

DUCOM TRIBOMETERS – LUBRICANT TESTING APPLICATIONS

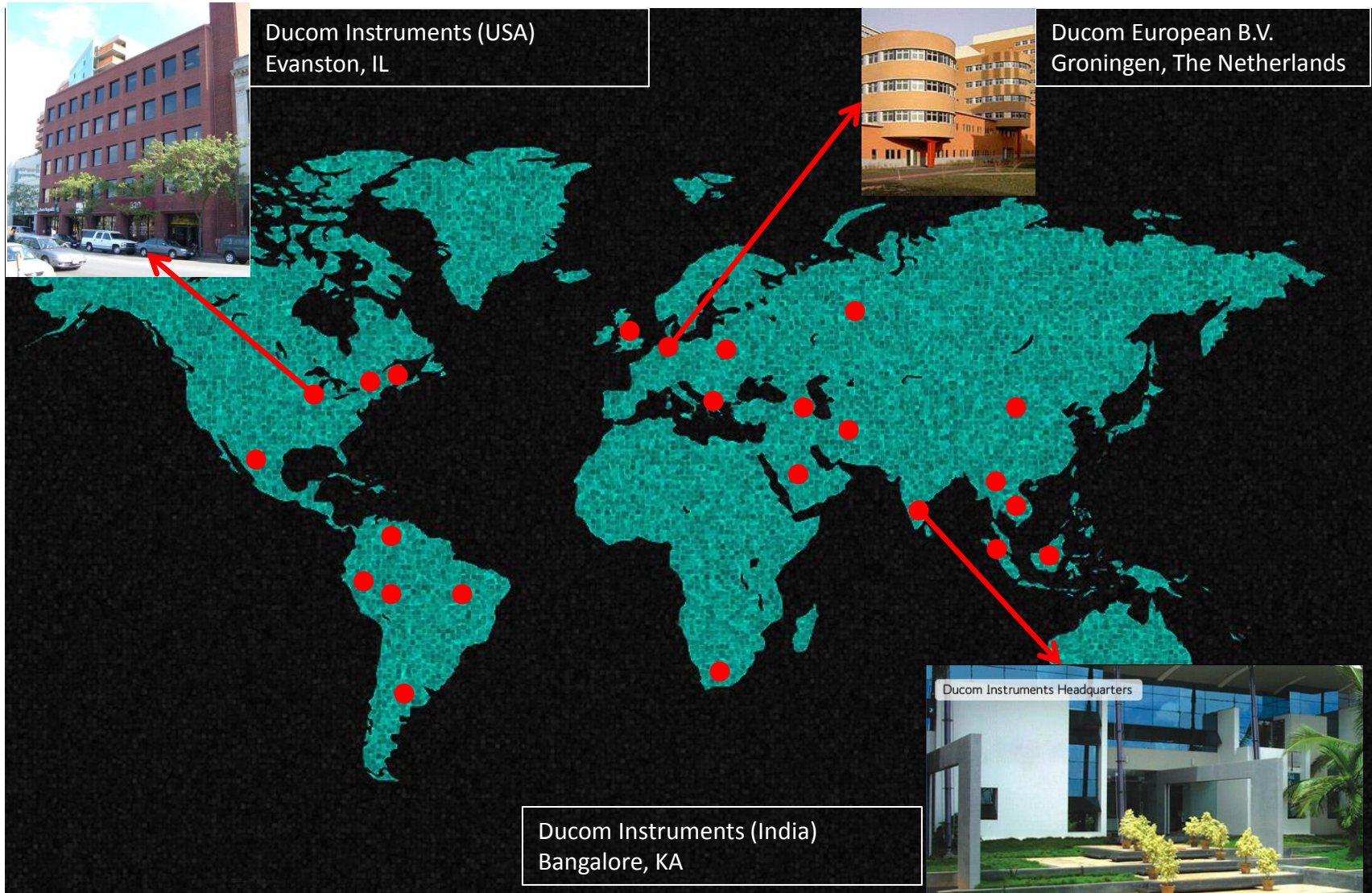
*This document focuses on instruments especially suited for **Lubricant Testing applications**. For detailed information about specific instruments, please contact Ducom:*

info@ducom.com

35 YEARS IN TRIBOLOGY

- Largest range of tribometers in the world:
 - almost **all tribo-testing requirements**
 - over **100 standard tribometers**
 - over **1200 labs worldwide**
- Tribometers manufactured in AS9100 certified space grade manufacturing facility - ***(parts have landed on the moon)***
- **DEVELOPMENT PARTNERSHIPS:**
 - Uni of Groningen (Netherlands)
 - Rush University (USA)
 - BITS Pilani (India)
 - National Metallurgic Lab (India)

Our Locations and Representations



Our relationship with tribology

Lubricant Testers

Bearing Testers

Mechanical Tester

Tribometers

Ducom

Expertise in Tribological Testing and Test Methods

Range of products by Ducom Instruments

TRIBOMETERS

- Abrasion Tester
- Gas (Air) Jet Erosion Tester
- Slurry Jet Erosion Tester
- *Linear Recip. Tribometer*
- *Micro Pin on Disk*
- *Macro Pin on Disk*
- *Roller on Roller Tribometer*
- *TriboChemist*
- Slurry Erosion Tester

LUBRICANT TESTERS

- *Four Ball Tester*
- *High Temperature Grease Tester*
- *Low Temperature Torque Tester*
- *Pin on Vee Block Tester*
- *Reichert Tester*
- *Timken OK Load Tester*
- *Tapping Torque Tester*
- *Shear Stability Tester*

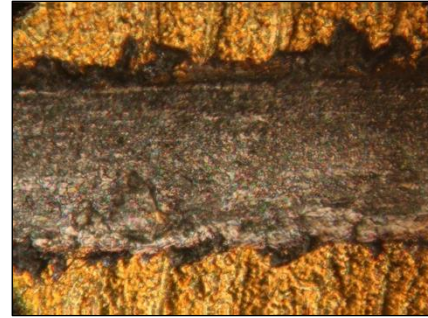
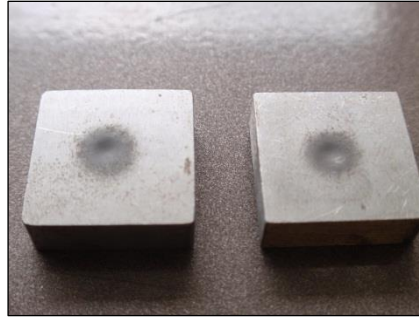
MECHANICAL TESTERS

- Automated Indentation Tester
- Scratch Tester

BEARING TESTERS

- Journal Bearing Tester
- Journal Bearing Tester (Advanced)
- Roller Element Bearing Tester

*These tribometers are especially relevant to the Lubricating Oils,
Greases and Additive Studies*



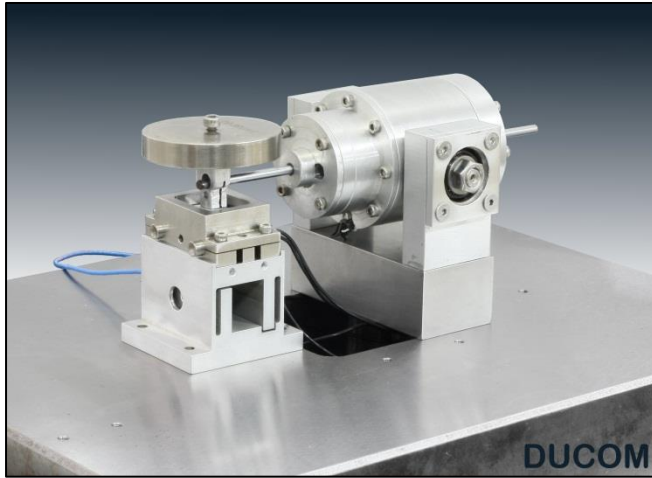
TEST INSTRUMENTS OF SPECIFIC INTEREST TO
LUBRICATING OILS, GREASES AND ADDITIVES

LINEAR RECIPROCATING TRIBOMETER

Ducom Linear Reciprocating Tribometer

for Additives and Lubricants

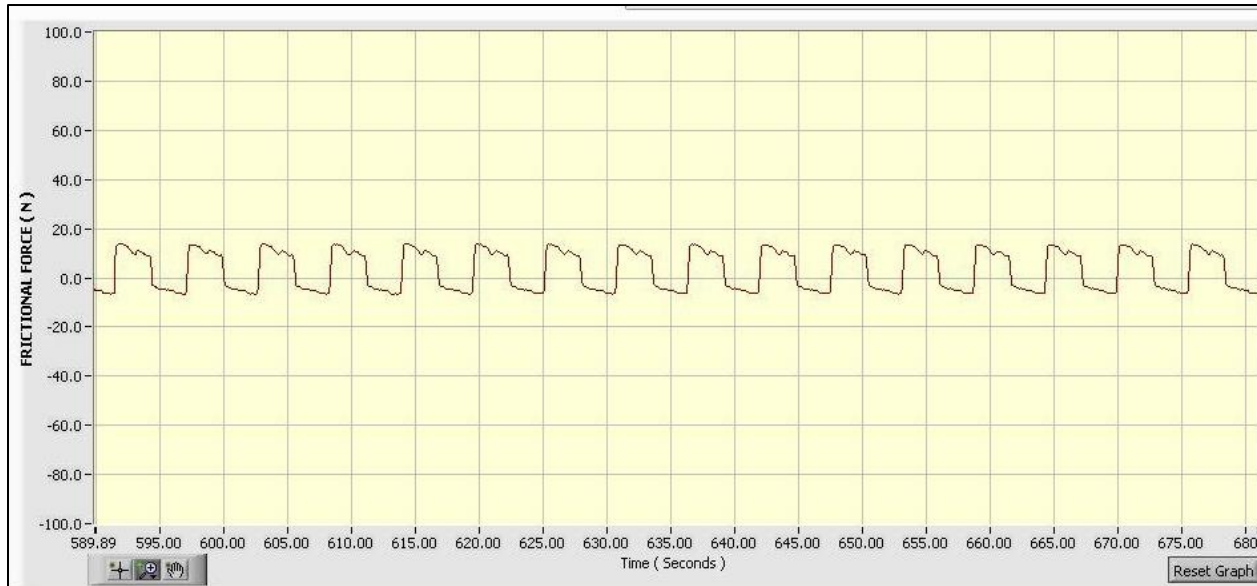
DUCOM LINEAR RECIPROCATING TRIBOMETER SET UP FOR LUBRICANT ADDITIVE TESTING



Materials and lubricants are often subjected to repeated back and forth (reciprocating) movement, in many real applications, from automotive to biotribological environments.

High variety of sample geometries available in order to study:

➤ *Point contact / Line contact / Area contact*



(friction data recorded in both forward stroke and reverse. Up to four results can be viewed in the same graph for comparison)

Ducom Linear Reciprocating Tribometer

SOME OPTIONS

OPTION FOR HUMIDITY CONTROL

OPTION FOR TEMPERATURE CONTROL

LUBRICATION CUP

ENVIRONMENTAL CHAMBER (10 – 95% RH)

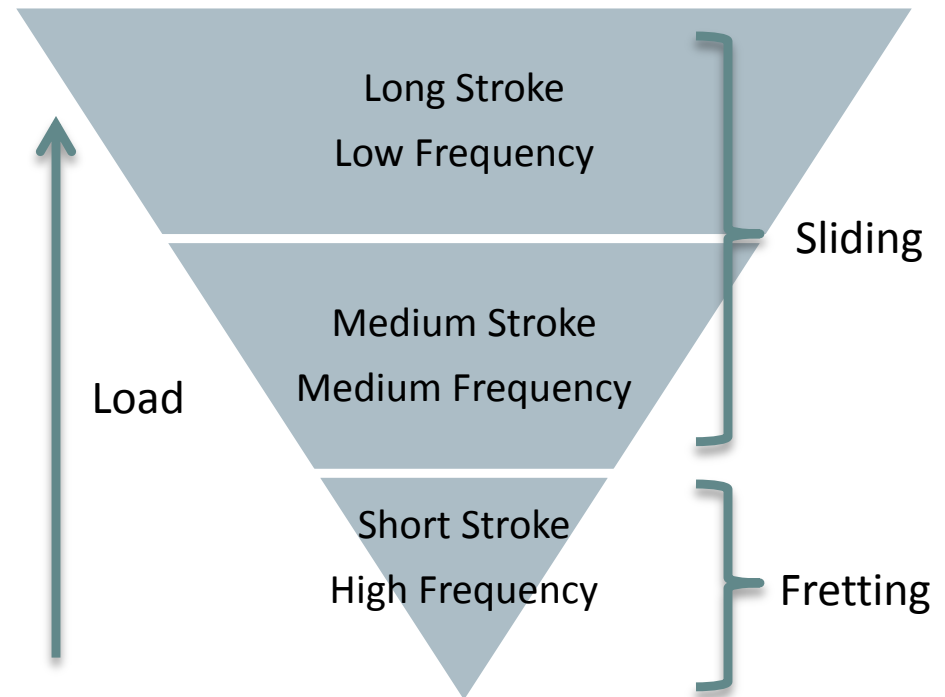
LOW TEMPERATURE STAGE (-25 Deg C)

HIGH TEMPERATURE STAGE (+400 Deg C)

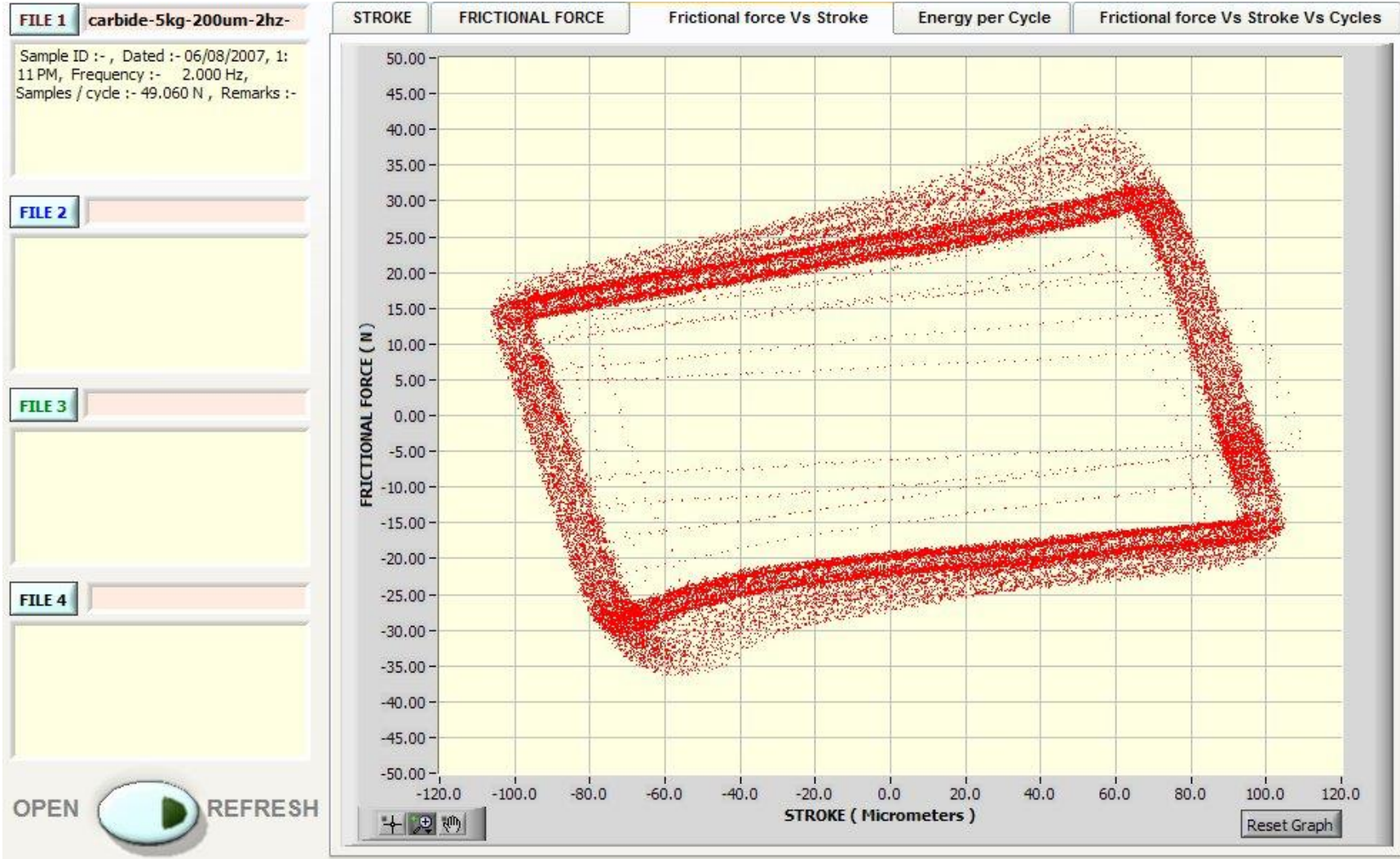
ELECTRICAL CONTACT RESISTANCE (ECR)
measurement

CCD BASED IMAGE ACQUISITION SYSTEM for
sample imaging and reporting

3D OPTICAL PROFILOMETER

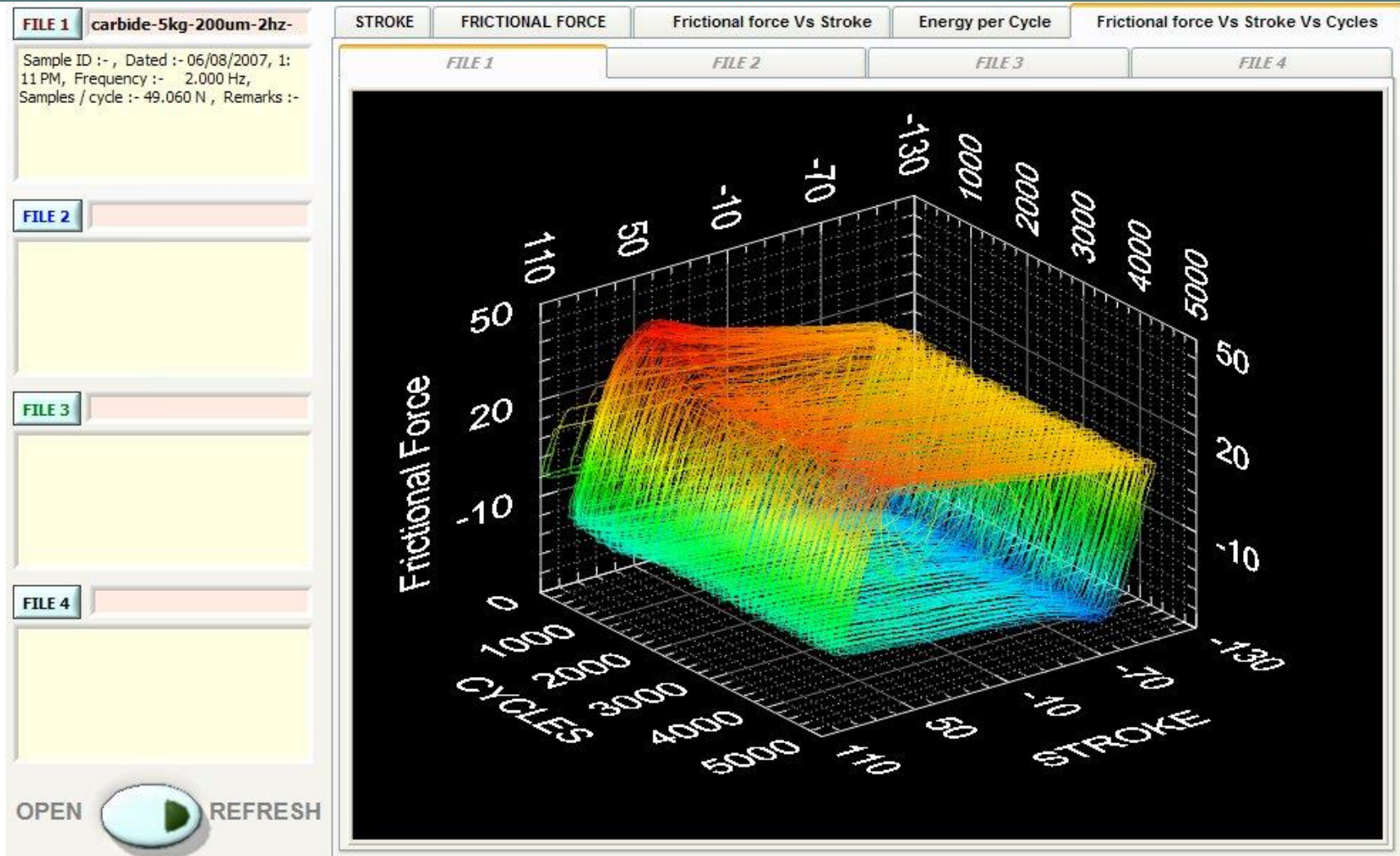


Frictional Force vs. Stroke Length – Linear Reciprocating Tribometer



Measured Frictional Force vs. Measured Stroke, given the energy loss per cycle

Frictional Force vs. Cycles vs. Stroke – Linear Reciprocating Tribometer



Energy Loss (Frictional Force vs. Stroke) over the Number of Reciprocating Cycles
(excellent representation of the energy lost over the duration of the test)

ROLLER ON ROLLER TRIBOMETER



Friction and wear evaluation of materials and lubricants in sliding/rolling configurations

TEST VARIABLES

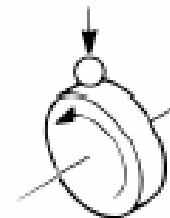
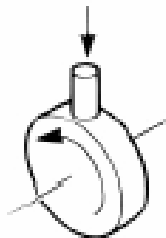
LOAD

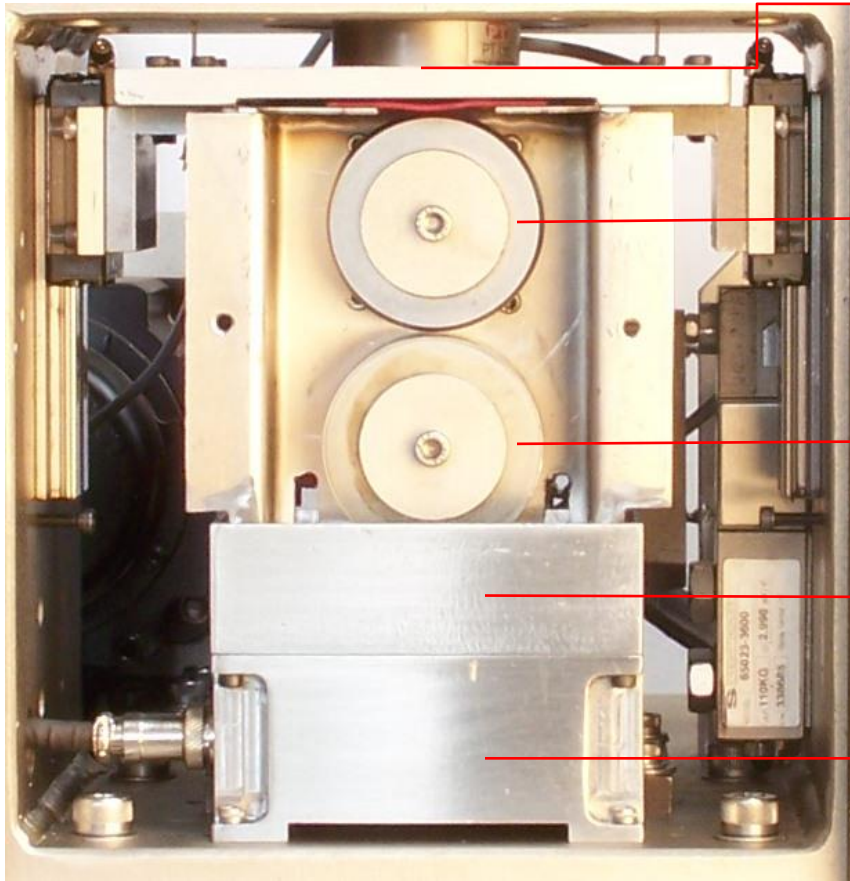
SPEED

TEMPERATURE

SPEED-ROLL COMBINATION

Excellent tool for lube and dry tribology studies!
Roll / Slide – full servo control
Variety of adapters





Choice of Manual / Automated loading systems

SERVO CONTROLLED ROLLER #1. User defined speed and direction of rotation for controlled slip and roll. Choice of holders for variety of contacts types.

SERVO CONTROLLED ROLLER #2. User defined speed and direction of rotation for controlled slip and roll. Choice of holders for variety of contacts types.

Lubricant Sump

Lubricant Heater

MAIN EQUIPMENT

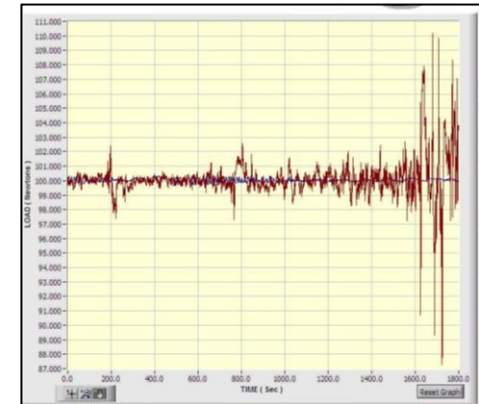
LUBRICATION FEEDER SYSTEM for lubricated wear and friction studies

GREASE FEEDER SYSTEM for grease lubricated wear and friction studies

HIGH TEMPERATURE MODULE (up to 120 °C, for heating lube reservoir)

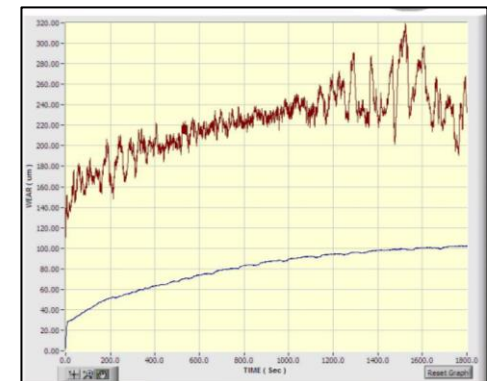
CCD BASED IMAGE ACQUISITION SYSTEM for sample imaging

3D OPTICAL PROFILOMETER for post test analysis



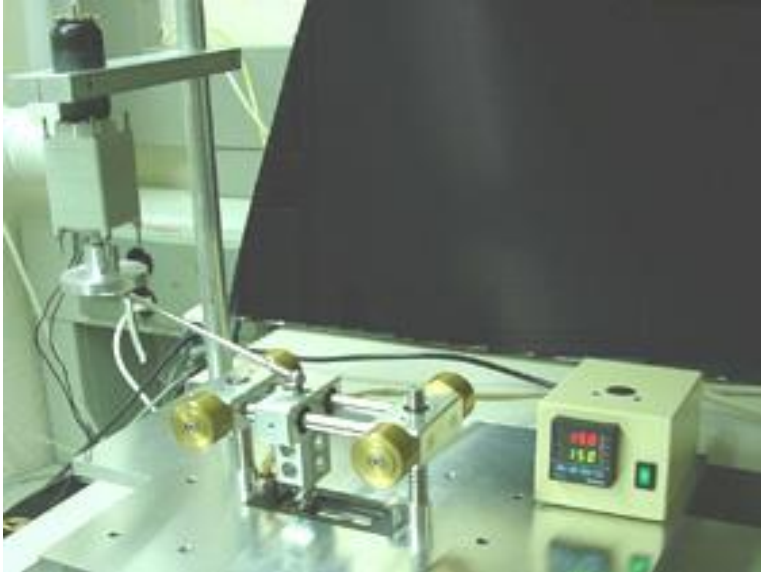
(load & vibration VS time)

PARAMETERS	UNIT	MIN	MAX
SPEED	RPM	1	2000
TEST LOAD	N	0	1000
LUBRICANT TEMPERATURE	Deg C	Ambient	120
WEAR MEASUREMENT	μm	0	2000
WEAR RESOLUTION	μm	1	

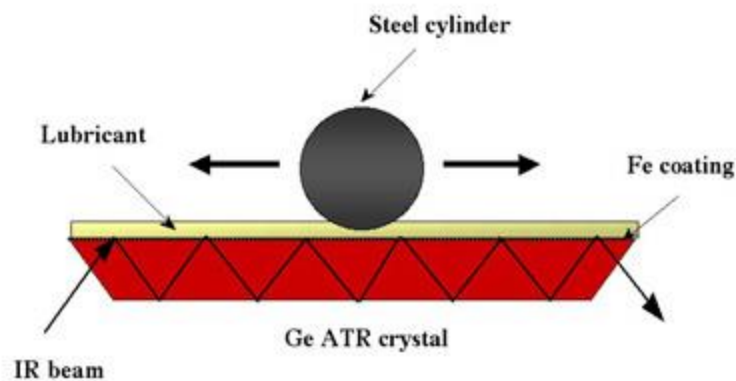


(wear & vibration VS time)

TRIBOCHEMIST®



- ***In situ* analytical technique**
- Tribological **films can be measured as they are formed** under steady-state conditions
- *in situ* ATR analysis allows users to correlate tribological conditions such as normal load and velocity directly to with changes in the chemistry of the lubricant/metal surface interface.



Applications:

1. Lubricant additives development
2. Fundamental lubricant film studies

TriboChemist - as an *in situ* analytical technique has the advantage that the ATR spectra of growing thermal/or tribological films can be measured as they are formed under steady-state conditions, through a thin metallic film representing one of the rubbing surfaces.

The *in situ* ATR analysis allows users to correlate tribological conditions such as normal load and velocity directly to with changes in the chemistry of the lubricant/metal surface interface.

In the case of lubricant additives development the TriboChemist Tribometer by Ducom allows the kinetics of formation of tribofilms and the relative roles of tribochemical and thermochemical processes to be investigated.

Specifications

Parameter	Unit	Min	Max
Test load	N	10	50
Stroke length	mm	10	20
Frequency	Hz	5	10
Test cylinder (diameter X length)	mm	10 X 50	

*Specifications subject to change without prior notice. Detailed specifications can be provided on request.

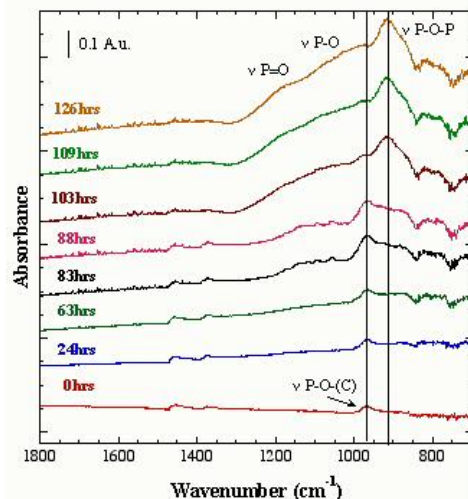
Tribochemistry of zinc dialkyldithiophosphates (ZnDTP)

In-Situ tribochemical research at ETH, Zurich focuses on the application of in situ ATR FT-IR Tribometry to the study of tribofilms formed from solutions of organophosphate additives (ZnDTP) in poly- α -olefin (PAO) lubricant on an iron-coated germanium ATR crystal.

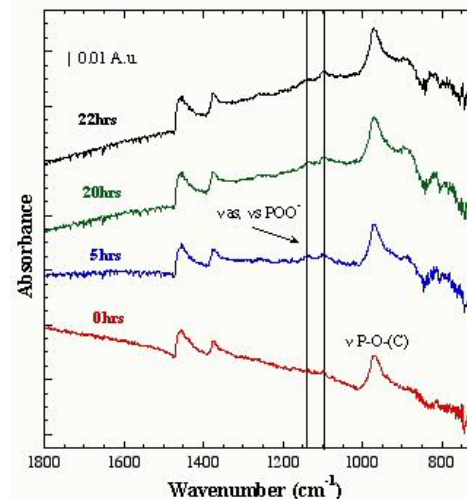
Changes in the ATR FT-IR spectrum of the near-surface region due to thermal and/or tribo-chemical reactions occurring between the lubricant additive and the iron surface have been investigated as a function of time. The ATR results on the surface reaction of ZnDTP under purely thermal conditions indicate the formation of P-O-P bonds, characteristic of polyphosphates ([Figure 2](#)). The modification of the ZnDTP molecule with the formation of (POO)- species, detected after friction at 150°C ([Figure 3](#)), could be an intermediate stage in the formation of inorganic phosphate.

References:

1. F. Piras, A. Rossi, N. D. Spencer, *In-situ attenuated total reflection (ATR), spectroscopic analysis of tribological phenomena*, Trib. Ser.40, "Boundary and Mixed Lubrication: Science and Application", 199-206, 2002
2. F. Piras, A. Rossi, N.D. Spencer, *The growth of tribological films: in situ characterization based on Attenuated Total Reflection Infrared Spectroscopy*, Langmuir, 18, 6606-6613, 2002
3. F. M. Piras, A. Rossi, N. D. Spencer, *Combined in-situ (FT-IR) and ex-situ (XPS) study of ZnDTP - iron surface interaction*, Tribology Letters, 15 (3), 181 - 191, 2003.

Example result 1

ATR FT-IR spectra of 20wt% solution of ZnDTP in PAO, collected during heating at 150°C.

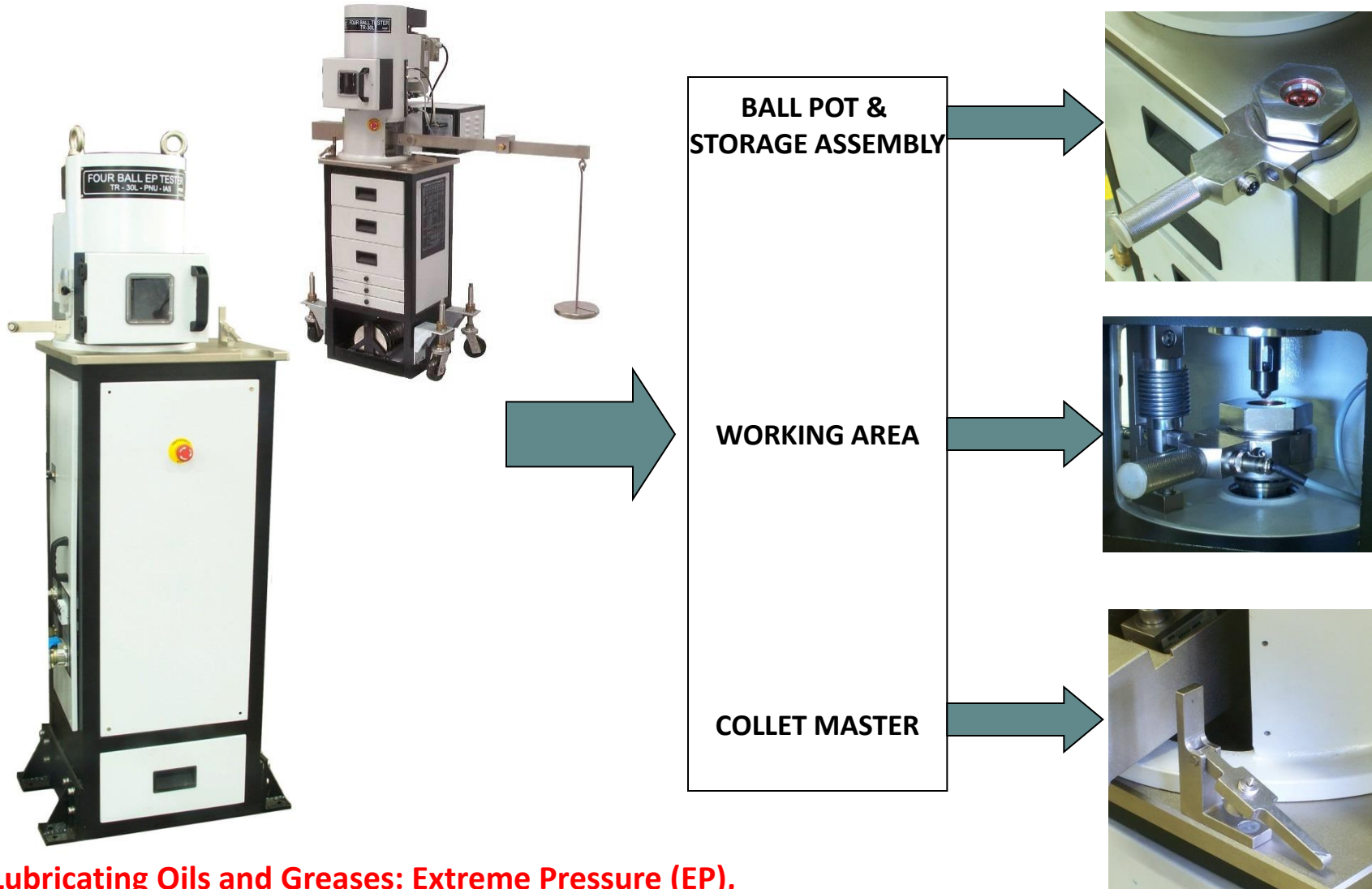
Example result 2

ATR FT-IR spectra of 20wt% solution of ZnDTP in PAO, acquired during sliding at 150°C.

OTHER IMPORTANT LUBRICANT TESTING INSTRUMENTS

Four Ball Tester

Lubricants and Additives



**Lubricating Oils and Greases: Extreme Pressure (EP),
Wear Preventive (WP) and Friction Tests in a single machine!**

Standards: ASTM D 2266 / ASTM D 2596 / ASTM D 2783 / ASTM D 4172 / ASTM D 5183



Application

Extreme pressure and Wear Preventive performance evaluation of Lubricating Oils, Grease and Solid Lubricants.

Standards

ASTM D 5620

ASTM D 2625

ASTM D 2670

ASTM D 3233

IP 241

Test parameters

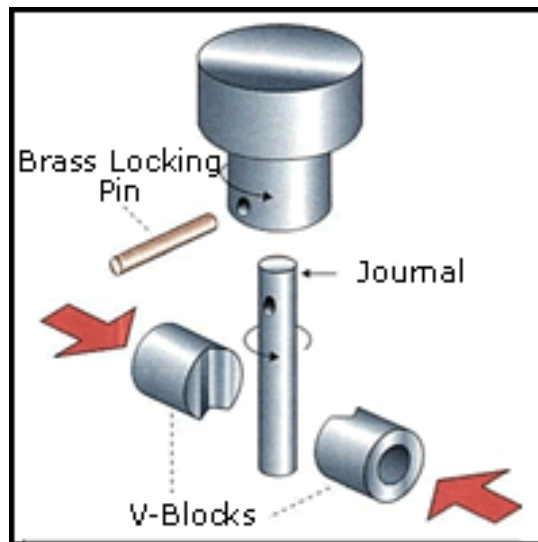
Load

Rotational speed

Temperature

Test duration

Frictional Torque





Application

Evaluation of extreme pressure properties and COF of lubricants

Standards

ASTM D 2608

ASTM D 2782

IP 326

IP 240

Test Variables

Load

Feed rate



Purpose

Evaluation of lubricants at high speeds, high temperatures and low loads

Standards

ASTM D 3336

Test Variables

Load

Temperature

Test Duration



Application

To detect the tendency of various greases to resistance to the rotation of bearing at negative degrees Celsius. Mainly for aerospace applications and equipment in sub zero environment.



- On line measurements of torque and temperature
- Liquid Nitrogen to cool sample to test temperature
- PID controlled test temperature
- Software to record and display on PC

Test Variables

Load
Torque
Temperature

Standards

ASTM D 1478



- ✓ *Precision aligned sample to rotational axis*
- ✓ *Instantaneous cutting torque measurement*
- ✓ *Over torque protection*
- ✓ *Easy calibration with special fixture*

Application

To record the torque for tapping operations in a pre-drilled sample. The test torque is recorded with a WINDOWS® based data acquisition system. Tests are performed with metal working fluids under evaluation in identical conditions. Data over several tests can be compared in performance.

Standards

ASTM D 5619

Test Variables

Rotational speed

Cutting Speed

Torque



Application

The Reichert Tester uses a drop in noise level (screeching) to identify when a lubricating film is successfully formed between the test surfaces.

Excellent for lubricant and additive manufacturers to evaluate wear preventive (WP) and extreme pressure (EP) properties of their samples.

- *Significant utilization to evaluate and rank of products*
- *Very useful for additive depletion studies and lubricant selection for metallurgy*
- *Effective tool to determine lubricant quality while in use in machinery*
- *This tester is capable of testing both lubricating oils and greases*
- *Ducom incorporates instrumentation to monitor and log noise level*

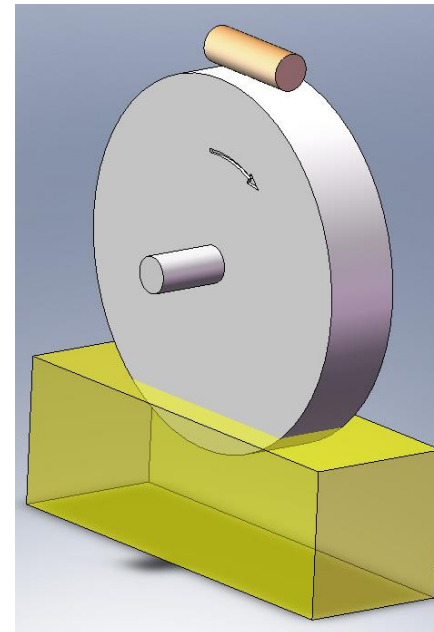
Instrumentation

- Contact load measurement
- Frictional force measurement
- Set test speed
- Set and control of lubricant reservoir temperature
- Test duration
- Dial indicator to measure radial wear
- Scar image acquisition on a PC for size measurement (optional)
- Average sound level recording

The Ducom Reichert Tester is supplied with the WinDucom software for data acquisition and control. This user friendly software is compatible with Windows 7 operating system.

Test Variables

- Rotational Speed
- Sliding Speed
- Test Load





Included Accessories

- Thermometer
- Operation and Maintenance manual
- Preset revolution counter
- Tool Kit

Application

To evaluate the shear stability of polymer-containing oils in terms of the permanent viscosity loss when a sample is mechanically stressed.

Method of Testing

The test fluid is mechanically stressed by pumping through a diesel injector nozzle and a diesel Injection fuel pump.

Samples are taken after the fluid has completed a predetermined number of passes.

Viscosities of the original sample and of samples taken during the test are determined.

The extent of oil degradation due to shear forces can be calculated.

Standard

ASTM D 6278, IP 234



Micro PoD

The Ducom Micro PoD® Tribometer has been developed as a modular test system capable of conducting tribological tests for micro scale tribological evaluation in a variety of test conditions.

Application

- Evaluation of wear resistance of bio-materials
- Wear and Friction properties of thin films and coatings .
- Tribological tests on polymers, soft materials and coatings in lubricated, lubricated and corrosive conditions.
- Determination of working load limit of soft coatings like PTFE and other polymers.
- Product development and quality control of surface engineered products

Test Variables

Pin-ball diameter
Disc diameter
Disc rotation speed
Normal load

Standard

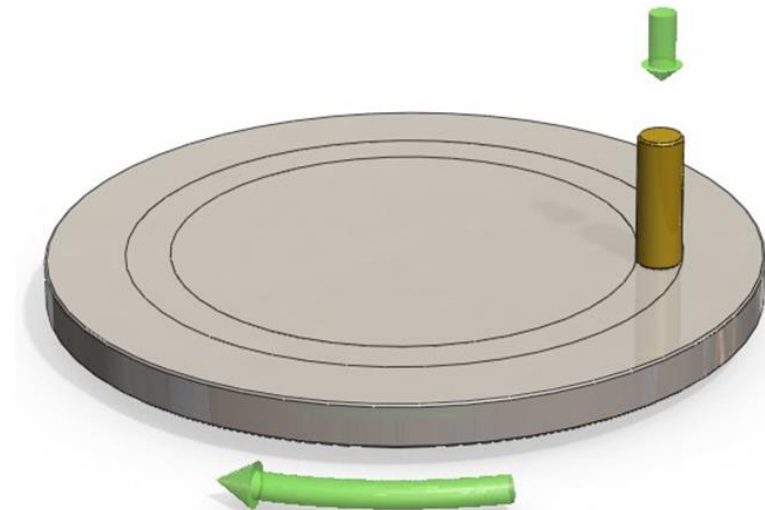
ASTM G99

Macro PoD

With the advent of new applications and technologies like automotive, advanced lubricants, new materials and composites, traditional tribometers and measurements technologies no longer sufficed. The Ducom Macro PoD® Tribometer has been developed as a modular test system capable of conducting tribological tests for tribological evaluation in a variety of test conditions.

Application

- Evaluation of wear resistance of bio-materials and coatings.
- Wear and Friction properties of bulk materials and composites .
- Tribological tests on polymers, soft materials and coatings in lubricated, un-lubricated and corrosive conditions.
- Product development and quality control of surface engineered products



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THANK YOU!