Development of Application-Oriented Friction and Wear Tests For Industrial Greases

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Overview

Established test methods and standards for lubricants can serve as the basis for screening greases based on their chemical properties, but has limited carry over to determining the behavior of greases in real-life operating conditions. The Translatory Oscillation Tribometer (SRV®) is a newly developed instrument that can conduct tests according to established test methods and standards, as well as application-oriented testing procedures, which can be used for evaluating friction, wear, and extreme pressure properties of lubricating greases. This poster will highlight application-oriented friction and wear tests through test scenarios involving the effect of wear particles on the lubricity of a lubricating grease, high temperature fretting behavior of industrial greases, and the simplified examination of rolling/sliding friction of high-performance greases that can be used as a FE8/FE9 rolling bearing pre-screening test

Experimental Setup

The SRV oscillation system can determine the coefficient of friction of a material pairing, with or without lubricant. The test system uses parameters of frequency, stroke, test load, test temperature, and test duration, all of which can be modified before the test. During the test, the upper specimen is pressed onto the lower specimen with a set normal force. Additionally, the upper specimen oscillates on the surface of the lower specimen, with a sinusoidal motion. The SRV system monitors the coefficient of friction results from the movement of the upper specimen on the lower specimen by measuring the lateral friction force. The total wear is measured and recorded, both during and after the test. In addition to these variables, modern tribometers such as the SRV system can measure more parameters, which allow a more in-depth interpretation of the tribological process during the tests. These parameters include temperature, frequency, stroke zero position, sliding speed, electrical contact resistance, and acoustic emissions at the lower specimen.

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Effect of Wear Particles on Lubricity

It is important for lubricating greases to maintain a constant coefficient of friction throughout its service life. As an example, considering greases used in steering systems, a change in the coefficient of friction can disrupt the sensitive measurement and control equipment in a modern steering system, which can affect the performance of the system. Therefore, it may be useful to see how the frictional behavior of a grease changes. The coefficient of friction of a newly applied grease was compared to the same grease after a certain service life, as shown in Figure 1. To simulate realistic operating conditions, the test parameters were modified.

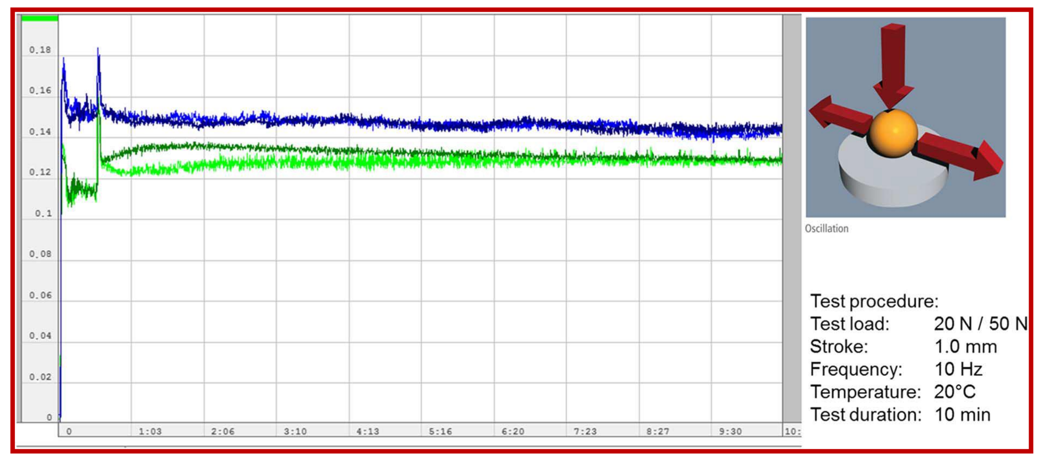


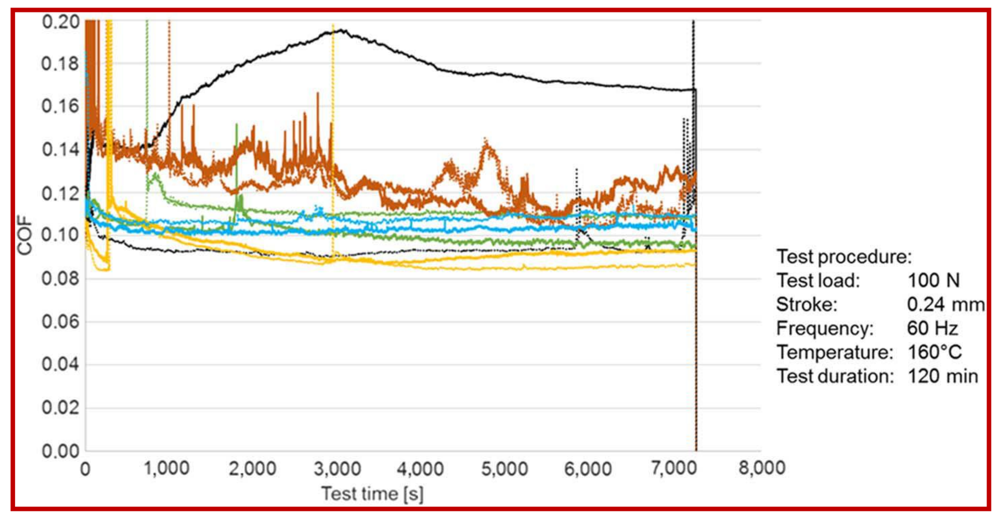
Figure 1. Coefficient of friction for new and used greases

The bottom two green lines represent the coefficient of friction of the new grease throughout the test, and the top two blue lines represent the same grease after use with wear particle contaminants. The introduction of wear particle contaminants increases the coefficient of friction by about 110%, resulting in more significant frictional losses.

High Temperature Fretting Behavior

Some industrial environments may be interested in analyzing the high-temperature fretting wear behavior of specialty greases. In these special cases, the real operating parameters like the swivel angle and frequency of a reference operating point can be isolated and transferred into load parameters in the SRV model test environment. By testing a variety of these competing special greases for the same application, they can be examined to see their behavior in these test load environments, as seen in Figure 2.

Figure 2. Coefficient of friction for different high temperature greases



In Figure 2, there are some greases that show a stable and repeatable coefficient of friction development, while others are more unpredictable. This shows that greases competing in the same market can react significantly differently under similar tribological conditions.

Figure 3. Electrical resistance for the high temperature greases.

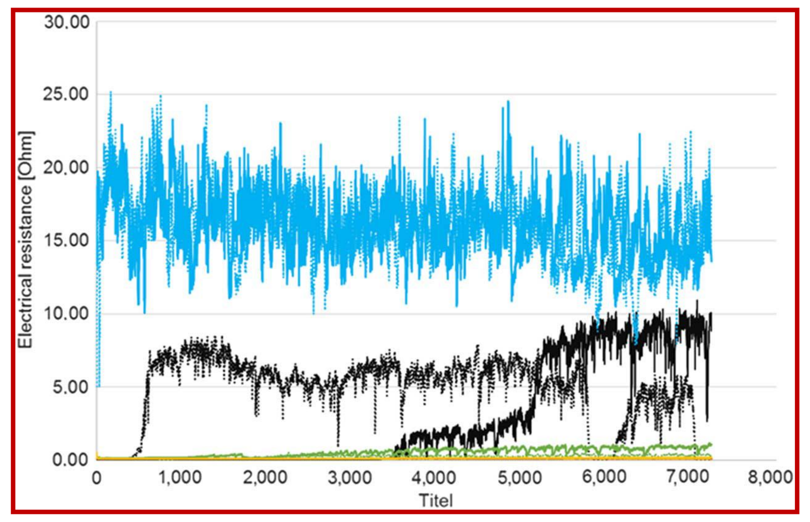


Figure 3 shows the electrical resistance of the same greases. The variance in the electrical resistance between the greases indicates different grease chemistries. Analysis of the electrical resistance indicates that greases with similar frictional performance can be chemically different.

FE8/FE9 Rolling Bearing Pre-Screening Test

Some variants of greases do not produce useful results under these oscillating sliding stress tests, typically greases with thick consistency of poor flow behavior. For these greases, a slip-rolling motion allows a quick screening test, with improved results. In this setup, the translatory movement of the SRV system is converted into a rolling motion of two cylinders. The cylinders roll over the surface of a test disk, which is confined by a grease filled cage. Throughout the test, the rolling friction and wear scares are monitored. A schematic of the test is shown in Figure 4.

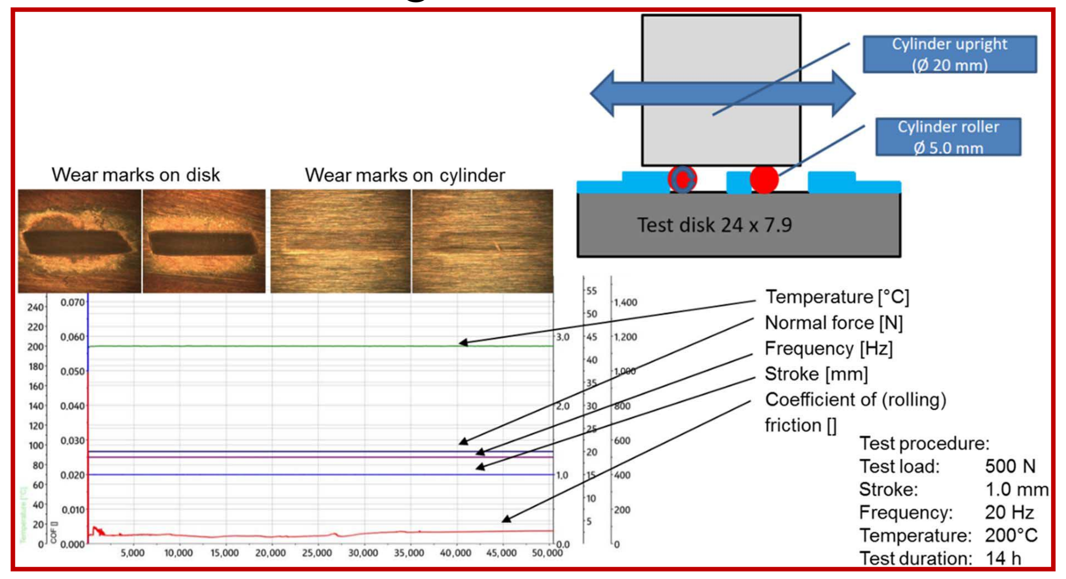


Figure 4. Diagram of the rolling friction setup (top right), wear scars (top left), and measurement curve (bottom)

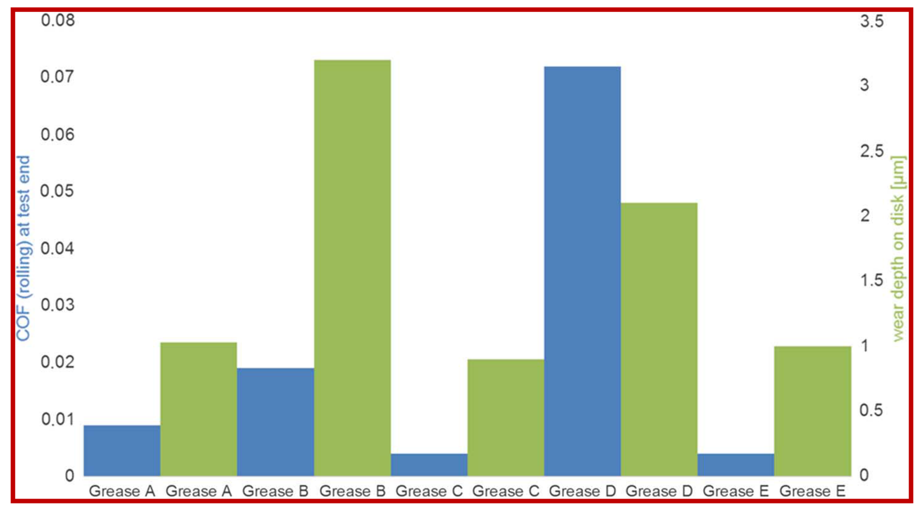


Figure 5. Friction and wear for 5 greases.

Five different greases were testing with the rolling friction setup, and the results are shown in Figure 5. Grease C and Grease E show promising behavior here, due to a relatively low coefficient of friction, and small wear depth on the disk.

Conclusion

The standards-based tribological examination of lubricants can only be a developer's first step in experimentation, due to the quantity of parameters. To represent a meaningful performance profile of a lubricant, more parameters besides the typical friction and wear must be monitored. The SRV test system can analyze a lubricant's performance and behavior beyond just friction and wear testing.