Debris demands your attention. . . at all times.

A failed component is not just expensive from the standpoint of repair costs, downtime and lost productivity, it also is an inconvenience. Too often, repairs simply consist of replacing the component without further investigation into what may be the root of the problem. Debris particle contamination in lubricants has been identified as a major cause of premature bearing and gear failure.Not only can contamination in a lube system cause failure, neglecting to run proper checks of the system can mean the problem goes uncorrected, leading to continued damage, more premature failures and diminished equipment performance.

The big picture

Controlling and preventing solid debris contamination in a system is not an easy task; that's why it is so important to stay mindful of this situation at all times. Contamination is defined as any solid, foreign materials that are suspended in the lubrication. Don't be misled by what you can't see; debris can be so small that it can only be measured in microns. It can enter the system at any time, including during assembly, rebuilding or repairs. Debris contamination also could be a byproduct of the environment, meaning that it can enter the system anywhere the lubricant is exposed to surfaces that rub or rotate together—*conditions that can create wear particles*. Contamination in any lubrication system can lead to failure, but in the process, it can continue to cause damage throughout a variety of areas in the lubrication cycle. By reducing the surface durability and resistance to fatigue, solid contaminants make themselves known through abrasive wear, denting/bruising, grooving and fatigue spalling on bearings or gears. A symptom of contamination also may reduce the function of the machinery. Once that happens, one can begin to predict the potential cost of losing the equipment at a critical time. Depending on an individual's role in the industrial arena— as an end user, OEM or manufacturer—fully understanding the potential cost of losing equipment availability at a critical time may include weighting the effects on production, warranty claims or sales.

Types of analysis tools

Various experimental and predictive methods have been developed to assist the design engineer in analysis and development of equipment that is less sensitive to contamination than in the past. But first, in order to determine the potential risk to an operation, ask yourself, "Is anyone doing analysis daily, weekly or monthly in an effort to define debris levels by sampling?" In regard to contamination characterization, today's equipment design engineers have a broad selection of contaminated lubricant analysis tools to help them assess the detrimental effects of debris particles on machinery wear and performance. Some of these existing analysis tools include wear particle and contamination analysis methods such as Ferrographic, Gravimetric Filtration, Atomic Absorption Spectroscopy, and SEM (EDAX) Spectroscopy–all of which are aimed at understanding the material make-up and characteristics of the contamination. In addition, particle size distributions and concentration levels are sought by particle sizing and counting techniques. Such techniques employ both manual microscopic methods and automatic direct counting through equipment using light scattering methods. Another option is a contaminated lubrication analysis. Comprehensive lubrication analysis programs monitor the physical properties of the lubrication, contamination levels and wear debris over time. If samples of oil, or in some cases grease, are taken on a regular basis, physical and chemical testing will help gauge how well the system is running. Properly implemented, such a program can provide early warning of problems before they become too serious. Most of these analysis tools are used in monitoring and understanding the evolution of equipment failure, as well as the level of lubricant contamination for predictive and preventive maintenance. While these techniques and methods are useful in understanding wear mechanisms and wear rates, they do little in helping to evaluate the impact debris damage has on finished gear and bearing surfaces as it relates to the fatigue life of their materials. With an increasing focus on reliability and uptime, equipment designers need to understand how to design equipment with debris resistant components and be able to account for its potential detrimental effects on fatigue life at the design stage.

A direct method, using surface damage characterization, has been developed for quantifying the effect of debris-contaminated lubrication environments on predicted life. Appropriately labeled as Debris Signature Analysis, this approach establishes a life prediction model based on understanding the relationship between particle material, size, shape, hardness or fracture toughness, and damage on the contacting surface. Performed during routine maintenance tear downs, Debris Signature Analysis provides a direct and practical approach to determine the severity through characterization of damaged surface topography. The contamination factor is then calculated and used in decreasing the predicted life under contaminated conditions. The key to this design understanding is being able to characterize damage on the components' surfaces and link it directly to performance.

Prevention and improving life

Although analysis tools can provide a clearer understanding of system contamination and damage, it is difficult to eliminate debris from these systems completely. Thus, efforts should be focused on minimizing and combating contamination. Two areas that provide alternative solutions for debris are nonbearing solutions and debris resistant products. First and foremost, when it comes to nonbearing solutions, is careful attention to the care of components in order to reduce contamination. Proper storage, cleaning and inspection of products and equipment are simple ways maintenance managers and operators can improve the health of their equipment. Efforts to minimize contamination include:

• Rebuilding in a clean environment

• Cleaning the lubrication system
• Applying a filtration system
• Enhancing sealing systems
• Removing debris caused by previous component failures when rebuilding equipment
• Inspecting any reused components for debris damage and discarding or repairing them if damage is found Each step taken to prevent and combat debris highlights an improved understanding of the contamination and its effects on the reliability of equipment. Because it is so detrimental to productivity and the bottom line, debris demands the attention of all maintenance and reliability professionals. **MT**

Reference

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Advancing the TechnologyManufacturers like The Timken Company have made significant advancements in metallurgical design and processes to improve bearing mechanical properties of strength, ductility and toughness. The result has been the development of debris-resistant bearings that are better equipped to handle contaminated environments.

Timken® debris-resistant bearings are created using proprietary alloy and heat-treatment modifications and hard-film coating technology to optimize their mechanical properties. This debris technology can interrupt adhesive wear and can self-repair microcracking, providing customers with reliable, extended life performance. According to the manufacturer, these products are available in a variety of sizes and bearing types to fit into existing application envelopes and offer increased bearing life and productivity without a system redesign.

For more information on Timken’s products and services, including the Debris Signature AnalysisSM tool and debris-resistant bearings referenced in this article, visit www.timken.com