

REWOCOROS® AL 200

Extreme Pressure (EP) &
*Lubricity improving additive
for water-miscible Lubricants

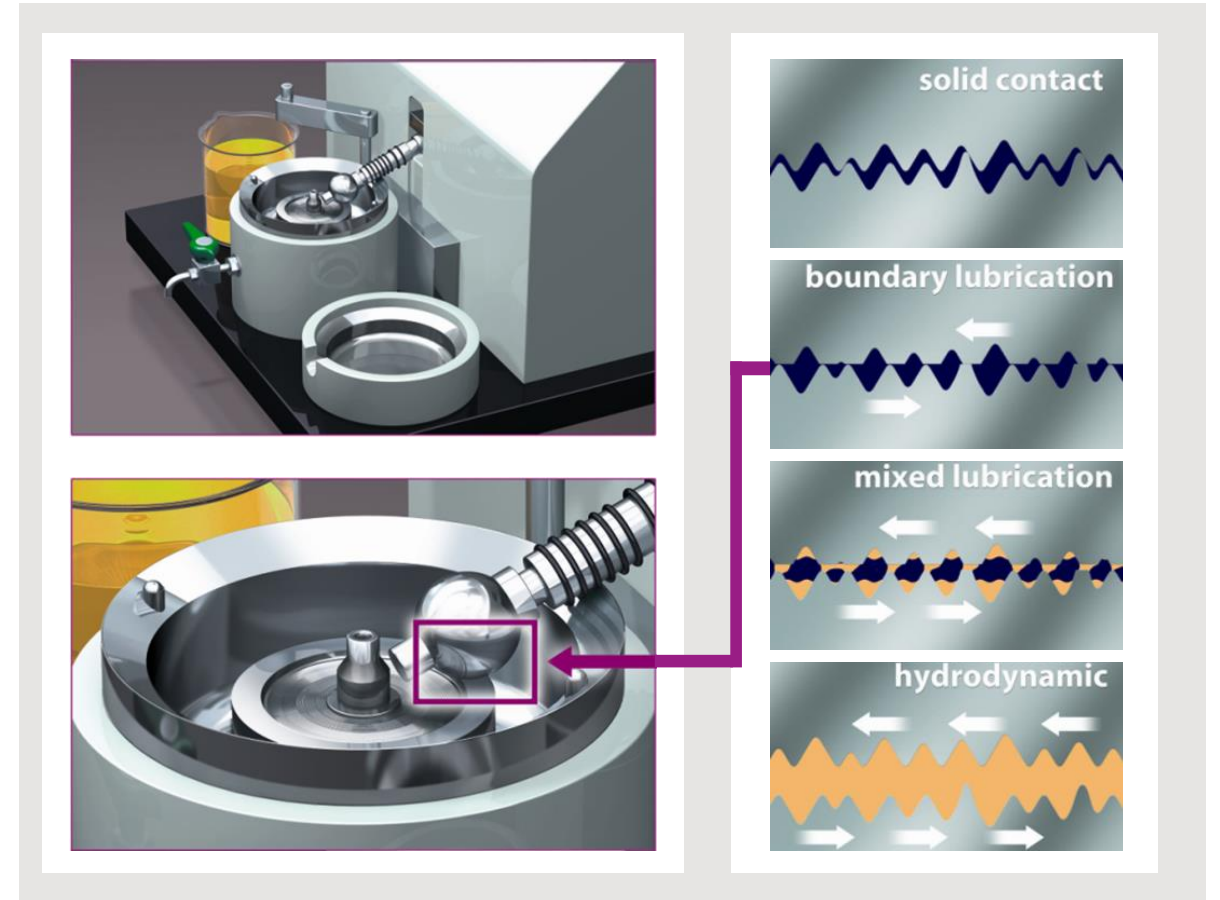
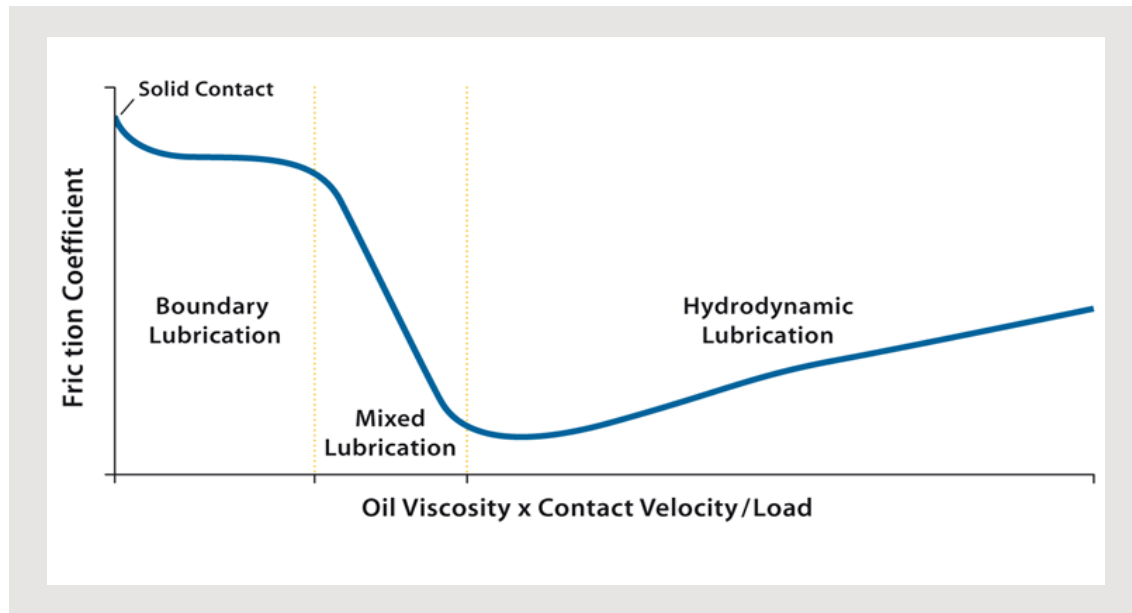
*Evaluated using Mini Traction Machine

Evonik Operations GmbH – Specialty Additives
Interface & Performance
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The Mini Traction Machine (MTM)

- A tool for evaluating properties of lubricants
- The Stribeck curve describes the different lubrication regimes



The Mini Traction Machine (MTM)

The Mini Traction Machine (MTM)

Computer controlled, precision traction measurement instrument

Provides fully automated traction mapping of lubricants and other fluids

Measures frictional properties under a wide range of speeds, loads and temperatures enabling quick characterization of lubricants

MTM simulates the lubrication regime found in non-conformal components such as gears, cams etc.

The test contact is formed between a polished ball and a disk, each independently driven to produce a sliding/ rolling contact

A small sample of fluid (approx. 35 ml) is placed in the test reservoir

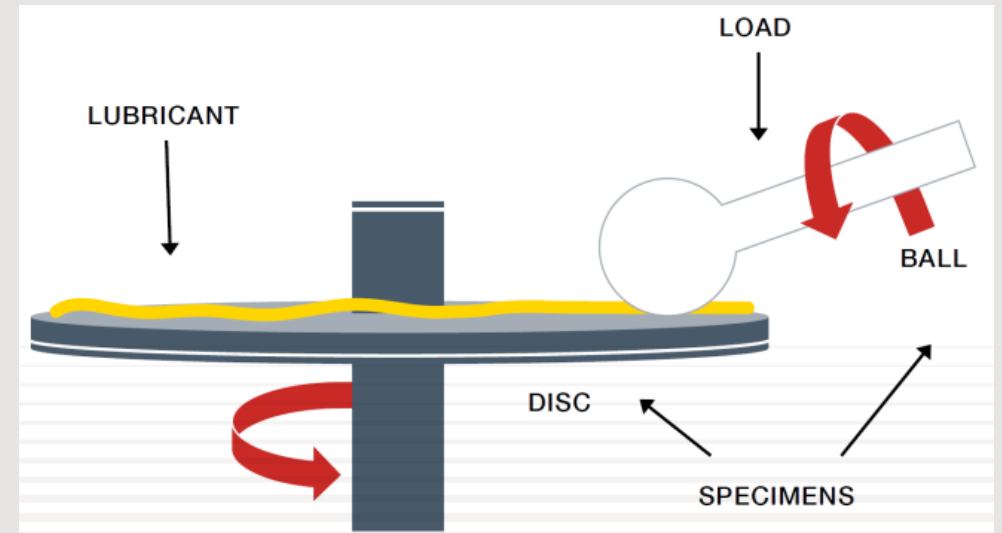
The system steps through a series of user defined loads, speeds, slide/ roll ratios and temperatures

The Mini Traction Machine (MTM)

Technical specs

Load	0 to 75 N
Contact Pressures	0 to 1.25 GPa (standard specimens) up to 3.1 GPa with alternative specimens
Speed	-4 to 4 m/s
Slide/Roll Ratio	-10 000 to + 10 000%
Temperature Range	Ambient to 150°C (below ambient with optional oil cooler)
Test Sample Volume	35 ml (10 ml with optional pot filler)
Power Supply	100 - 240 Vac
Dimensions (h x w x d)	400mm/18" x 400mm/18" x 600mm/24"
Weight	30kg/66lb

Contact area schematic

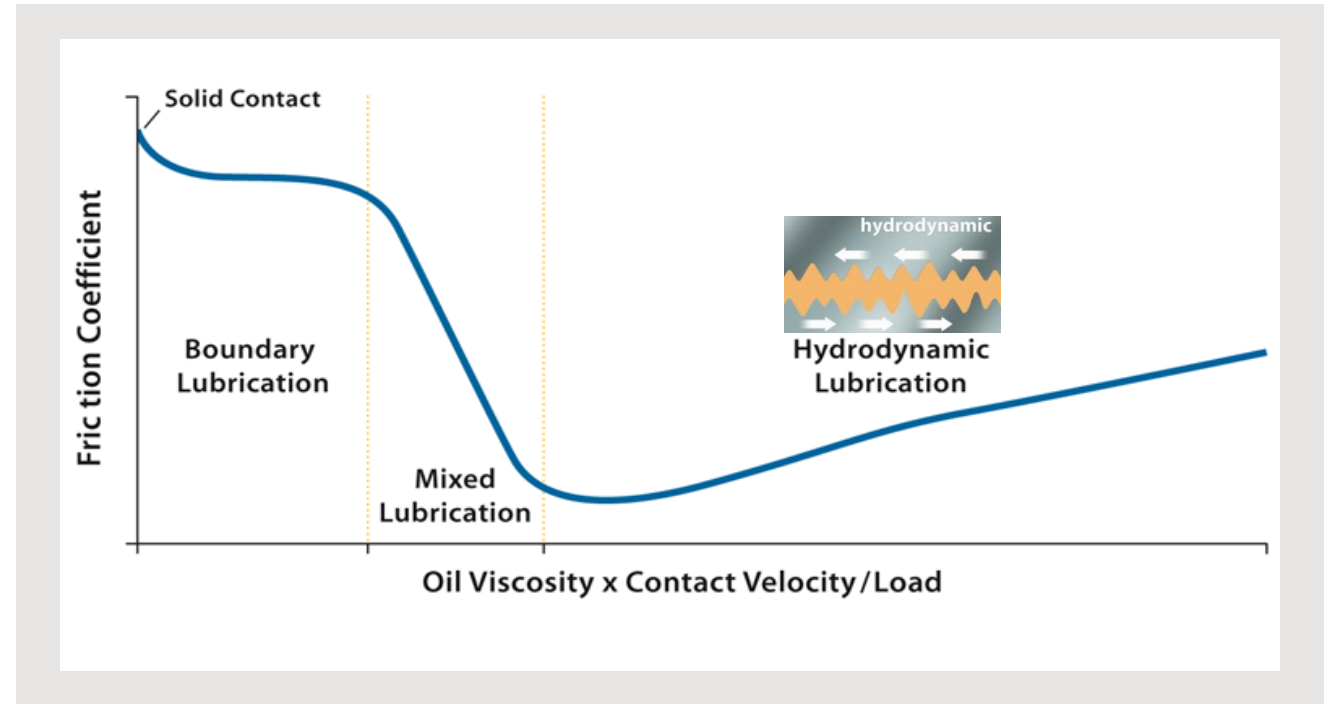


Source: PCS Instruments, <https://pcs-instruments.com/product/mtm/>

Stribeck Curve

Hydrodynamic Lubrication

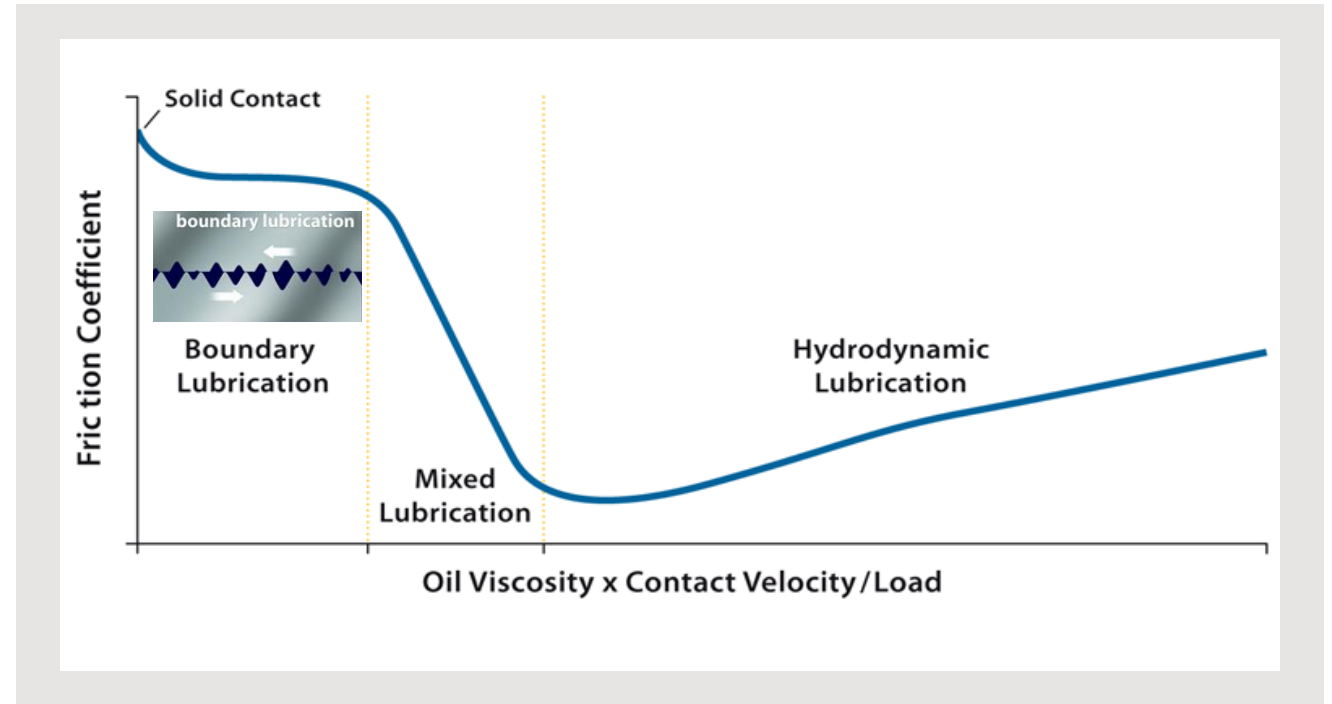
- Hydrodynamic lubrication occurs when metal surfaces approach each other but remain completely separated by a continuous film of liquid lubricant
 - This improved wear protection is influenced by the lubricant's viscosity
 - Occurs at high speed. A similar phenomenon is aquaplaning
- Oil film thickness is influenced by
 - Increase in speed or viscosity
 - Increase in load



Stribeck Curve

Boundary Lubrication

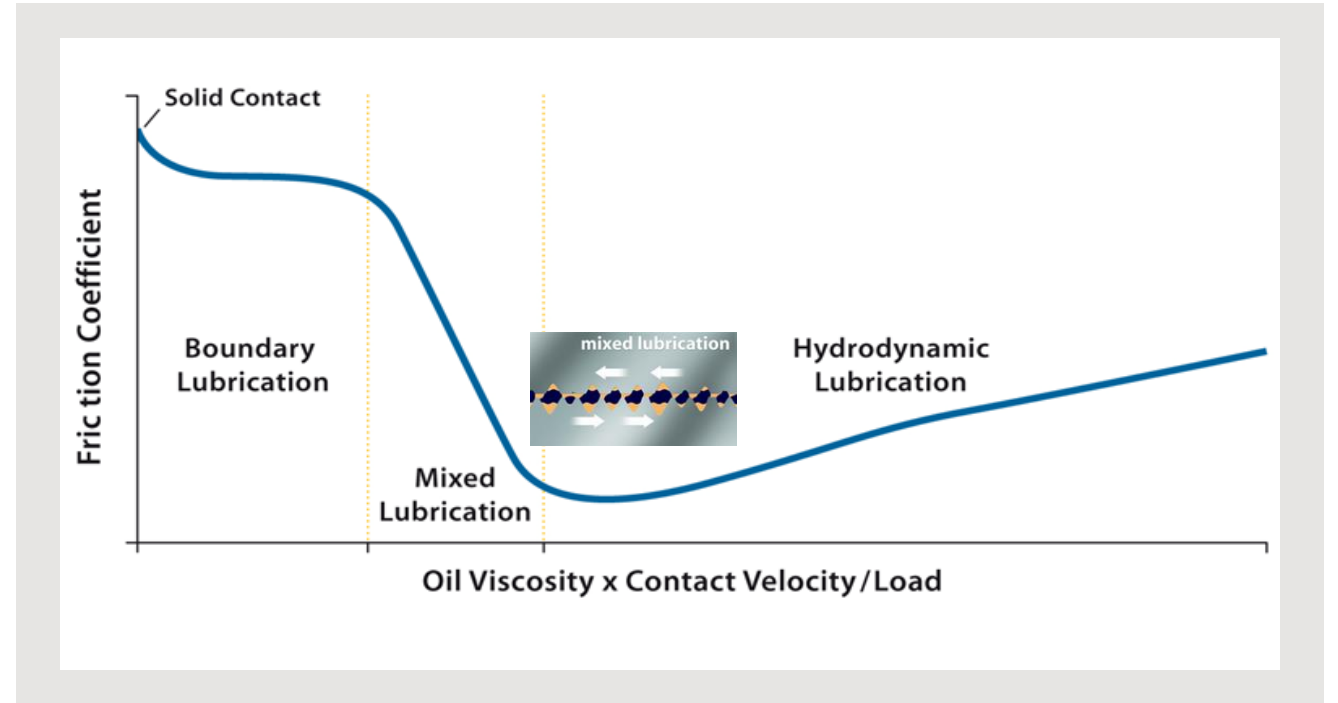
- Boundary lubrication occurs when metal surfaces come into direct contact in the absence of a hydrodynamic film, or the lubricant film is too thin to provide total surface separation
- Phosphorus containing additives (REWOCOROS® AL 200) result in a controlled boundary lubrication by forming a mono-layer onto the two solid surfaces
- High temperatures generated during machining or heavily loaded conditions release substances from phosphorus-containing compounds, which react with metal surfaces and form layers on the metal surface
 - These layers are sheared off under the high pressure, which prevents welding of the metal surfaces



Stribeck Curve

Mixed (elastohydrodynamic) Lubrication

- Mixed lubrication is a combination of both hydrodynamic and boundary lubrication
- This occurs as
 - pressure or load increases
 - the lubricant's viscosity provides higher shear strength than the metal surface that the lubricant supports



REWOCOROS® AL 200

Evaluating of Lubricity Improving Properties in a Soluble Oil

Test formulation

50.0 % Naphthenic oil

17.5 % POE-Oleyl/Cetyl alcohol

8.0 % Tall oil fatty acid (low resin)

15.0 % TEA

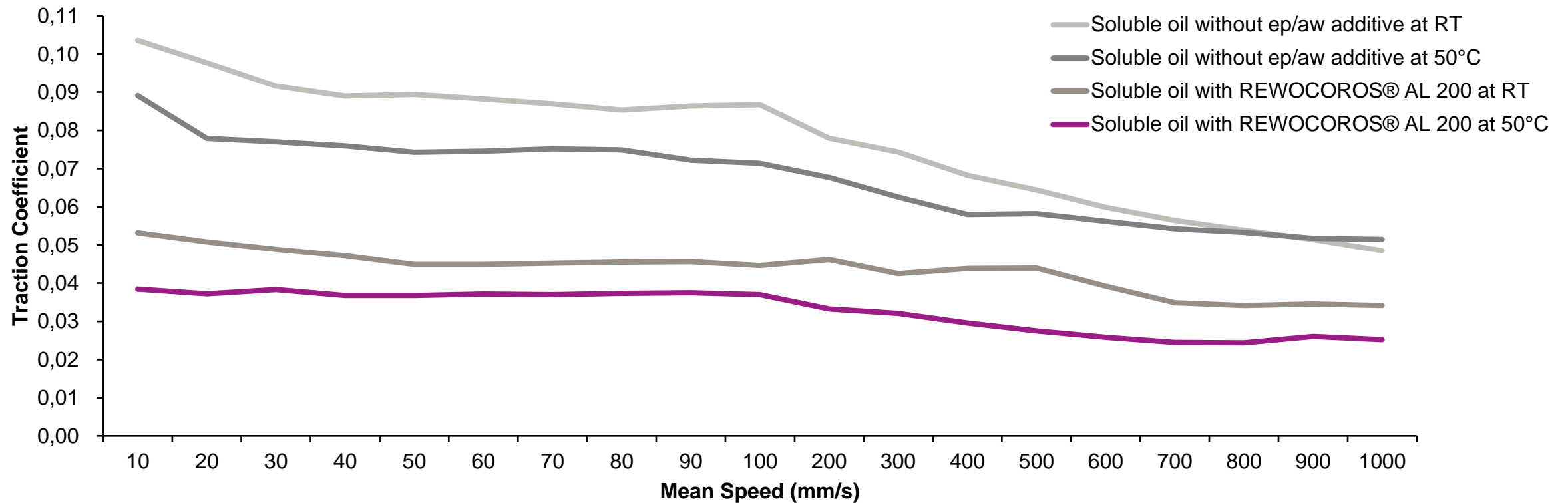
4.5 % Butyldiglycol

5.0 % **REWOCOROS® AL 200**

(Modified ethoxylated phosphoric acid ester)

REWOCOROS® AL 200 enhances Lubricity Properties of a Soluble Oil

- Stribeck curve of the 5 % water mixed soluble oil
30 N 50 % SRR



Evaluating EP Properties of REWOCOROS® AL 200 by using MTM



Important note!

- REWOCOROS® AL 200 is a phosphoric acid partial ester with a calculated phosphorus content of ~5 %
- It forms on metal surfaces even at room temperature adsorption layers which provides both corrosion inhibiting as well as lubricity improving properties on metal surfaces (the latter can be seen on slide 9)
- In the literature it is described that high temperatures that are generated during machining or heavily loaded conditions release substances from phosphorus containing compounds, which react with metal surfaces to form metal phosphide layers
- It is also described in the literature that “activation” temperatures for organo-phosphorus compounds start from temperatures of approx. 200 °C upwards
- The temperatures selected for our measurements described on slide 9 to determine the lubricity improving properties of REWOCOROS® AL 200 in a soluble oil were room temperature (RT) and +50 °C
- The maximum possible temperature at which traction measurements can be determined using the MTM is +150 °C (see slide 4 "Technical specs")
- In addition, the tests we carried out were based on a water-mixed emulsion with a water content of 95 %. It is not useful to carry out investigations of such a medium at higher temperatures



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