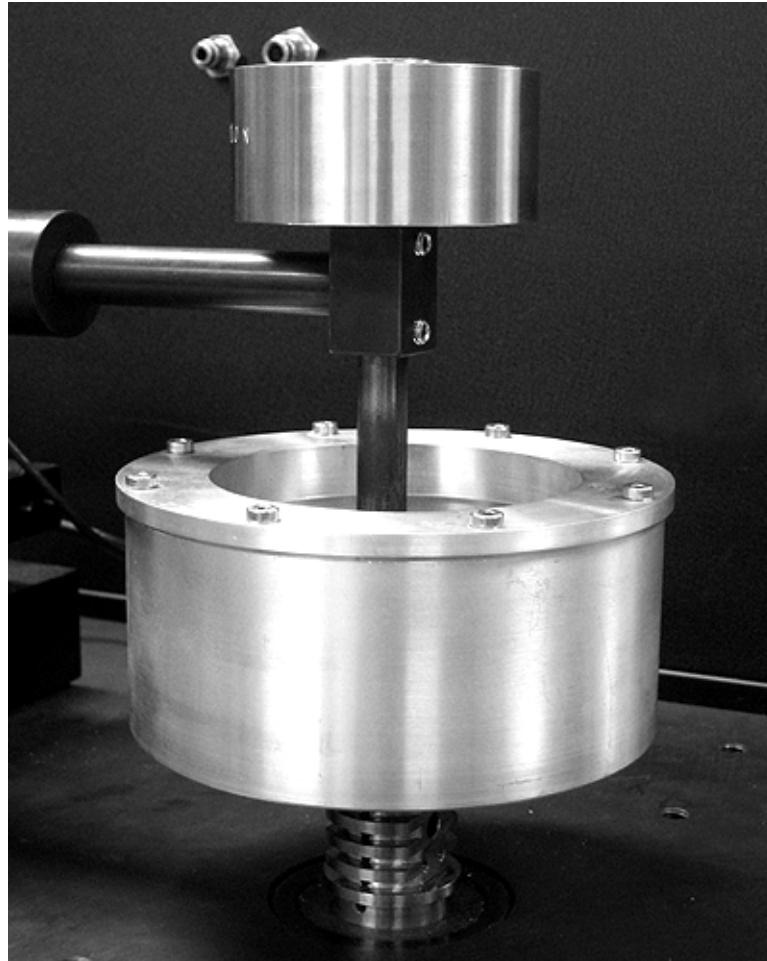


**Stribeck Curve Analysis  
Using Tribometer**



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## INTRO:

When lubrication is applied to reduce the wear/friction of moving surfaces an increasing load can shift the lubrication from several regimes such as Boundary, Mixed and Hydrodynamic Lubrication. The fluid viscosity, the load that is carried by the two surfaces and the speed that the two surfaces move relative to each other combine to determine the thickness of the fluid film. It is this process that determines the lubrication regime. How the regimes react to friction is shown in what is called a Stribeck curve. To evaluate lubricants, and their reaction with applications the Stribeck Curve can be identified using a Pin On Disk Tribometer.

## IMPORTANCE OF TRIBOLOGY INSPECTION FOR QUALITY CONTROL

The Tribometer, like the Stribeck Curve, plots the friction as it relates to viscosity, speed and load. On the vertical axis is the friction coefficient and the horizontal axis is a parameter that combines the other variables. With this capability the development of new and improved cost-saving lubrications studied to battle with the forces of friction and wear. The purpose of Tribology research is ultimately the minimization and elimination of losses resulting from wear and friction at all levels of technology where the rubbing of surfaces is involved. Tribology research is vital to greater production efficiency, application performance, controlled replacement breakdowns, and most importantly to the cost savings to allow industrial growth.

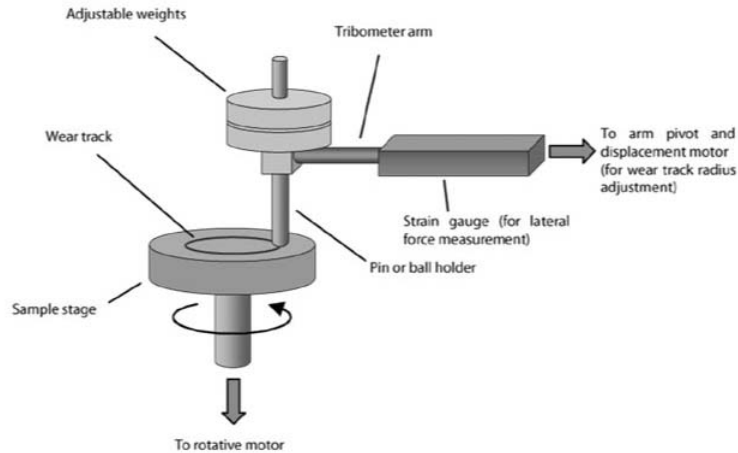
## MEASUREMENT OBJECTIVE

The Nanovea Pin-On-Disk Tribometer will be used along with the lubrication module. A steel ball tip will be used against a glass slide submerged in Compressor Oil. The Tribometer speeds will range from extreme low to high in order to showcase the precise sensitivity of the Tribometer capabilities. The 3D optical profiler, unique to the Nanovea Tribometer, could have also been used to investigate surface asperity but was not the case in this test.

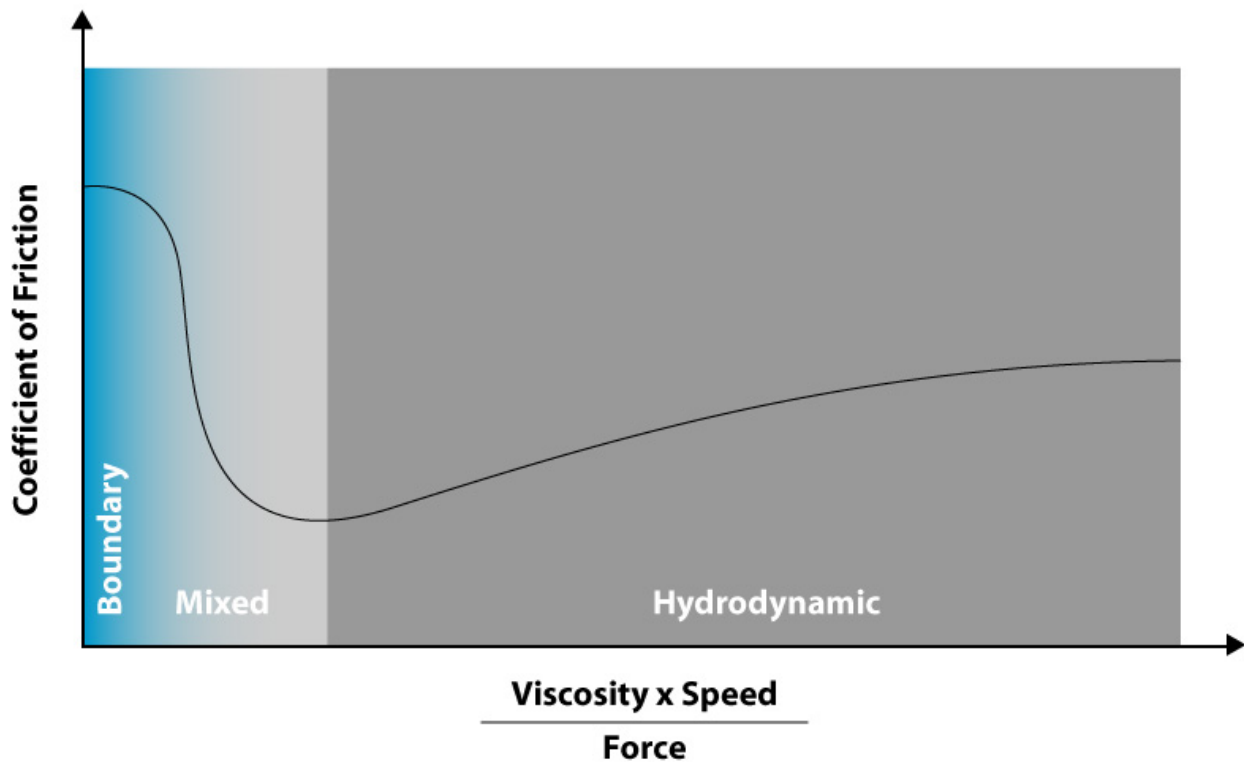


## PIN-ON-DISK TEST PRINCIPAL:

The sample is mounted on a rotating stage and a pin, or ball, comes in contact with the sample surface, with a known force, to create the wear. The pin-on-disk test is generally used as a comparative test in which controlled wear is performed on the samples to study. The volume lost allows calculating the wear rate of the material. Since the action performed on all samples is identical, the wear rate can be used as a quantitative comparative value for wear resistance.



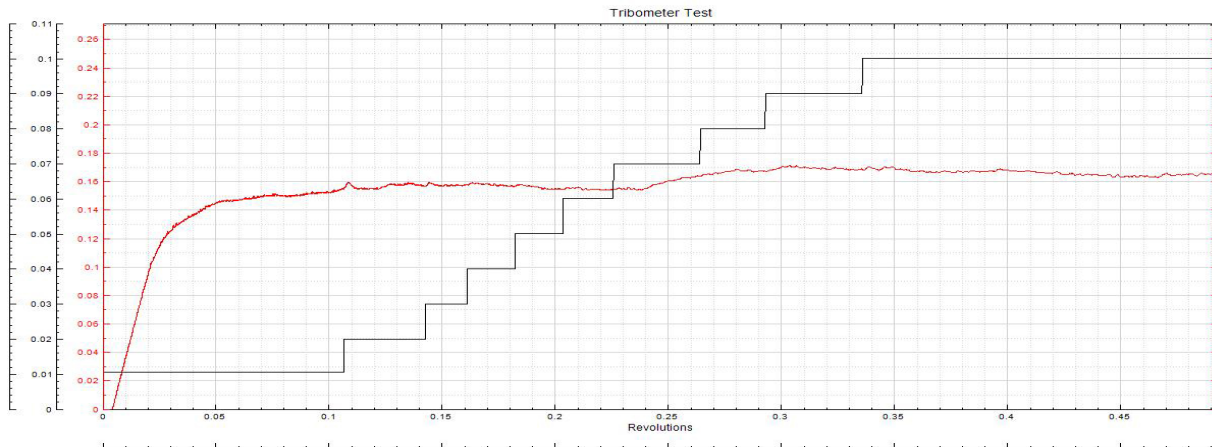
## STRIBECK CURVE PRINCIPAL:



## PIN-ON-DISK TEST RESULTS:

### Boundary

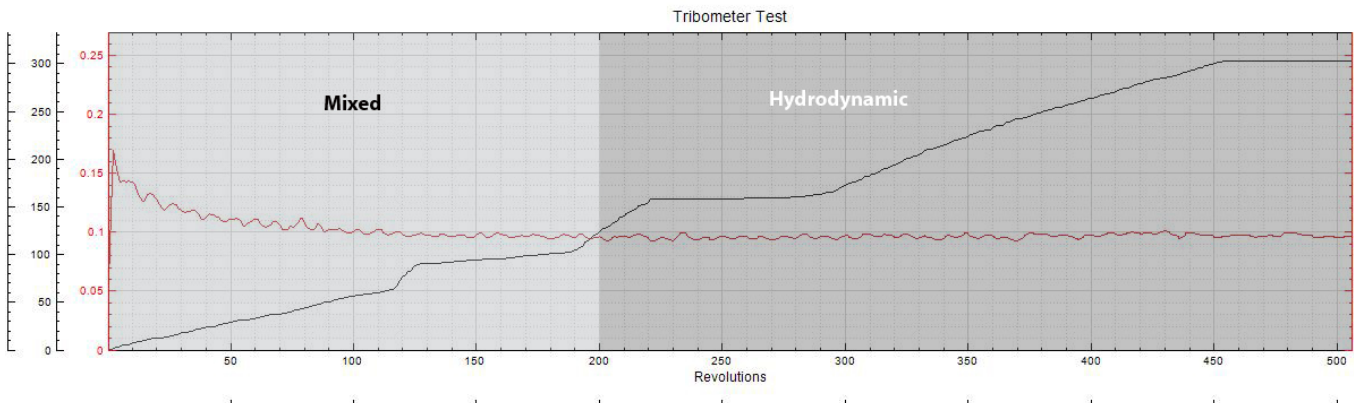
To show case the capability of the Nanovea Tribometer the speed was slowly increased from 0.01rpm to 0.1rpm. This corresponds with the 3mm radius to 0.188mm per minute or 0.003mm per second. This extremely low speed allows to study the actual moment when the friction builds up as the contact point start moving. This period was around 3seconds which corresponds to a displacement of about 9micron. When the speed of the Tribometer is set very low there should be no pressure build up in the lubricant and should only result from by the asperities in the contact area, protected by adsorbed molecules of the lubricant. Characteristic for boundary lubrication is the absence of hydrodynamic pressure. Dry contact is excluded from boundary lubrication.



### Mixed & Hydrodynamic

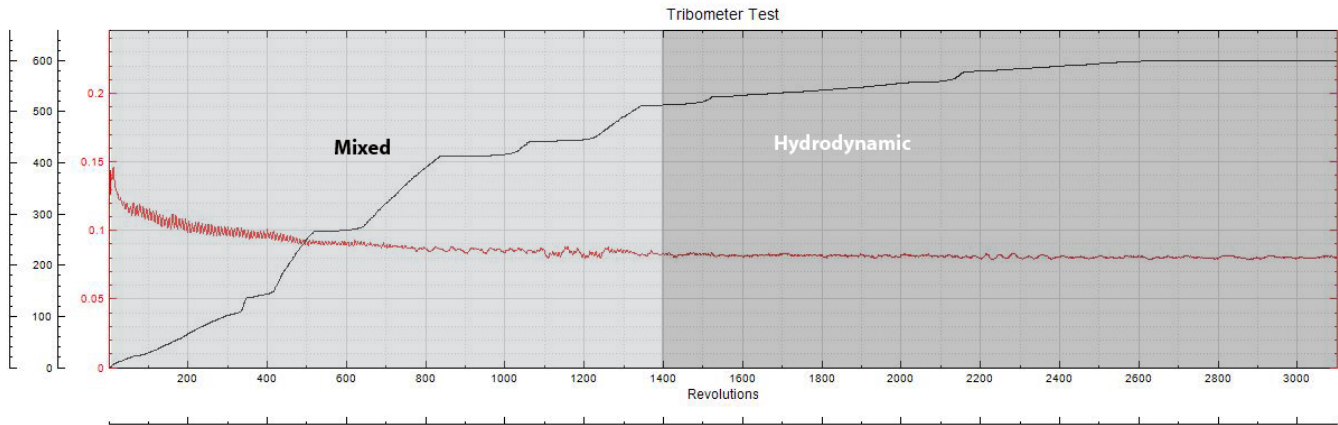
During increasing speed of the Tribometer a hydrodynamic pressure is built up in the lubricant. Identifying mixed is when loading is carried by a combination of the hydrodynamic pressure and the contact pressure between the asperities of both surfaces. As the Tribometer reaches high speed the hydrodynamic pressure increases and the surface asperities are completely separated by a lubricant film. Identifying hydrodynamic is when the load and hydrodynamic pressure is in equilibrium. This is where aquaplaning occurs. The higher the load the higher the speed threshold will be between mixed and hydrodynamic.

**TEST #1 (2N)** At approximately 200 revolutions or 120rpms the COF begins to stabilize to 0.95. Initial COF was 0.173



<b>Force applied</b>	2.0 N
<b>Speed of rotation (Range)</b>	0.1-300 RPM
<b>Radius of wear track</b>	3.00mm
<b>Duration of test</b>	2 min
<b>Total disk rotations</b>	505
<b>Distance traveled</b>	9.53 m
<b>Lubrication</b>	Compressor Oil

**TEST #2 (10N)** At approximately 1400 revolution or 500rpms the COF begins to stabilize to 0.82. Initial COF was 0.136



<b>Force applied</b>	10.0 N
<b>Speed of rotation</b>	0.1-600 RPM
<b>Radius of wear track</b>	3.00mm
<b>Duration of test</b>	3.6 minutes
<b>Total disk rotations</b>	3099
<b>Distance traveled</b>	58.39 m
<b>Lubrication</b>	Compressor Oil

## CONCLUSION:

Using the Nanovea Tribometer, user can plot a Stribeck curve of various liquids and oils. Friction coefficient is plotted as the speed is changed in steps or using a linear acceleration. A step loading was used in this note, but linear mode would lead to a smoother transition. The sensitivity of sensor allows for detecting small change in friction. The full range of speed from 0.01rpm (and lower) to 2000rpm allows for the full range of lubrication behavior to be studied through Pin-on-Disk. The Nanovea Tribometer can be equipped with a temperature module to study these properties up to 150°C. The liquid cup can be used to test by fully submerging or by using an optional lubrication module that adds a drop-by-drop or spray mode. With this list features and precision, the Nanovea Pin-on-Disk Tribometer is the ideal tool for Tribology study. To learn more about the Nanovea [Tribometer](#).