Bearing failure modes pdf

Rolling element bearings are some of the most commonly used mechanical components that require a lubricant. Their application is very wide, ranging from small, non-critical button-control bearings to large, critical wind turbine main bearings. In general, bearings tend to fail well ahead of their design lives. This is often because the environmental and business factors are not checked or taken into account when the lubricant is selected. In this article I will refer to rolling-element bearings simply as bearings. However, this does not necessarily cover the subject when it comes to magazine lagers. Regardless of whether a bearing achieves its design life, the life you need to achieve from your bearings must be based on the optimal reference state (ORS). When considering the application of a bearing and the associated reliability objectives, a particular maintenance strategy should be used to achieve an optimised return on investment. For example, if the result of a bearing failure does not result in immediate downtime and the corrective action costs are insignificant compared to the use of regular proactive and predictive maintenance over the life of the bearing, then a run-to-failure strategy may be the ORS. 42% of lubrication professionals say contamination is the most common cause of carrying failures at their plant, according to a recent poll on MachineryLubrication.com It is not uncommon for small bearings (with low speed factors) to be kept sealed without any relubrication and very little maintenance required. However, in most cases, a carefully selected relubrication schedule and maintenance strategy are recommended that are more comprehensive than just reactive maintenance, depending on the optimal reference status. When performing an error modes and effects analysis (FMEA) on a bearing, a series of questions should be asked. These would include the following: On what kind of application is it lower subject? What function does the application perform for the organisational goals? (How important is the device that contains the bearing?) What are the possible failure modes? (In what ways can the machine fail?) What are the consequences of the error modes? (What is the consequence of failure on operations?) What is the severity of each of these effects? (What is the relative impact of these error modes on operations?) What are the failure mechanisms for each error mode? (What is the underlying cause?) How likely is it that the failure mechanism exists? (What is the probability of the fault mechanism?) What failure detection mechanisms are implemented? (What methods are there to predict the error?) How effective is the detection mechanism? (What is the chance to detect the malfunction early?) The answers to these questions can be used to calculate a risk/priority number and determine the best maintenance strategy. This article describes the most common error lower due to lubrication (or lack thereof). When analyzing these failure mechanisms, one can perform a lubricant FMEA. This approach asks questions similar to those in the machine that FMEA previously discussed, but in this case the cause of the lubricant is identified and how they can result in a malfunction in lubrication of the machine. In his book, Machinery Failure Analysis and Troubleshooting Vol. 2, Heinz Bloch states, Lubrication-related problems, according to our experience, are most often caused by lack of lubrication or lubricant contamination. This information is not new and has been repeated by contributing manufacturers and end users through numerous root root cause analyses (FRCA). But why? Remember that rolling elements in bearings ride on a thin film of lubricant (often less than 1 micron) on the mating surface of the bearing race. In small contact areas, the pressure on the surfaces can exceed 500,000 pounds per square inch (psi). If a lubricant is moved by a foreign contaminant, such as dirt or water, in these critical load zones, the bearing will eventually experience more wear and tear. If the wear is exaggerated, the life of the bearing will be significantly reduced. The result is a pollution-induced bearing failure. However, even if pollution is kept to a minimum, if the lubricant selected for use does not meet the operating and environmental requirements, there will be a lubricant-induced bearing failure. Therefore, whether it is excessive contamination or misapplied lubricant, it is important to understand the underlying causes that can contribute to lubrication mechanisms, along with the most common reasons why bearings reach the end of life prematurely. Below are the top eight lubrication mechanisms for rolling element bearings: 1. Unsuitable lubricant First you must choose the right lubricant for the application. Basic properties, such as viscosity, additive package and consistency (for fat), should be carefully selected based on the bearing type, speed factor and operating conditions. If these factors are not thoroughly considered and an unsuitable lubricant is applied, the lubricant may become too stressed or insufficient for the lubrication needs of the machine. In both situations, the bearing is likely to experience premature wear and tear and defect. Read Select the right lubricant for bearing applications for more details. 2. Lack of lubricant For greased bearing applications, the correct regreasing volume and frequency should be determined to ensure that the bearing load zones are properly lubricated. Too much time between re-shaming intervals or applying too little fat will lead to excessive preconditions wear. Take a look at The Hidden Dangers of Lubricant Starvation. This type of failure mechanism also tends to be a chain reaction of other failure mechanisms, such as conditions, and generate wear particles, further perpetuate the malfunction mode. Even in oil applications, routine oil level monitoring can mean the difference between optimal lubrication and no lubrication. 3. Excess lubricant More fat is not always better. When too much fat is added to a lower in medium to high speed applications, the temperature will rise from churning, and the machine will have to work harder to overcome the fluid friction. If the temperature rises for the excessive fat load, the viscosity will decrease and other adverse effects will result. 4. Hot Running Conditions A lower temperature that runs at a higher than expected temperature may be a cause or symptom. If the bearing is exposed to an external environment that is exceptionally hot, this would indicate a cause. If the temperature increase comes from an internal condition, then this would be a symptom with possible causes such as excessive lubricant, lack of lubricant or misalignment. Regardless of the source of the hot operating conditions, the heat will lead to increased lubricant oxidation oxidation, thermal degradation, additive depletion, viscosity changes and other interference modes. If the source of the higher temperatures is mechanical, this can be identified as part of the FMEA process. 5. Fixed pollution Solid contaminants can enter a system in a number of ways, including via a new lubricant, ingested from a headspace port or hatch, through faulty seals, etc. The type of solid contaminants may vary depending on the source, but typical air dust/dirt will consist mainly of silica and alumina. Excessive contamination will lead to lubrication failure, as the lubricant will probably not be able to overcome the various wear modes, such as three-body wear. In addition, if the contaminants are metal catalysts, they can contribute to lubricant degradation in the form of oxidation, especially in combination with water, higher temperatures and air. 6. Moisture contamination Like solid contaminants, moisture can enter a system in many different ways, including through the entrance point of the main room, seals or new oil. When the headroom is humid, thermal cycles can cause moisture to escape the air, sweat on surfaces and find its way into the oil through gravity. Moisture can be present in a lubricant if dissolved, emulsified or free water. Emulsified water has the most destructive potential in oil. Water is not a good lubricant, so if it moves oil into the load zones of a bearing, the water collapses, causing a lubrication failure and mechanical wear. Water also contributes to oxidation and hydrolysis, where the lubricant permanent chemical degradation and additive depletion These can lead to a lubrication failure by changing the viscosity of the lubricant, removing additive functionality, and forming other contaminants, insoluble and acids. Of course, when considering the machine, water is the main cause of rust. 7. Mixed lubricant lubricant up (as oil) or regreasing (if fat) a bearing with the wrong lubricant can drastically change the physical and chemical properties of the resulting lubricant mixture. Not only can factors such as the wrong viscosity affect, but additives can also react negatively with each other, hindering their functionality. Read the risks of fat mixing for more information on this. 8. Other contaminants Depending on the type of machine, bearings may be applied to other process chemicals, impact contaminants, glycol, etc. Based on the type of contamination, the lubricant can change chemically or physically, resulting in a lubrication error. In short, regardless of whether you have a lubricant or pollution-induced fault mechanism, the result will either lead to lubrication error modes or directly contribute to mechanical failure modes of the bearing. When multiple failure mechanisms are combined, there is a greater potential for a lubricant failure. An FMEA machine performed on a failed bearing can often reveal mechanical wear signatures that indicate whether the failure was lubricant-related, although often the damage during the final stages of a catastrophic failure will destroy or overshadow the evidence of the true cause of the malfunction. In these cases, it is usually best to perform lubricant analysis (fat or oil) to detect indications of the cause, such as a thermally degraded lubricant, abnormal levels of contaminants, changes in viscosity, etc. When developing a conclusion, it also helps to include available maintenance data or condition monitoring data, such as vibration analysis, thermography or maintenance logs in relubrication and inspections. Again, just because a lubrication failure occurred does not necessarily mean that the lubricant was insufficient in volume. Many failures are associated with too much of something, such as the viscosity of the lubricant or the quantity. In addition, if a contamination takes the place of the lubricant or interferes with the function of the lubricant, the contamination will be the ultimate cause of the lubrication failure. Read more about bearing lubrication: How to Protect Bearings from the Elements Why You Should Inspect Bearing Grease Discharge References Troyer, D. (2000, May). FMEA process for lubrication errors. Practicing oil analysis. Bloch, H.P. (1999). Analysis of machine errors and troubleshooting. Vol. 2. p. 1. About the author's author