> Performance Evaluation of Lubricants with Ball-on-Disk Type Rolling/Sliding Friction Tester

Introduction:

Various lubricants are used in sliding parts to reduce friction and wear between two surfaces or to transmit power. In many tribological designs, rolling elements are employed to reduce friction and wear; however, in real rolling contacts may also include sliding components. To understand the characteristics of lubricants, it is necessary to reproduce boundary lubrication, mixed lubrication, and elastohydrodynamic lubrication (EHL) regions by varying slip ratio (SRR) and entrainment speed, and to comprehend the friction behavior in each region. Additionally, in the development of electric motors for electric vehicles, it is important to evaluate considering factors such as high speed, high load, and induced electromotive force.

What Is A Traction Test?

The Traction Machine is a widely used tribological test that evaluates the friction and wear properties of lubricants under controlled conditions. During a traction test, two surfaces (often ball and disc) are brought into contact under a controlled load. These surfaces are then moved relative to each other to create various sliding rolling ratio speeds. The test measures the coefficient of traction and performs Traction curve (Figure.1) and Stribeck (Figure.2) curve analysis at various loads and environmental conditions.

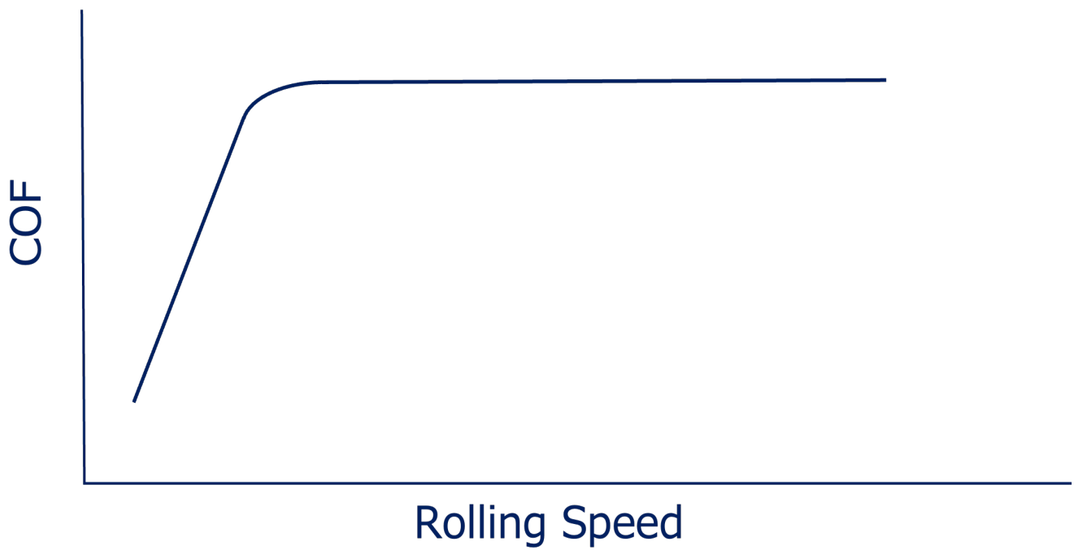


Figure 1: Traction Curve

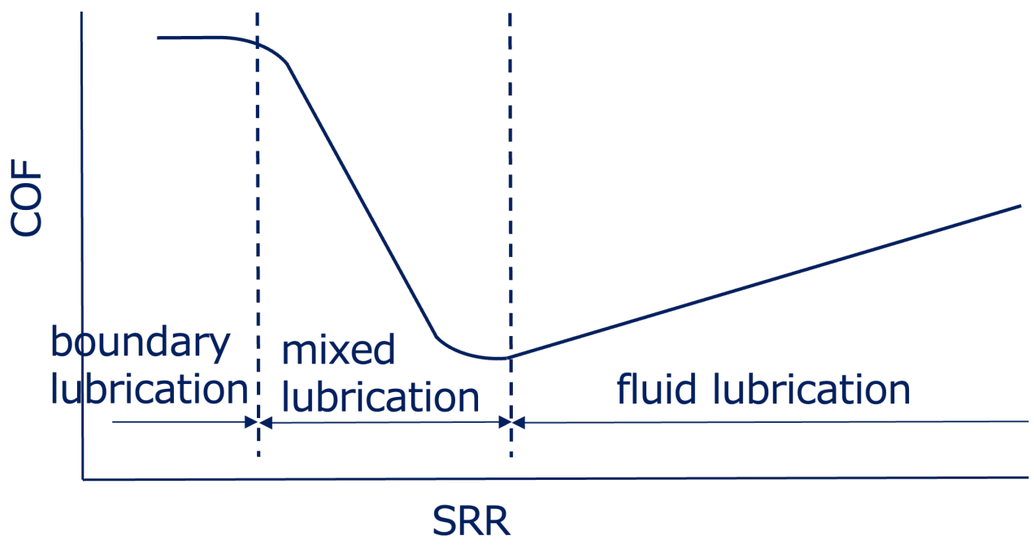


Figure 2: Stribeck Curve

Mini Traction Module:

The next-generation Mini Traction Module (Figure 3) and Extreme Traction Module from Rtec-Instruments accommodate the widest range of loads, speeds, environments, and electrification conditions. With maximum loads of 100N, 200N, and 2000N (depending on the platform) and twin servo motors, high-speed (±6000 mm/sec) and long-duration fatigue tests are possible. The unique contact structure (Figure 5) that cancels out spin components generated at the contact surface, along with the patented capacitive force shift sensor that reduces drift, enables highly sensitive friction force detection. The oil container temperature can reach up to 180°C. The EV module is effective for simulating tribocorrosion by applying AC/DC and for evaluating friction behavior electrochemically through electrical resistance/impedance measurements. Additionally, the MFT (Multi-Function Tribometer) platform (Figure 4) equipped with the Mini Traction Module allows for linear reciprocating and pin-on-disk tests in addition to traction testing (load range depends on the load cell).

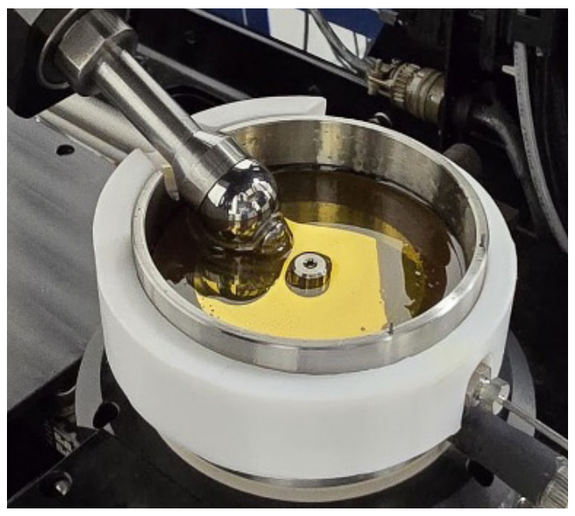


Figure 3:
Mini Traction Module

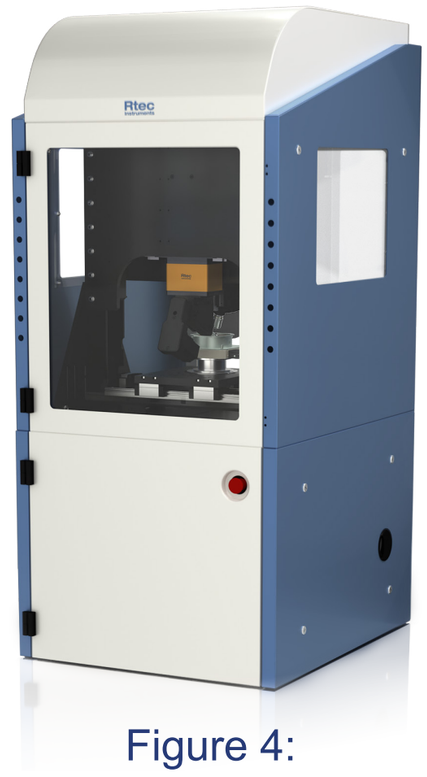


Figure 4:
Multi Function Tribometer
MFT5000

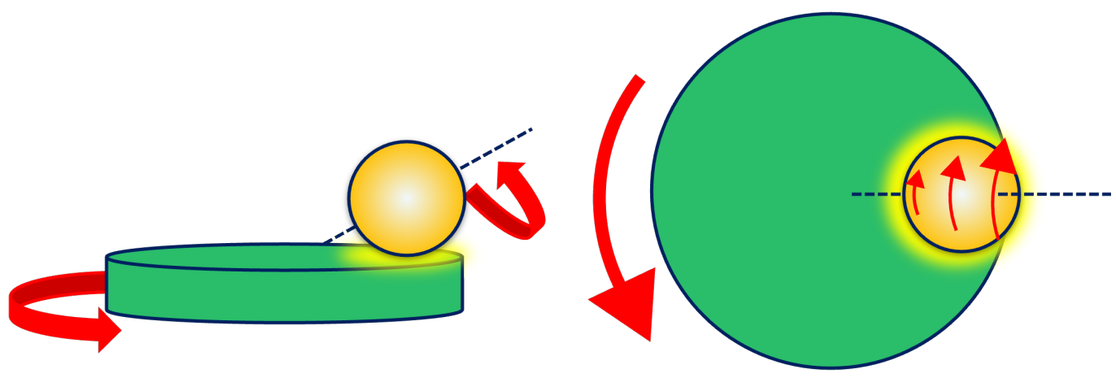


Figure 5: Mini Traction Module Schematic

APPLICATION NOTE - MINI TRACTION

Test Method:

Using the Mini Traction Module from Rtec-Instruments, traction tests for several lubricants were conducted under the test conditions outlined in Table 1 to obtain traction curves and Stribeck curves. The SRR was set between 0% and 8% to include rolling elements with minor sliding components.

	Test 1	Test 2
Load (N)	133	
Contact Pressure (G Pa)	1.5	
SRR (%)	**0~8**	**8**
Rolling Speed (mm/sec)	3000	0~3000
Temperature (°C)	80	

Table 1: Traction and Stribeck Test Conditions

In the Mini Traction Module, SRR is defined as shown in Equation 1. Additionally, for all tests, both materials were grade 5 bearing steel balls made of SUJ2 and steel disks with a mirror finish of Ra = 0.02μm, using Japanese test specimens (Figure 6).

$$SRR\ (\%) = \frac{(v_{Ball} - v_{Disk})}{\left(\frac{v_{Ball} + v_{Disk}}{2}\right)} \times 100 = \frac{(v_{Ball} - v_{Disk}) \times 200}{(v_{Ball} + v_{Disk})}$$

Equation 1: Definition of SRR in Mini Traction Module

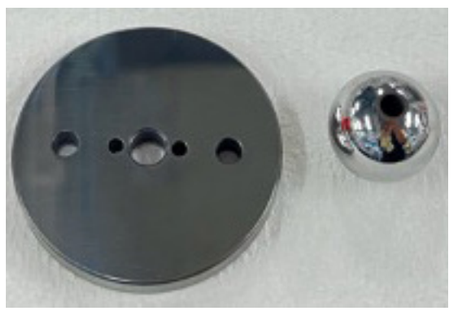
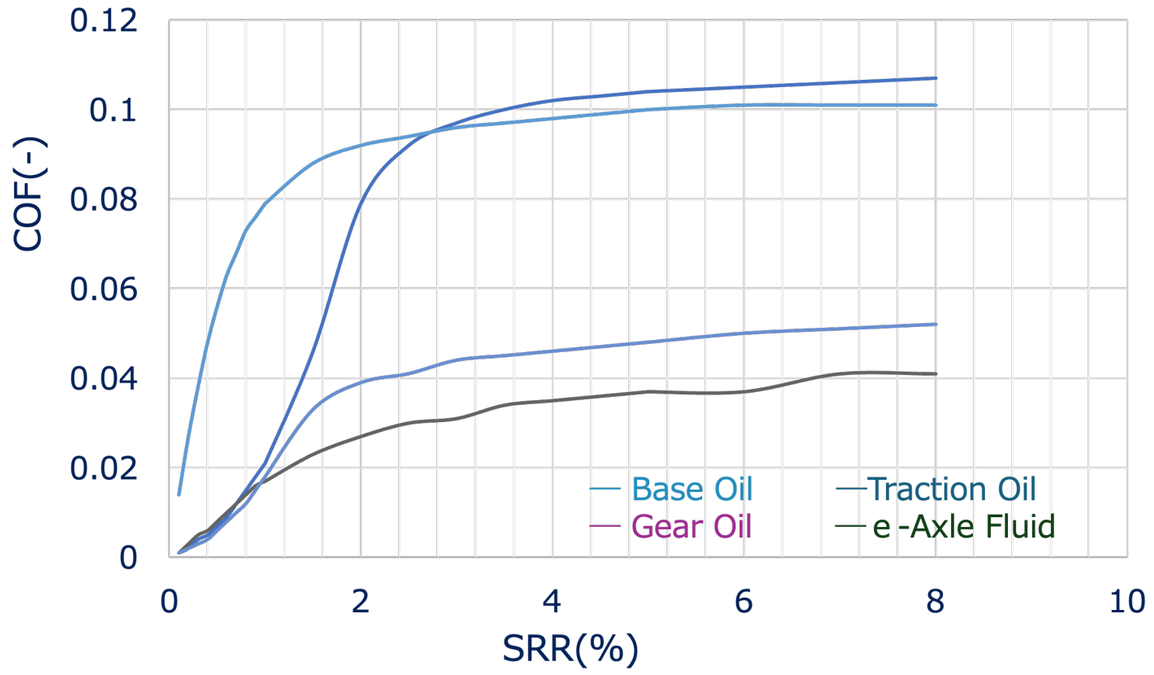


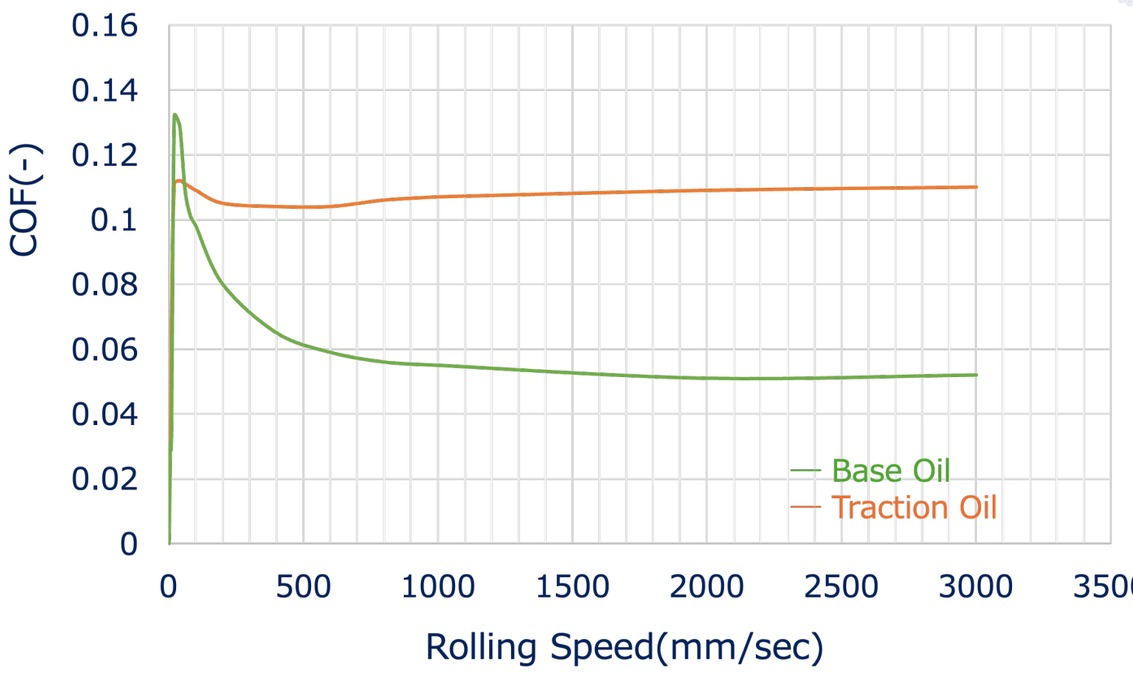
Figure 6: Made in Japan specimens

Test Results:

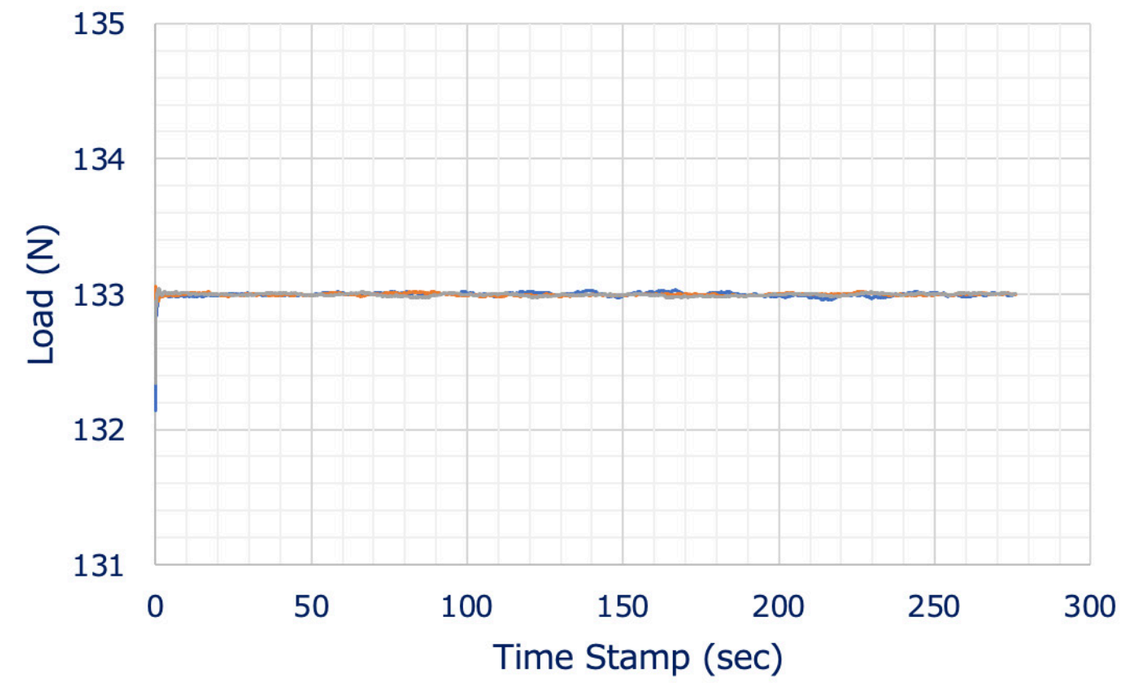
The measurement results obtained from this test are shown in Graphs 1 and 2, respectively. The load transitions during all tests are shown in Graph 3.



Graph 1: Traction Result (Test 1)



Graph 2: Stribeck Result (Test 2)



Graph 3: Load transition during the test

The Mini Traction Module can be used to evaluate various lubricants by analyzing traction curves and Stribeck curves derived from friction force data obtained with its unique capacitive force shift sensor. The robust platform and testing mechanism of the MFT (Multi-Function Tribometer) enable stable load control regardless of sliding or speed conditions.

For further information, please contact us at:

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