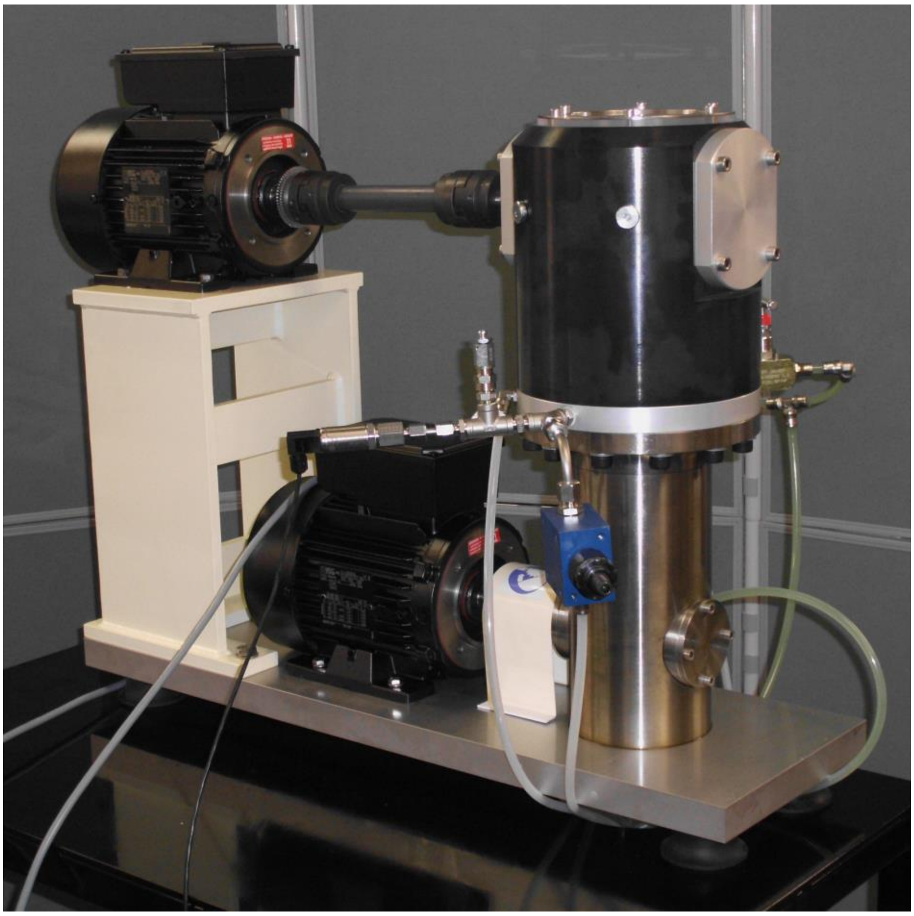
TRIBOLOGY UPDATE: *ISSUE 34 –September 2017*

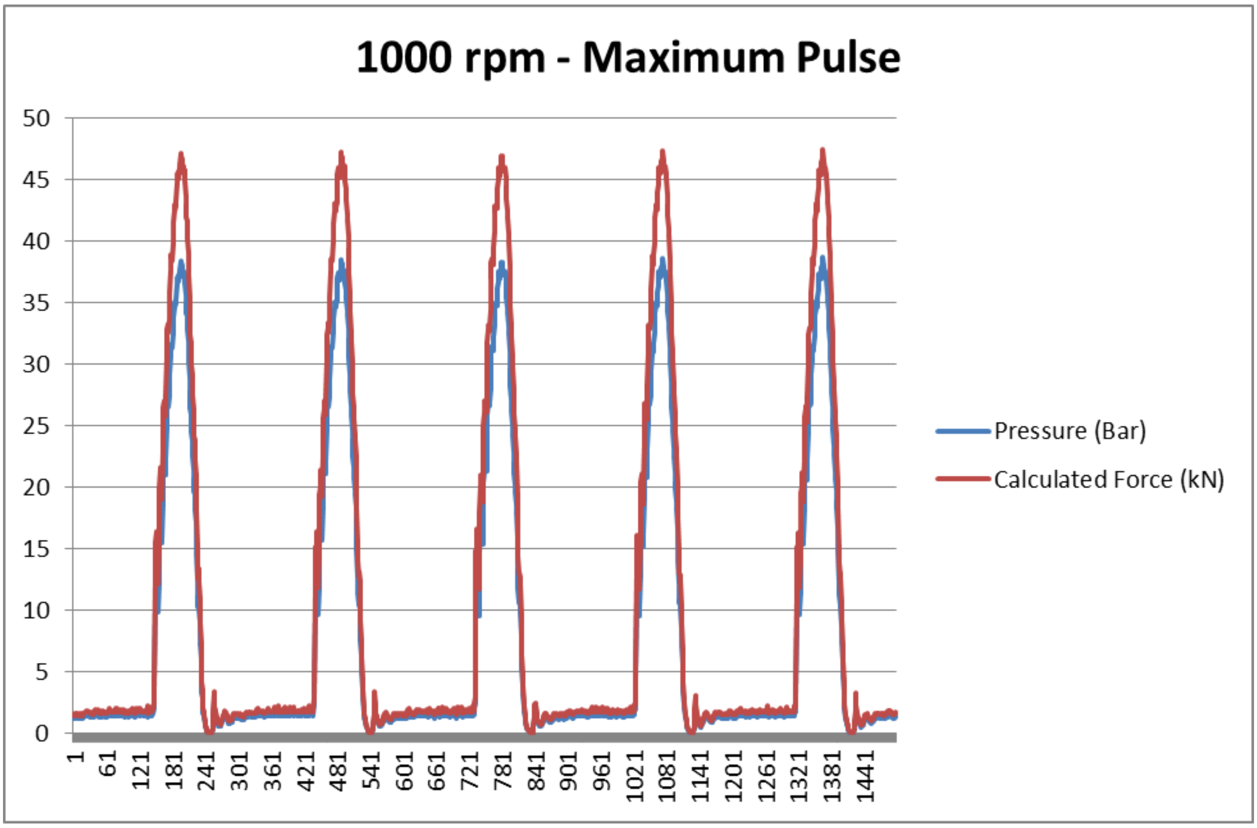
This is the latest issue of our **Tribology Update** newsletter. The last year has been exceptionally busy for us, so we have a lot to report. For further information, we can be contacted by e-mail at ***info@phoenix-tribology.com***.

WORK IN PROGRESS – PRODUCT DEVELOPMENT

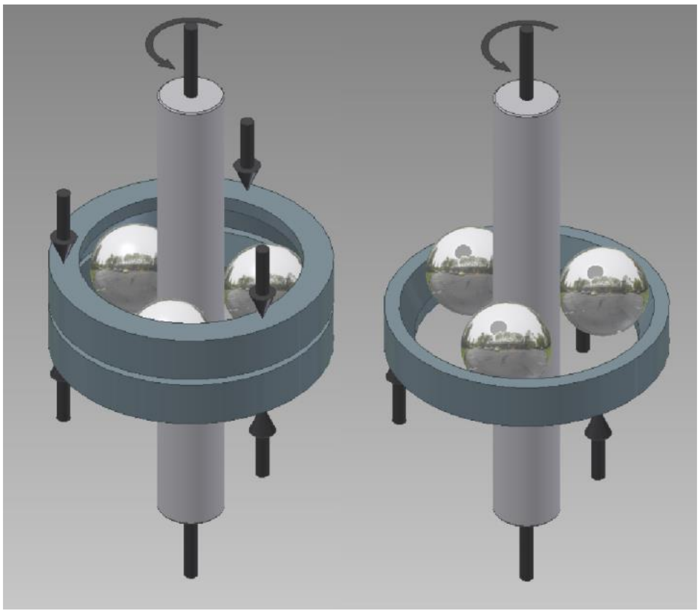
Pulse Actuator Bearing Fatigue Rig



The prototype pulse actuator bearing fatigue rig is now under test. The theoretical force generated by the current actuator, which has a diameter of 125 mm, is 1227 N per bar. The current unit produces a peak force of approximately 47 kN. The design is fully scalable and can be adapted for testing both plain and rolling element bearings. Click on the link to view the YouTube video.



Ball on Rod Adapter



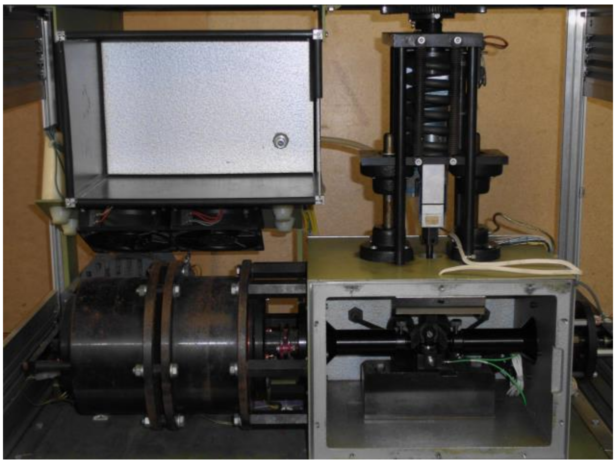
We are developing a ball on rod rolling contact fatigue adapter for use with the TE 92 and RCF 2 test machines. We may also offer the adapter as part of a free-standing test machine.

UPGRADES – NON-PHOENIX PRODUCTS

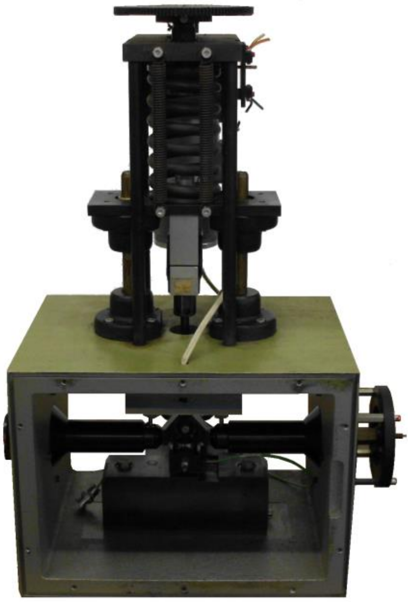
In addition to upgrade packages for Falex block on ring and CSM pin on disc machines, we are now producing upgrade packages for other well-known tribometers.

Reciprocating Tribometer Upgrade

There are numerous ASTM standard tests using a ball on flat test configuration and a fixed stroke of either 1 or 2 mm, using a well know, electro-magnetic oscillator driven, reciprocating tribometer. We are not permitted to mention it by name! We have been given the task of producing an upgrade package for this machine.



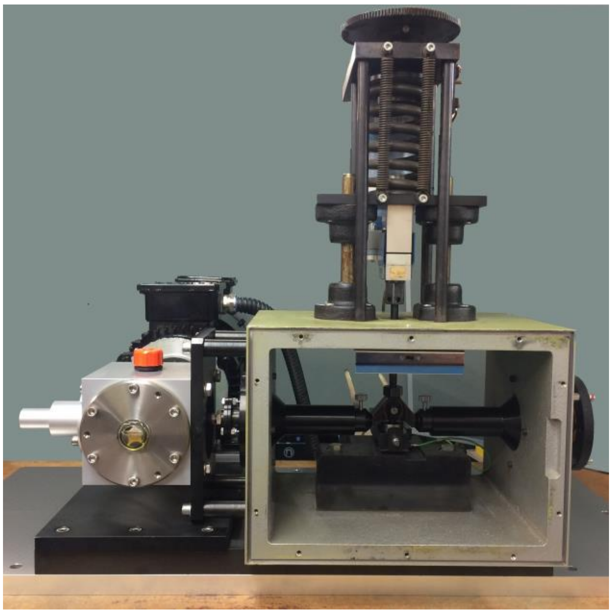
We decided that it did not make sense to attempt to re-use or replace the expensive and very heavy electro-magnetic drive system and that the right solution was to replace this with a simple, low cost, fixed stroke, motor driven reciprocating drive.



The guts of the machine comprises a test enclosure in which is mounted the heated, fixed specimen assembly. The fixed specimen is mounted on a standard Kistler 3-axis piezo transducer, of which only one measuring axis is used, this to measure friction. The loading system incorporates a spring and screw actuator mechanism driven by a standard servo motor and incorporating a standard Interface strain gauge force transducer, for load feedback.

After removing the side panels, this assembly can be removed by disconnecting the electro-magnetic drive and releasing four bolts on the underside of the machine. Wires are cut through to release the assembly.

The motor and scotch yoke drive assembly, which incorporates a magneto-inductive position sensor, can then be connected, the machine re-wired and connected to standard TE 77 High Frequency Friction Machine hardware and software.

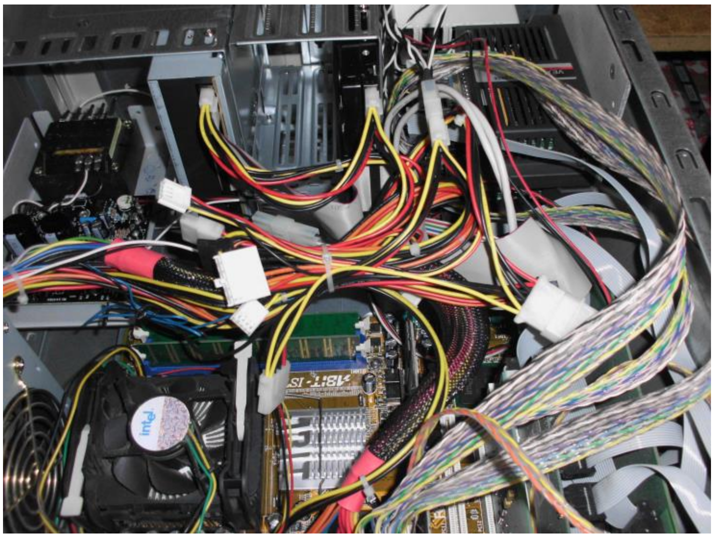


CETR UMT Rig Upgrade

We have another upgrade contract in hand, this time a CETR UMT unit, for which product support is no longer available. In addition to restoring the unit to a serviceable and maintainable condition, we have also been asked to design and make a new reciprocating adapter.

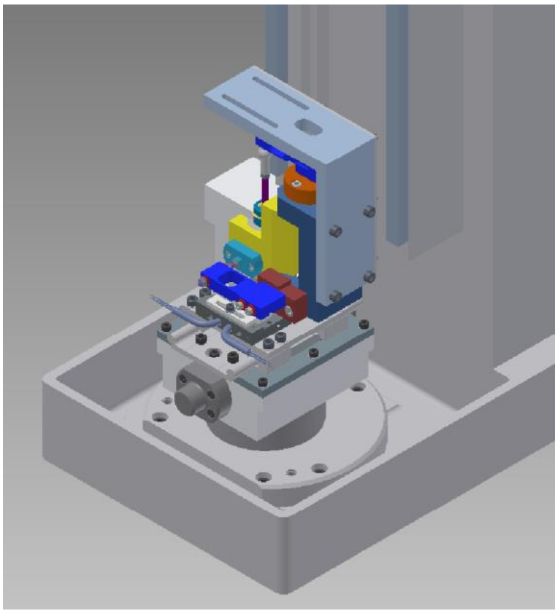
Stripped down to the bare essentials, the machine comprises a standard servo motor for driving the test adapter and two linear slides, with stepper motors, one on a vertical axis for applying the load and one on a horizontal axis for positioning the upper specimen. The drive for the servo motor is mounted on the machine and the drives for the steeper motors are very curiously mounted in the PC.

This latter arrangement makes it impossible to upgrade the PC and also mixes signal and power level electronics, which does not seem to be a good idea. We decided that the only solution was to replace the existing drives with new drives, mounted in a separate power cabinet.

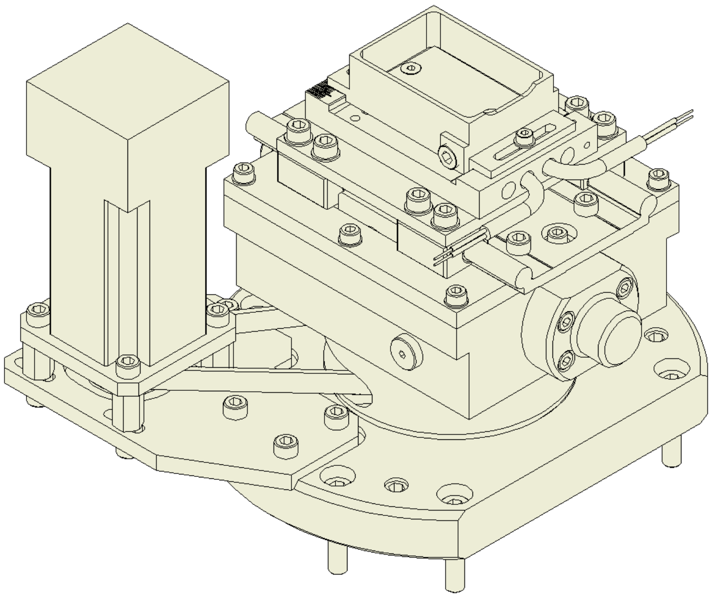


We next turned our attention to the load and friction measuring transducer and, despite seeking expert advice from a transducer manufacturer, could not work out how CETR were compensating from crosstalk between the measuring axes.

The manual stated: “All sensors are factory calibrated, and an option file containing the calibrated values is created for each sensor. If that file is lost or corrupted the following methods may be used to restore the file”. Without access to the original calibration and with little confidence in the calibration method described in the manual, we came to the conclusion that the only way we could complete the contract was to use one of our own load and friction measuring test assemblies in which the axes are mechanically isolated, thus eliminating the issue of crosstalk.



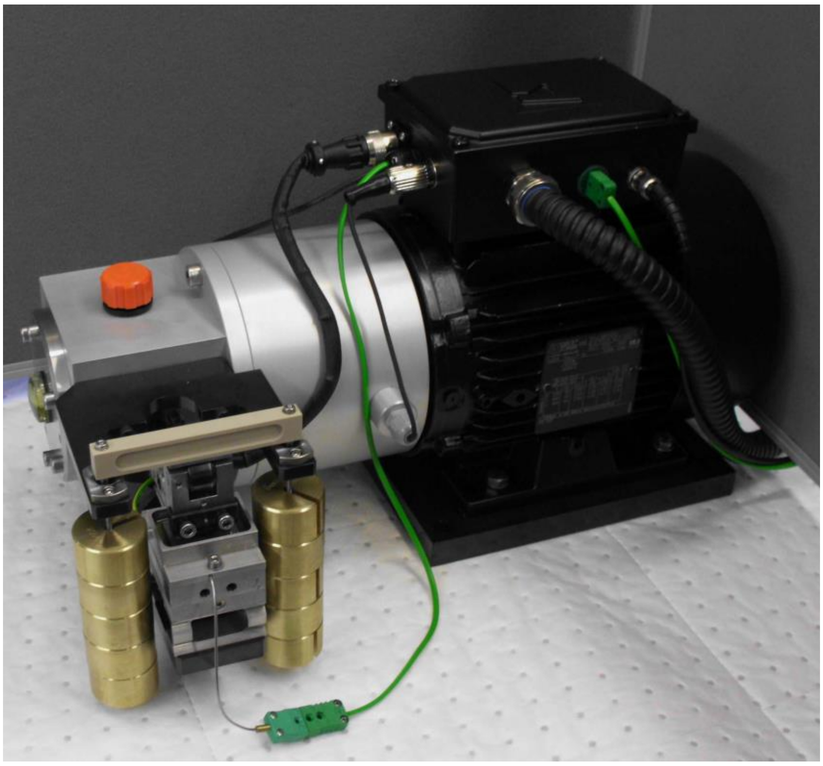
The new reciprocating drive assembly uses the same scotch yoke cam system as on the standard TE 77 High Frequency Friction Machine, a drive system with proven longevity.



The control and data acquisition system is our standard COMPEND 2000 software and hardware package.

WORK IN PROGRESS – IN PRODUCTION

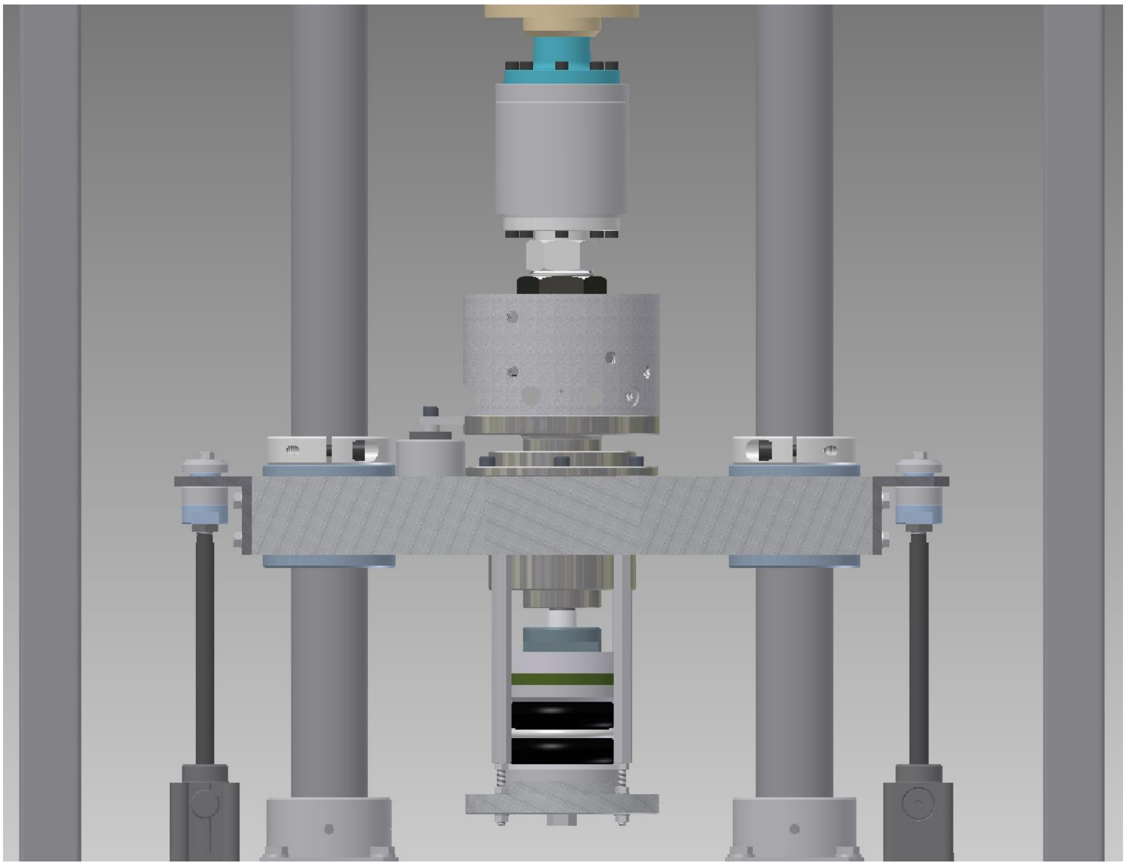
TE 81 Modified Fuel Lubricity Tester



We are currently assembling a modified fuel lubricity tester, designed to run at higher loads and longer strokes than those specified in the diesel fuel lubricity test standard, allowing tests to be performed with a sliding line contact as opposed to a less sensitive sliding point contact. Key specifications are:

- Load: 2 to 20 N
- Stroke: 1 to 5 mm
- Temperature: ambient to 100 C
- Frequency: 5 to 25 Hz (depending on stroke)

TE 95 Precision Thrust Washer Rig for Low Temperature Tests



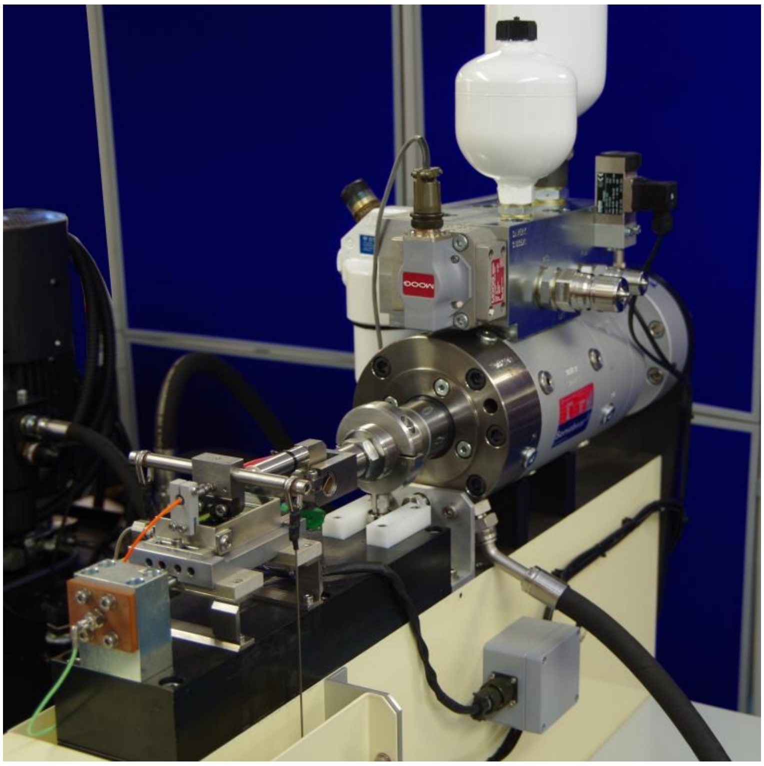
Having successfully developed a chilled test assembly for the TE 77 High Frequency Friction Machine, rated to – 50 C, we are now in the process of using the same refrigerant probe technology to allow similar low temperatures to be achieved, on a rotary tribometer. This is more challenging than on a reciprocating tribometer, if one sticks with a conventional torque reaction mounted lower specimen arrangement; it is impossible to prevent the refrigerant probe tube from interfering with both the applied load and friction torque measurement. The only sensible solution is to move the location of friction torque and load measurement to the upper, rotating, specimen.

In this new design, the upper rotating specimen is mounted on a rotating, two axis transducer, with an axial force measurement range of 1 kN and a torque measurement range of 10 Nm. The transducer can be used with any axisymmetric specimen configuration, so thrust washer, three pin on disc, sliding and rolling four ball etc.

In addition to the 1 kN – 10 Nm transducer, we can also provide a 10 kN – 50 Nm unit, for higher capacity applications.

WORK COMPLETED

DN 44 Dry & Lubricated Reciprocating Sliding & Fretting Machine



We have updated the design of the DN 44 to incorporate a new hydrostatic bearing servo hydraulic actuator and to replace the manual loading system with servo controlled loading.

TE 72S Traversing Roller on Drum Adapter

The traversing roller on drum adapter is now in service. Click on the link to view the YouTube video.

TE 47 - Recent Publications

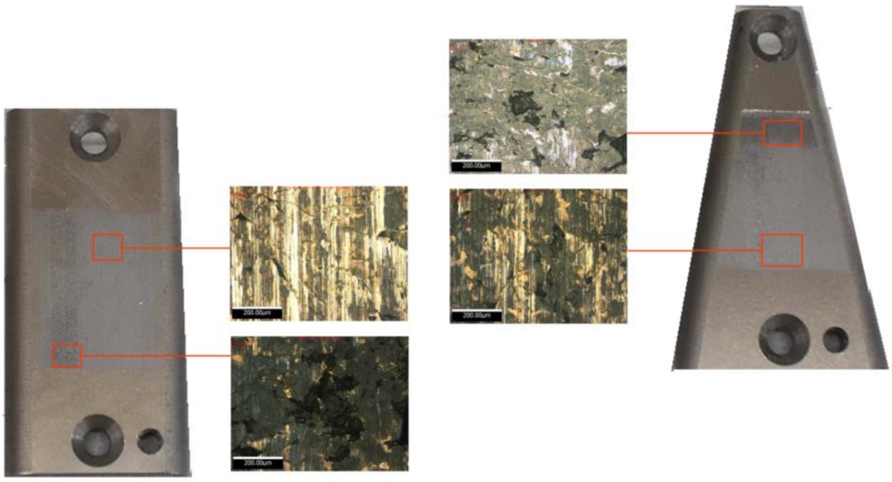
Development of a test method for a realistic, single parameter-dependent analysis of piston ring versus cylinder liner contacts with a rotational tribometer
J Biberger, HJ Füßer - Tribology International, 2017

Near-surface and depth-dependent residual stress evolution in a piston ring hard chrome coating induced by sliding wear and friction
J Biberger, HJ Füßer, M Klaus, C Genzel - Wear, 2017

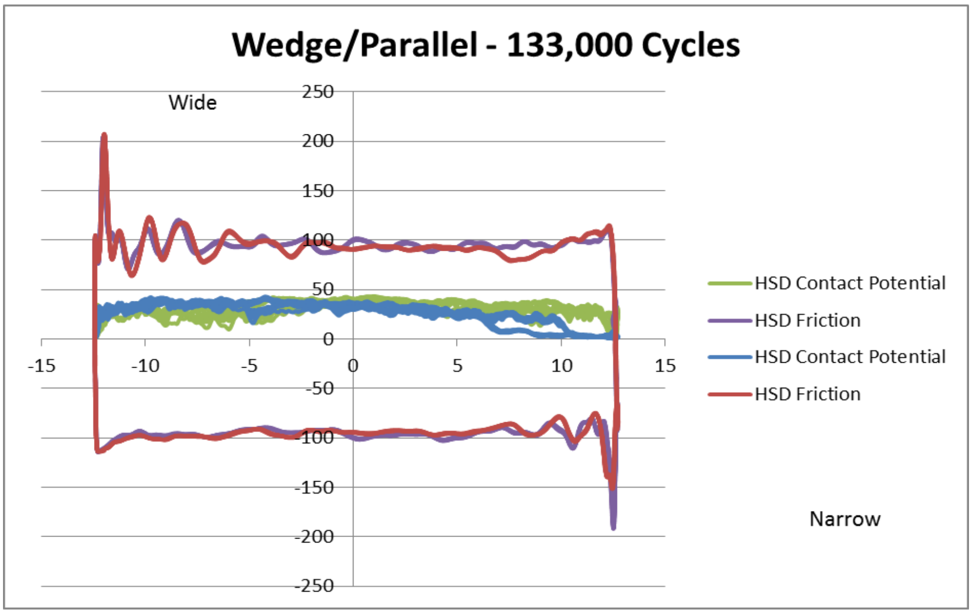
TE 77 – Recent Experiments

Parallel/wedge curved edge specimens

We presented results at STLE 2017 from tests run on curved edge specimens with both parallel and tapered profiles. With the latter, contact pressure varies with stroke position.

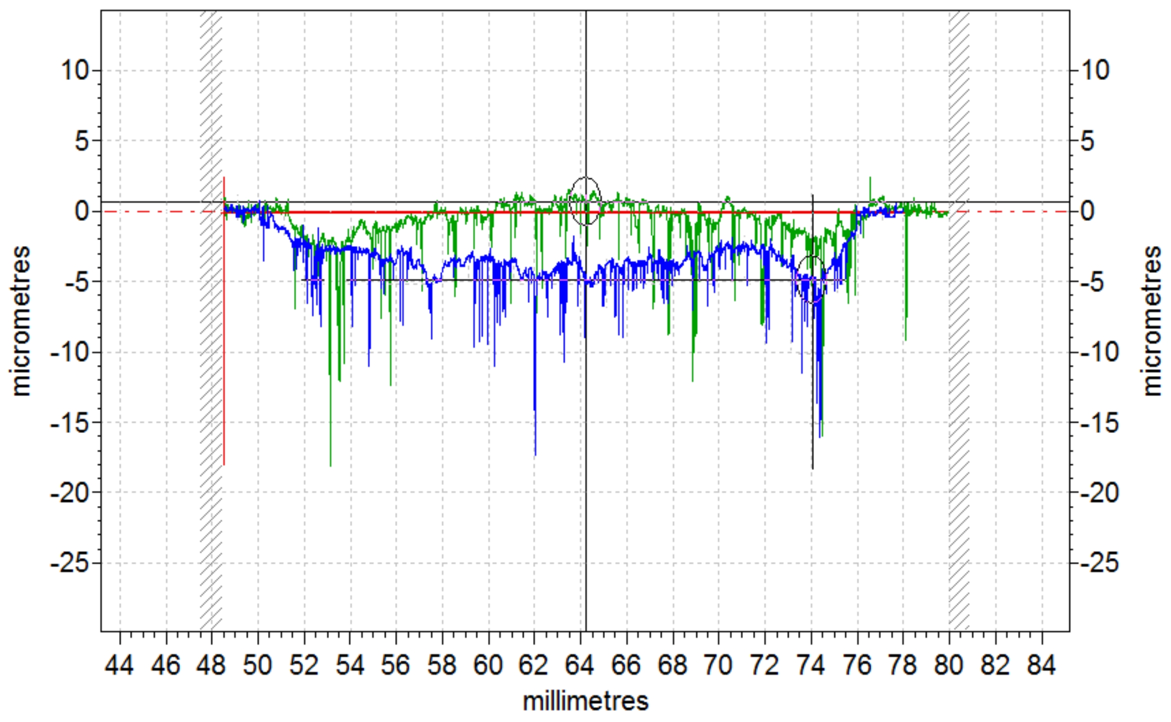


One of the interesting features of these experiments is that they successfully demonstrate the lack of connection between friction and wear. Furthermore, they demonstrate that with these particular experiments, friction is independent of apparent area of contact, the friction being independent of contact width.



Green/Purple: Parallel – Blue/Red: Wedge

Axial surface profilometry shows that with the parallel samples, wear is a maximum at stroke ends and a minimum a mid-stroke. With the wedge specimens, the overall wear is greater and is indeed greatest at the narrower end of the wedge.



Green: Parallel – Blue: Wedge

With a curved edge wedge specimen it is possible:

- to generate different wear regimes at either end of the specimen, hence providing more information from a single test run
- to produce mild and severe adhesive wear, while running under conditions of steady load and temperature, in other words, without resorting to the application of ramped loads or temperatures

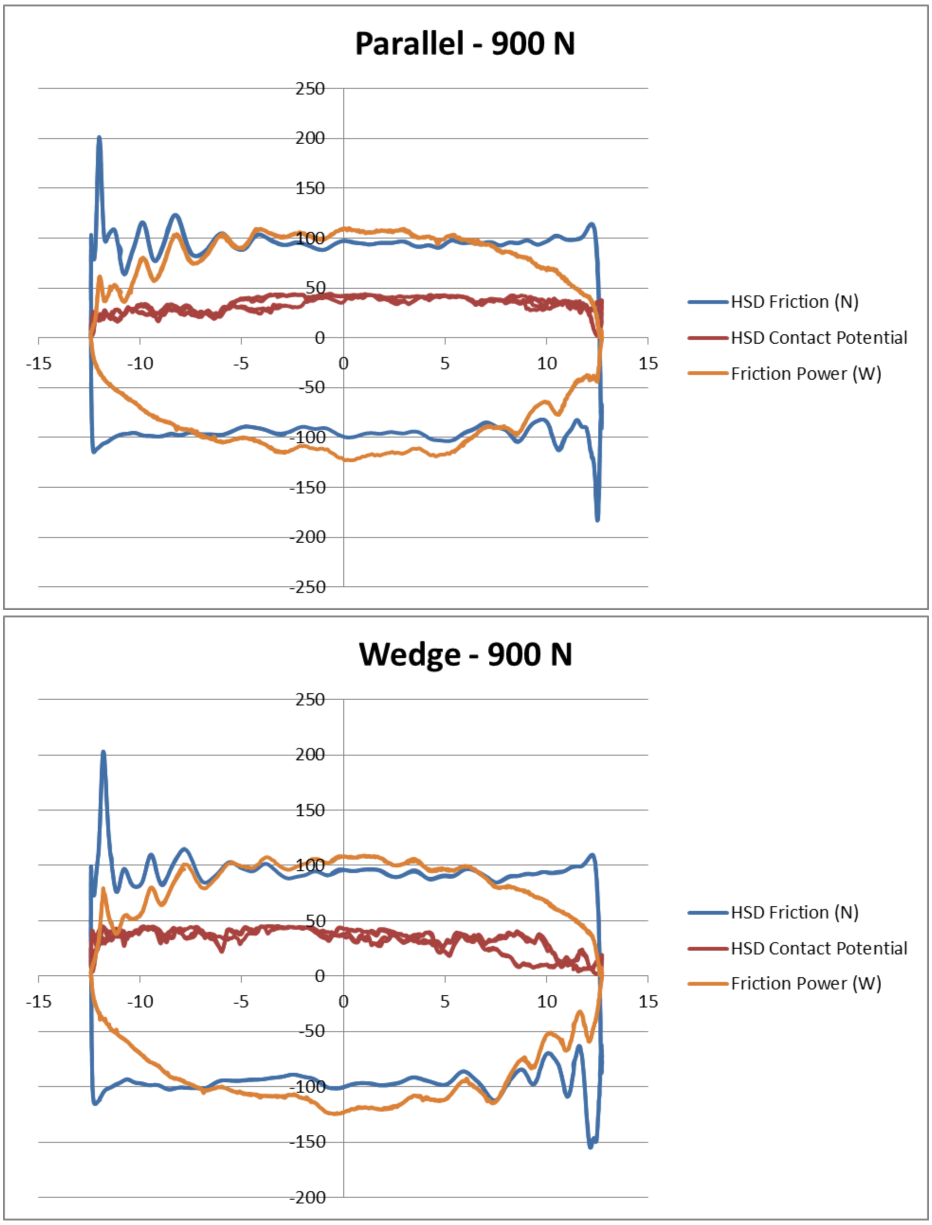
Friction Power

The instantaneous friction power can be calculated by multiplying the instantaneous friction by the corresponding sliding speed. To do this, the instantaneous speed must be calculated from the stroke displacement measurement. Because the displacement data is digital, a sliding average must be applied to the data before dividing by the corresponding time interval.

Calculating the instantaneous friction power for selected data from the parallel/wedge series of experiments illustrates some fairly obvious points:

- At the beginning of the stroke, friction power increases as velocity increases, with perturbations caused by local frictional events.

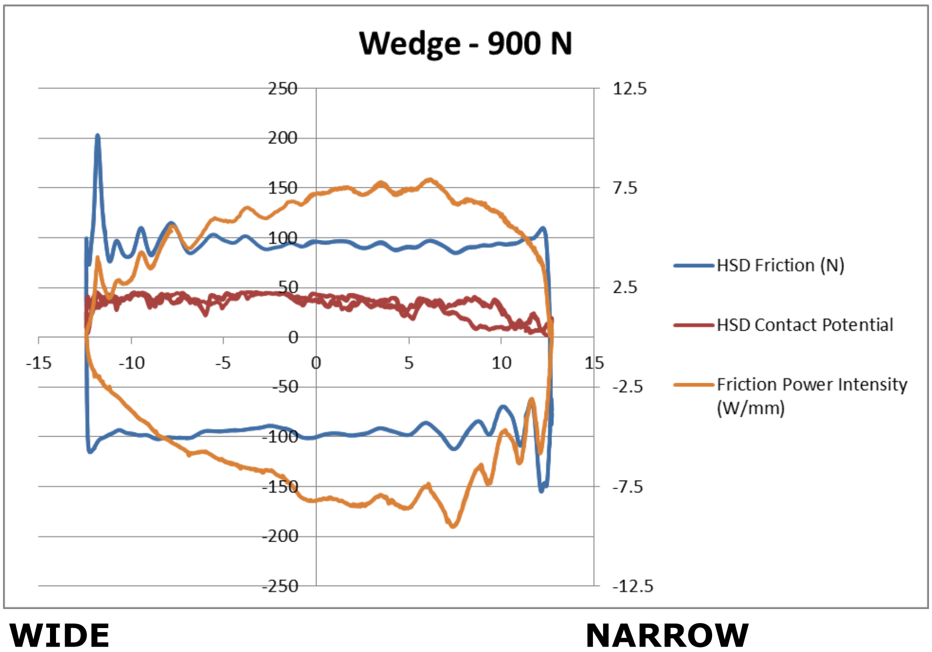
- The friction power reaches a maximum at mid-stroke, where the velocity is a maximum.
- The friction power falls smoothly at the end of the stroke, as a result of decreasing speed, combined with established smooth sliding.



WIDE **NARROW**

This perhaps provides further explanation as to why scuffing does not start at stroke end, but at stroke beginning.

With the wedge sample, we can perform a second calculation, by dividing the instantaneous friction power by the contact width. If we asume that the contact length does not vary, just the width, then we can derive an equivalent to instantaneous friction power intensity.



The resulting friction power per unit width is naturally skewed towards the narrow end of the wedge sample for both directions of motion.

TE 77 - Recent Publications

Tribological behaviour of an electrochemical jet machined textured Al-Si automotive cylinder liner material
JC Walker, TJ Kamps, JW Lam, J Mitchell-Smith… - Wear, 2017

Scuffing mechanisms of EN-GJS 400-15 spheroidal graphite cast iron against a 52100 bearing steel in a PAO lubricated reciprocating contact
TJ Kamps, JC Walker, RJ Wood, PM Lee, AG Plint - Wear, 2017

In-situ stylus profilometer for a high frequency reciprocating tribometer
TJA Kamps, J Walker, AG Plint - Surface Topography: Metrology and Properties, 2017

Shock absorber test

Dirk Drees at Falex Tribology NV has made a useful adapter for the TE 77 for testing shock absorbers. Click on the link above to watch his video.

OTHER NEWS

Timothy Kamps

In July, our sponsored PhD student at nCATS submitted his PhD thesis under the title: "Development of Detection Techniques for Investigating Scuffing Mechanisms of Automotive Diesel Cast Irons".

Cambridge Tribology Course 2018

The 26th Cambridge Tribology Course will take place from Monday 10th to Wednesday 12th September 2018.

George Plint and David Harris

Phoenix Tribology Ltd