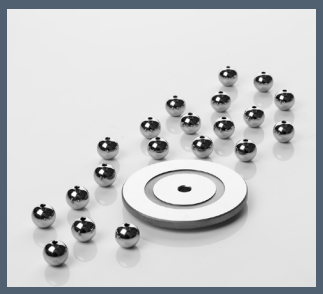
PCS Instruments

LEADERS IN TRIBOLOGY TEST EQUIPMENT

EHD



A fully automated, benchtop instrument, measuring lubricant film thickness down to 1nm in the elastohydrodynamic (EHD) lubricating regime.

precision

EHD Overview

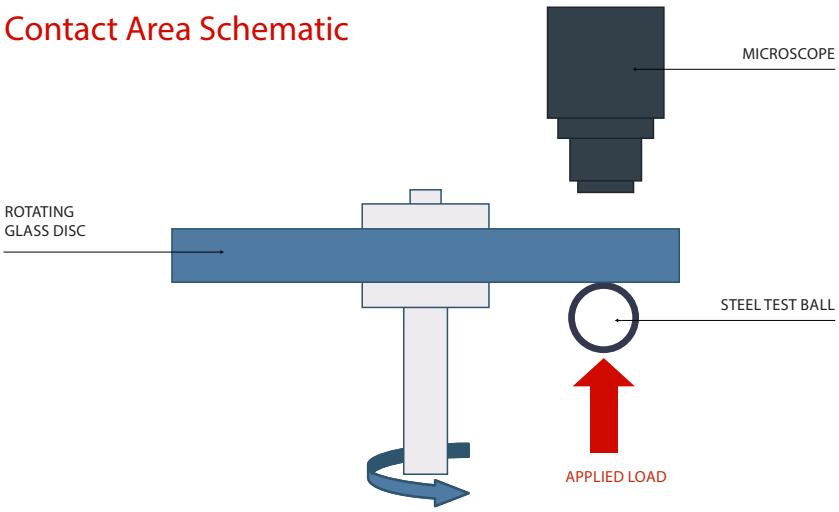
The EHD uses optical interferometry to measure the film forming properties of lubricants under a wide range of conditions, enabling researchers to optimise efficiency and durability.

Modern system designs have super finished contacting surfaces allowing them to operate with lubricant film thicknesses below 10 nm and the unique interferometry method used by the EHD enables accurate measurements down to 1 nm, far below the values possible with other measurement techniques.

The contact pressures and shear rates in the contact are similar to those found in many industrial applications. The ability to measure the film thickness in mixed rolling sliding contacts expands the EHD's research capabilities even further, making it the preferred choice for researchers studying the effect of additives in automotive lubricants, metalworking fluids, emulsions, turbine oils and greases.

In addition to film thickness measurements, traction coefficients can be measured at any slide/roll ratio from pure rolling up to 100% sliding.

Contact Area Schematic

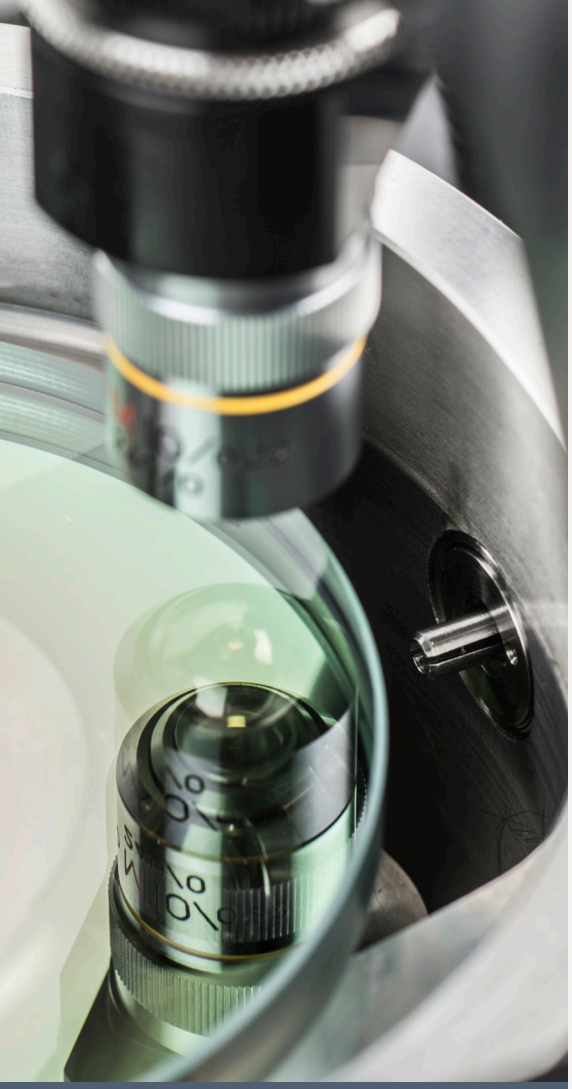


Principle

A steel ball is loaded against a rotating spacer layer disc. The contact between the ball and disc is illuminated by a white light source directed down a microscope through the disc on to the contact. Part of the light is reflected from the Cr layer and part travels through the SiO2 layer and fluid film and is reflected back from the steel ball. Recombining the two light paths forms an interference image which is passed into a spectrometer and high-resolution monochrome CCD camera. The camera image is captured by a video frame grabber and analysed by the control software to determine the film thickness.

Applications

- OEM lubricant specifications, e.g. DEXTRON ® automatic transmission fluid specification
- Additive development e.g. US patent 5962381 which describes the addition of high viscosity esters to increase low speed film thickness and reduce friction
- Evaluation of low viscosity lubricants formulated for the e-mobility era
- Measurement and qualification of emulsion film thickness including starvation and breakdown studies under severe conditions
- Film forming properties of water based "superlubricity" fluids
- Dispersion, stability and morphology of nanoparticle additives



Specimens

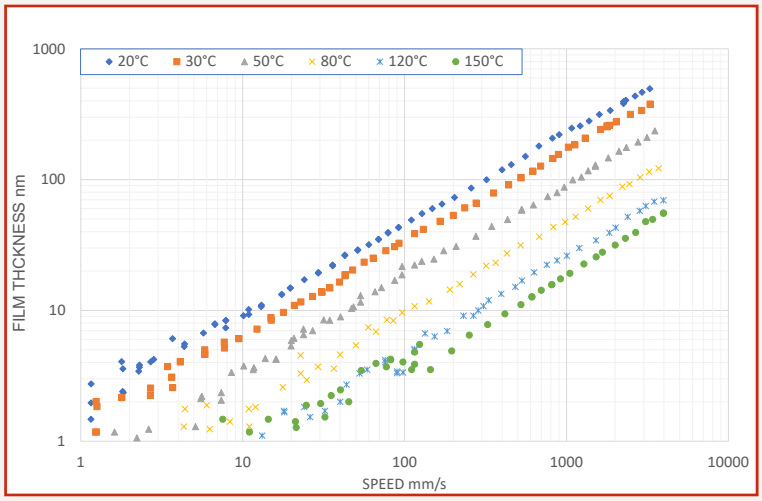
The ¾" diameter plain standard ball is made from carbon chrome steel and has a high-grade surface finish to ensure good reflectivity. The standard glass disc is coated with a semi reflective layer of chromium and approximately 550 nm of silica. A drilled ball can be used which can be driven during the test at a set slide/roll ratio. While the ball must be reflective, it can be made from different materials. In the past we have supplied tungsten carbide balls (both plain or drilled) and sapphire discs to enable contact pressures up to 3GPa.

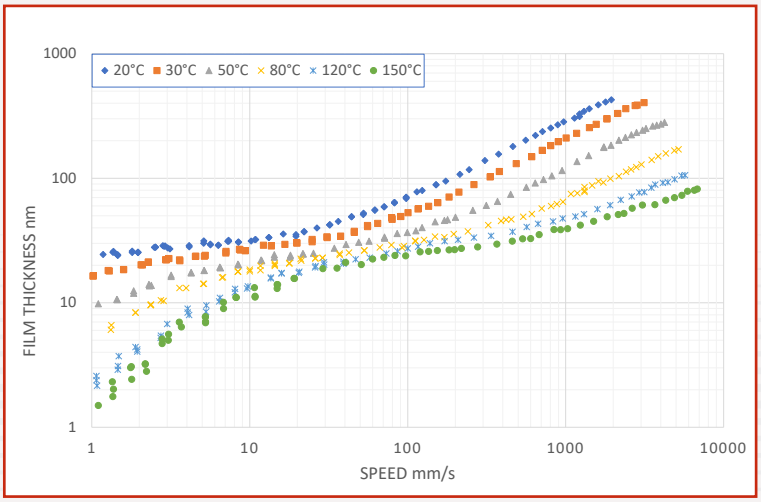
Features and Benefits

- Fully automated, easy to calibrate and intuitive software programs, improves repeatability, and reduces training needs
- Precision components enable accurate measurements down to 1nm
- Two independently driven motors allow any slide/roll ratio to be entered, enabling many applications to be replicated
- Temperature controlled test chamber further expands testing capabilities
- Compact, ergonomic design minimises the required lab space
- Small sample volume, saving on cleaning time, sample wastage and running costs

Film Thickness Data

Award winning research carried out using the EHD rig led to the development of ashless polymeric friction modifiers (e.g. patent WO045389A1). The polar polymer segment of such additives adsorb onto the contacting surfaces, while the non-polar tail reaches into the adjacent lubricant to form a thin fluid layer of enhanced viscosity. The results shown below compares the EHD film thickness measurements made on a pure base oil (top) to that of the same oil containing a polymeric additive (bottom). This clearly demonstrates how the additive layer acts in a quasi-hydrodynamic fashion to maintain separation of the rubbing surfaces in the low speed region.



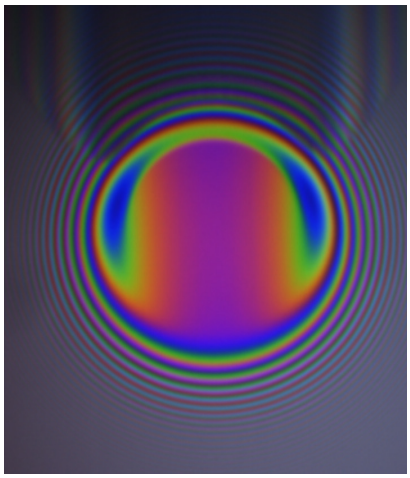


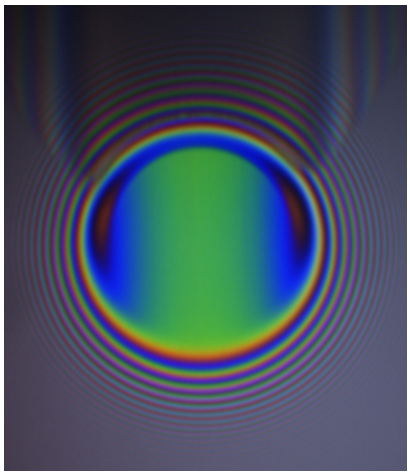
EHD

Option: Spacer Layer Imaging Method (SLIM)

Instead of using a spectrometer to determine the wavelength of the light returned from the image of the EHL contact, the innovative Spacer Layer Imaging Method - or SLIM - uses a high resolution, RGB colour camera to grab an image of the whole contact.

Developed by PCS, the SLIM software uses a previously determined colour space calibration to match the colours in the image to oil film thicknesses. The system can produce a film thickness map of the whole EHL contact in only a few seconds, making it a unique and easy-to-use tool for examining conditions such as parched or starved lubrication, grease lubrication, and rough surface EHL.





SLIM Software

The control software for the SLIM system allows the user to conduct a test on the EHD system and acquire images of the contact under user-defined test conditions.

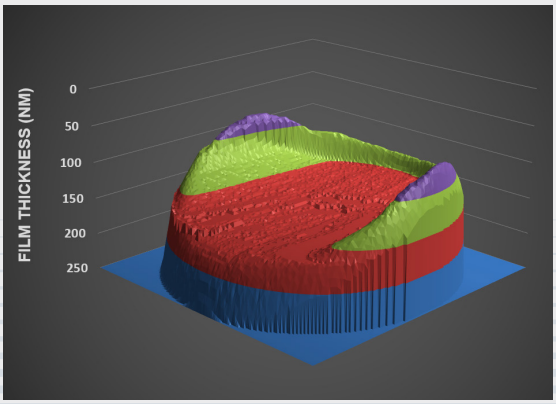
Once the test is completed, the images are analysed using a stand-alone analysis program. The analysis program matches colours in the image to the calibration data supplied with the instrument to determine the film thickness at every point in the image up to a maximum film thickness of approximately 250nm. This allows the user to generate a complete film thickness map of the contact area or point and line measurements of a specific area of interest. The analysis program writes out the film thickness data as a text file, which can then be loaded into a suitable graphical spreadsheet package.

Pressure Viscosity Coefficient

The pressure viscosity coefficient is a fundamental fluid property which controls the lubricant film thickness in an EHD contact. Although it is possible to measure the pressure viscosity coefficient of a lubricant using high pressure viscometry, this can be both difficult and time consuming. A simpler method is to calculate a representative value by measuring the EHD film thickness and then determining the effective pressure viscosity coefficient using a known reference oil. The EHD2 can perform this method according to the SAE ARP 6157 standard.

The AVA program is a software tool which automates EHD2 test profile generation and subsequent data analysis, as well as managing the calibration of the software using an EHD2 instrument and a well-defined reference fluid, available from PCS Instruments. This eliminates the need for any manual calculation or user intervention, greatly simplifying the process.

EHD SLIM 3D film thickness measurement



EHD Accessories

To further expand the capabilities of the EHD, we have developed a range of additional accessories, some of the most popular acessories are shown below.
All accessories can be easily retrofitted to the instrument.

Spherical Roller Carriage

The spherical roller produces an elliptical contact and can be used to generate a lower contact pressure for the same applied load. To ensure that pure rolling is maintained, the ball motor is used to drive the roller.

Grease Scoop

The optional grease scoop consists of a PTFE block supported in a stainless steel pillar that is attached to the ball carriage. The PTFE block has a channel which guides the grease into the contact, ensuring a constant supply of grease through the test.

Cooler

An optional cooler can be connected which circulates silicone cooling oil through the cooling ports in the pot. This allows for a quicker turn-around of tests. The EHD2 cooler comes with an associated switch-box, that automatically switches on at the end of a test and cools the pot down to a pre-defined temperature.

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Technical Specification

The EHD system comprises separate electronic control and mechanical units and a PC with custom control software.

TEST PARAMETERS	
Film Thickness	2 to 1000 nm
Load	2 to 50 N
Contact Pressure	0.24 to 0.7 GPa (Steel ball on glass disc) 0.66 to 2.0 GPa (Tungsten carbide ball on sapphire disc) 0.38 to 1.1 GPa (Steel on steel contact)
Speeds	1 mm/s to 4 m/s
Temperature Range	Ambient to 150 °C
Test Sample Volume	120 ml

CONTROL SYSTEM	
PC	Custom software running on Microsoft Windows
Safety Checks	Dual platinum RTDs for temperature measurement, Emergency stop on front cover
Power Supply	100-240V, 50 / 60 Hz, 750 VA

DIMENSIONS & WEIGHT	
Weight	(Mechanical Unit) 47 kg (Electronics Unit) 17 kg
Size (h x w x d)	(Mechanical Unit) 750mm/30in x 1100mm/43in x 350mm/14in (Electronics Unit) 440mm/17in x 230mm/9in x 500mm/20in

Industries

For further information or a demo,
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