Recent Advances on Tribology Testing for Lubricants and Greases

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Introduction

Tribology, the science of interacting surfaces in relative motion, is focused on the design and effective lubrication of machine components for industrial applications. Traditionally, tribological research is geared towards the pursuit of reliability, but focus has shifted towards minimizing energy consumption and maximizing efficiency, which has resulted in the formulation of more complex lubricants. These complex lubricants can promote increased efficiency and performance, while reducing operational and maintenance costs. With further advancements made in the field of tribology, the importance of designing and applying the proper lubricant or grease has permeated throughout a wide range of industries. There are five identifying parameters that need to be identified to select and produce the proper lubricant and/or grease for use, which include load, speed, temperature, and operating environment.

Load

The weight if the load is very important in selecting the right lubricant to use. If a light load is used, then a lubricant that is designed to minimize fluid friction. On the other hand, if there was a load, then a lubricant designed to protect against extreme wear needs to be selected for use. If the wrong lubricant or grease is used then extreme friction occurs which causes wear such as two-body abrasion, three body abrasive wear as well as surface fatigue. Not only does wear occur but it can also cause heat generation and if excessive heat happens it can cause loss of viscosity, an increase of oil oxidation as well as an increase in varnish potential which is potentially harmful.

Speed

Speed is broken down into three sections: fast, moderate, and slow. To determine the ranges for speed categories, it is a must to understand the Stribeck curve. The Stribeck curve is a graph that displays how friction in a fluid-lubricated contact is a nonlinear function of lubricant viscosity. By knowing the speed of contact the right lubricant is selected and produced to reduce friction

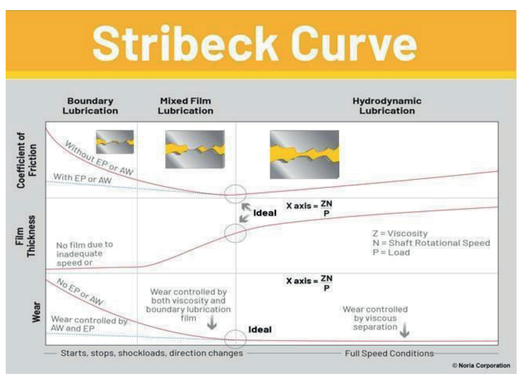

Figure 1. The Stribeck curve is named after Richard Stribeck, a German engineer, who founded this concept in 1902. This graph shows how the generation of lubricant films are are crucial in the reduction of friction and wear of parts in a machine

Temperature

Temperature is vital for lubricants and greases due to the specific temperature ranges that allow for optimal performance and effectiveness. Depending on its chemistry some operate within a large range while others perform at lower temperatures. By identifying a system's temperature, a tribology engineer can select the lubricant that enables the machine to achieve its best operating life and performance.

Type of Motion

Motions can range from sliding to rolling both of which require a different lubrication theory to be analyzed with. Sliding requires the hydrodynamic lubrication (HL) theory. The HL theory is determined to reduce friction/wear of rubbing of solids, which creates a thin liquid film. Rolling requires the electrohydrodynamic lubrication (EHL) theory. EHL is in fact a type of HL where a significant elastic deformation occurs, altering the shape and thickness of the separation lubricant film.

Operating Environment

If the system is operating in certain environments, different lubricants must be used for optimal performance. A few common factors that must be taken in accountability are any contaminants, moisture, as well as any environmental liabilities. For example, if the system is in an environment that is subject to moisture/water then the required lubricant must be water resistant. Other factors include vacuums, if a vacuum is in play the applications atmospheric pressure must be within the operational limits of the lubricant.

Importance of Lubricants and Greases

The control of friction and wear with introduction of friction reducing film placed in between surfaces that are moving constantly while in contact with each other. There are multiple functions of lubricants and greases, including but not limited to controlling wear, friction, corrosion, temperature, contaminants, and the transmission of power. They also act as an adhesive to prevent an ingress of water as well as incompressible materials. In most cases the water or a specific material when enters the lubrication oil can cause severe damage to your machinery and negatively affect the productivity of the oil. When the right lubrication or grease is used all damages can be prevented.

References

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2) "Products." *Koehler Instrument Company Inc*, https://koehlerinstrument.com/products/benchtop-four-ball-wear-and-ep-tester/?search=four+ball+wear&description=true&sub_category=true

Koehler Benchtop Four Ball Wear and EP Tester

The Four Ball Wear and EP Tester is designed to conduct tests that determine the coefficient of friction of lubricants and extreme pressure (EP) property of lubricating oils under a variety of test conditions.

Figure 2. The Benchtop Four Ball Wear and EP Tester designed as per American Society for Testing and Materials (ASTM) standards to conduct tests to determine multiple variables

K93170-PN Four Ball Wear and EP Tester

This instrument can also be used to determine load carrying properties by the load wear index and the weld point method. The test load is directly controlled by a software-based drive enabling precise control over the load application. There are several load sequences which include a constant load, progressive loading and more. This dynamic load control system can be used for understanding the Stribeck curve.

Test Methods

A ball of a specified diameter rotates at a set velocity and contacts three similar steel balls that have been immersed in the lubricant. The frictional force between the rotating balls and the three stationary balls are measured through a digital load cell mounted in a specific location which h allows for the constant or progressive load to be used. All process variables such as temperature, loss friction force and coefficient of friction, are measured a downloaded through a software through an integrated PC

This device allows for the acquisition of the parameters to ensure that the tested lubricant, which was applied to the stationary balls, can withstand the temperature and pressure that is set with the four-ball wear and EP tester.

Conclusion

Lubricants and greases play a big role in changing and improving the energy efficiency in the transportation and the machinery industries. It has been proven that they increase productivity time after time, yet lubricants and greases are not widely used in industries. This is mainly due to the negative stigma around lubricants and greases due to pricing, but with the new advances in tribology we can create new complex greases as well as lubricants. These complex fluids have been proven to be cheaper, and last longer than any other temporary fix.