle from lubricant and bearing manufacturers. The purpose of these calculation tools is to provide a guideline for where to start when developing a maintenance plan that includes adding grease between chock inspection cycles.

There is a best practice for the quantity of grease to add for regreasing. However, the maintenance technician will often add grease until it purges out past the seals. The addition of grease until it purges leads to increased bearing operating temperatures due to lubricant churning, bursting of seals and contamination of the product being processed.

The suggested amount of grease to add at replenishment is one-third of the initial fill. The goal of replenishment is to introduce fresh oil and thickener to combat the continuous oxidation and shearing of the lubricant. Maintenance practices that require additional grease to purge contamination and process water should be adjusted after reviewing the seal condition, which includes inspection, replacement, lubrication and care of the seal lead, chamfer and riding surface.
Sealing Enhancements — The typical sealing arrangement for chock seals for grease application is to have the chock seals facing out, as shown in Fig. 1. This allows the seals to exclude water from the bearing cavity while allowing for lubrication of the sealing surfaces by grease that purges from the bearing cavity. Water ingress into the bearing chock may be due to many factors related to seal application, and should be addressed one by one to optimize process water exclusion from the bearing cavity.

Seal Maintenance: The primary issue with roll neck bearing lubrication is with process water ingress into the chock, and the common corrective action is to overcompensate the issue with higher grease usage to purge the water. Improvements to seal maintenance, from more frequent replacement, inspection of seal lands, to adding shields to deflect high-pressure water spray, will improve roll neck bearing lubrication and service life.

Reuse of chock seals saves the cost of a replacement; however, this may be at the detriment of grease consumption. When combating water ingress, inspection of seals for damage and wear of the seal lip is critical to performance. Working with a seal supplier is suggested to determine inspection criteria and wear limits for replacement.

Seal Lubrication: Lubrication of seals during start-up is critical for their break-in with the seal land. The cavity between the two chock seals as well as the seal lips should be greased prior to putting the chock into service. The addition of a grease fill between the chock seals fulfills two purposes: it provides an additional fluid barrier to process water, and the grease will purge out of the chock seals as they are installed onto the roll, ensuring lubricant availability to the seal lip during start-up.

Seal Land/Riding Surface: There are published guidelines for seal-riding surfaces for both surface finish and texture. As rolls age and are reground, often the seal-riding surface is not part of the maintenance of the roll. Corrosion may form on the seal land, directly outside of where the seal is riding on a roll during a campaign. As chocks move from roll to roll during rotation, the axial position of the chock seals will vary when referenced from the roll body depending on fillet ring length, bearing width tolerance and axial clearance of the thrust bearing in the chock. This axial position difference from roll to roll may lead to the seal riding on a corroded surface, accelerating seal wear and encouraging process water contamination.

Adding routine inspection to seal lands on rolls during roll changes and addressing corrosion and grooving of the seal-riding surface on rolls will lead to improve seal performance, and longer bearing service. The improved exclusion of water will lead to longer grease service life and improved maintenance, as regreasing cycles may be completed without the need to flush water contamination from the chock.

Additional Seals: To address seal maintenance issues, a common step is to use a sealed roll neck bearing in place of an open-bearing design. The extra seal barrier internal to the roll neck bearing provides for improved contaminant exclusion. However, to improve the performance of the sealed design, regardless of bearing supplier, chock modification to add drain slots is suggested.
In general, sealed roll neck bearings are sized to be interchangeable with open roll neck bearing designs (TQO), and do not require roll or chock modification. However, one change to the chock is strongly recommended.

The change to the chock is straightforward: adding drain slots allows process water that passes through the chock seals to drain out of the bearing cavity and not pool next to the bearing seal. The suggested chock arrangement for adopting a sealed bearing design may be seen in Fig. 2. The suggested size of the slots is 25 x 40 mm, with a goal of making the slots large enough that they will not become clogged with purged grease.

The benefit of the configuration shown in Fig. 2 is that any contamination past the chock seals from poor seal condition can continuously drain. This design configuration increases the likelihood of keeping roll neck bearings and their grease free from process water contamination. The use of a sealed roll neck bearing effectively treats the chock seals as a splash guard to prevent water from running against the bearing seals, and when combined with drain slots will greatly improve bearing grease contamination issues.

Conclusions

There are multiple paths to improve roll neck bearing lubrication, from contaminant exclusion to improved grease selection. Specific grease tests are proposed as they simulate a contaminated roll neck bearing environment by evaluating grease contamination, with a modification to utilize a mill’s rolling fluid solution as the additives will react with the grease used to provide an understanding of the influence on grease and bearing performance. To reduce contamination, evaluating maintenance practices such as increased seal inspection and replacement, inspection of the seal riding surface, and controlling axial movement of the seal from stack-up of bearing tolerances are discussed.

Discussion with lubricant and bearing suppliers for review and feedback of current practices will provide specific feedback to identify cost-effective strategies to improve bearing lubrication.

References


Did You Know?

Report: Climate Change Could Strand New BF Investments

The global steel industry is at risk of having to write off US$47 billion to US$70 billion in new steelmaking assets as the world moves to a carbon-neutral future, according to a new report.

According to California-based NGO Global Energy Monitor, the estimated risk comes as the industry plans new integrated steel plants in countries pledging to reduce carbon emissions. “Several countries and regions with major steel industries have pledged to reach carbon neutrality or achieve partial carbon reductions, but at the same time plan to build numerous large BF-BOF steel plants. Unless BF-BOF retrofits for low-carbon steel-making are developed and brought to market in a fraction of the time predicted in various steel decarbonization road maps, these commitments are at odds with each other since BF-BOF steel plants offer limited options for decarbonization,” the group wrote in the report.

Most of that risk is in India and China, which, by the organization’s count, together have proposed or are building more than 46 million tons of capacity.