

2017

MICROTEST

MT Series Pin-on-Disk Tribometers Wear and Friction Testing Systems



MT PIN-ON-DISK- TRIBOMETERS

The control of friction and wear in moving parts of machines is a critical issue to face in the industry. It is important to have comparable data of analyses obtained during years, with variable humidity and temperature and/or in the presence of lubricants. The fields of application of these tests are, among others:

- ➔ New materials (ceramic, metals, polymers)
- ➔ Lubricants and oil additives in auto-lubricating systems
- ➔ Quality assurance

The most common asymmetric test rigs employ a pin or a ball pressed against a disk on the flat surface of the disk (pin-on-disk, ball-on-disk). The pin-on-disk tribometer serves for the investigation and simulation of friction and wear processes under sliding conditions. It can be operated for solid friction without lubrication and for boundary lubrication with liquid lubricants. Thus both material and lubricant tests can be executed.

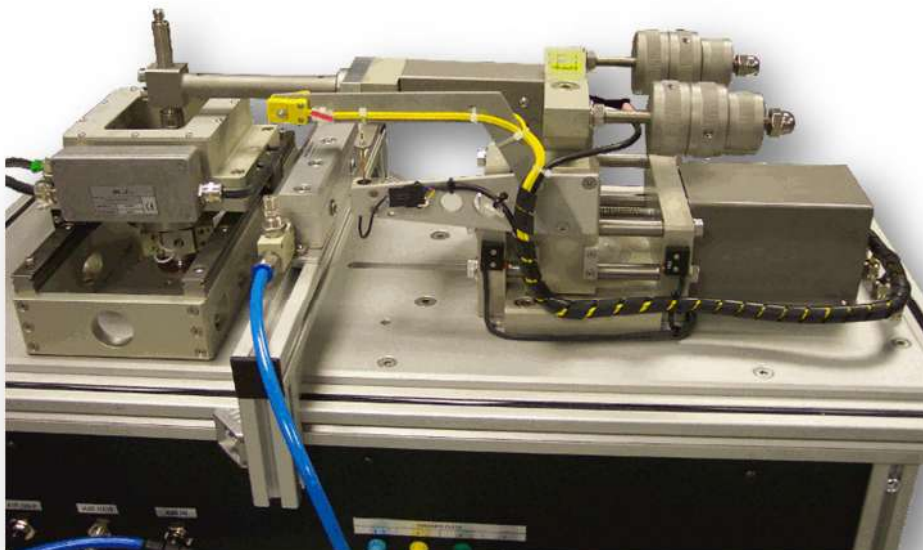
According to the standard test (ASTM G99) principle a stationary test specimen (pin or ball) with a defined normal force is pressed against the surface of another test specimen placed on the rotary disk.

The normal force is applied over the pin or ball by means of a set of dead weights between 0 N and 200 N (other ranges under demand). This way of application allows a stable force during the test.

The friction coefficient (μ) is determined during the test by measuring the friction force by means of the deflection of the elastic arm (strain gages bonded on the elastic body of the arm convert it in a force sensor and allow the direct measurement of the frictional force).

GENERAL FEATURES

- ➔ Normal force, temperature, wear rate, frictional coefficient, number of turns, speed and other parameters are, firstly, registered and then real time displayed
- ➔ Rotational speed from 0 to 2000 rpm (or even higher upon request)
- ➔ Controlled atmosphere tests by means of polycarbonate coffin (Makrolon®). Its mechanical characteristics assures protection against hazard debris during the test
- ➔ 16 bit measurement resolution
- ➔ Wear measurement thanks to capacitive sensor
- ➔ 32-bit angular position measurement resolution (encoder)
- ➔ Temperature acquisition measure in different point (placed by the user) by means of K-type thermocouples
- ➔ High stiffness force transducer
- ➔ Versatile and powerful test sequence configurator. Automate your own sequence!





PID CONTROLLER

MT equipment for tribological tests, has the chance of controlling under different target's variables (vertical force, displacement, number of cycles) by means of a servo controlled PID (proportional - integral - derivative)

SOFTWARE

Set of special developed software for proper control, execution and accurate analysis related with tests produced by test equipment MT.

This set of programs enables fully customized software by the user for the former test, for further data analysis and for subsequent report generation.

Even more, that software, integrates all device management (camera, optical microscope, sensors, engines...) in the same environment.

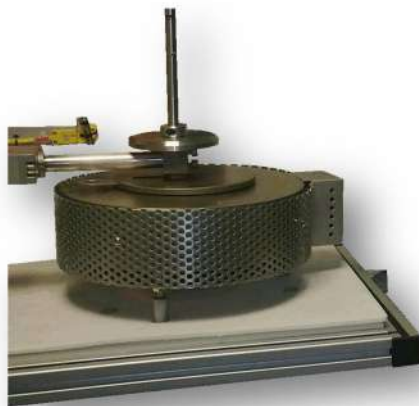
OPTIONAL MODULES

Test equipment MT is suitable to be attached with different purpose modules such as high and medium temperature (furnace), temperature thermocouples, lubrication set, reciprocating or different dead weights ranges out of values by default.

High Temperature Module

High temperature tests through ceramic furnace (600 - 800 °C). High temperature furnace includes:

- ➔ Resistor furnace specially adapted for test equipment MT
- ➔ Automatic temperature control from specific software upgrade. Or manually controlled directly from the interface



- ➔ Measures by means of thermocouple type K placed inside the furnace at test's area
- ➔ Tribometer critical components are manufactured in heat resistant stainless steel. Outside cage works as protection against burns
- ➔ Thermal insulation in order to minimize heat transmission to tribometer inside

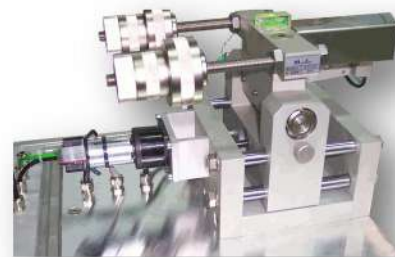
Furnace has been specially designed for easy mounting and dismounting operation allowing both high and room temperature tests.

Motorized Radius Module

By default radius selection is set by means of a manual micrometer. However motorized radius option allows adjusting and controlling the radius from the computer, even when tests are



on process. The specific features cover displacement speeds from 0 to 50 or 300 mm/min, that allows both the accurate contact point positioning and that displacement in order to tests under material without any groove, "new zone".



The movement is controlled closing loop by means of displacement measure and the optic sensor placed at the geared motor. The assembly includes the corresponding motor regulator and the mechanical and electronical adaptations required. Basic control and acquisition software suffers modifications in order to real time control between axis turning plate and frictional arm displacement. It does not carry out any incompatibility with extra options.



Lubrication Module

Proper lubrication is achieved by means of spray dispenser unit equipped with an oil tank impulse by air.

Pulverizer tip (270 mm) is flexible in order to facilitate the best possible installation. That



means directing it to the desired zone. Optionally (if user's installation does not provide



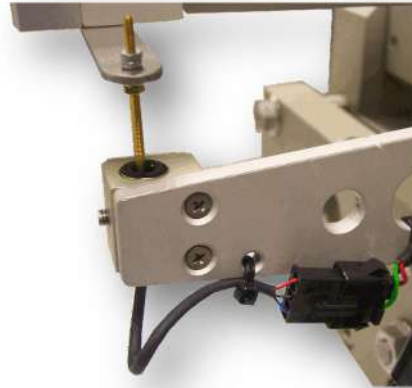
compressed air line to the tribometer) a compressor, geared motor and adequate filters are provided.

That interesting complement is suitable to be controlled from the same computer rest of tasks are commanded. It is also included a bracket with the aim of fixing the pulverizer with the tribometer. Dropping speed is regulated by means of a manual needle valve.

Finally specimen's holder tray shaped for tests under lubricated conditions is included. It is suitable to be coupled directly to tribometer plate.

Wear Module

This option adds capacitive displacement sensor attached at the tribometer arm carrier, for group specimen and ball or pin wears evaluation (as far as arm carrier's inclination is



increased).

Sensor total measurement range varies between 2 and 4 mm (sensor type SM200). It includes fitting-out electronic itself; with power supply and high level output connected directly to control and measurement tribometer system. For sure it includes attaching elements with the aim to fix it to the arm carrier, includes both the core and the coil.

Rotating Connector Module

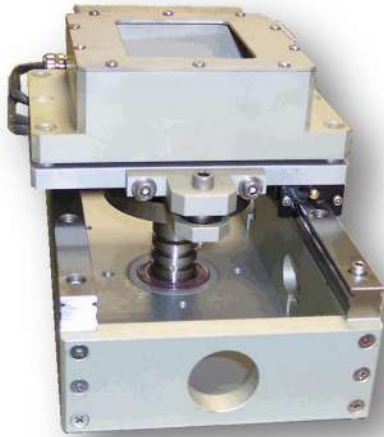
The incorporation of rotary electrical connectors¹ with mercury contacts (up to 1200 rpm) 430 four - terminals model, for carrying signals from turning plate to measurement system or transmit electric intensity. Less than 1 mΩ resistance.



¹ Connector rotational installation while manufacturer's process. Previous tribometer shipment

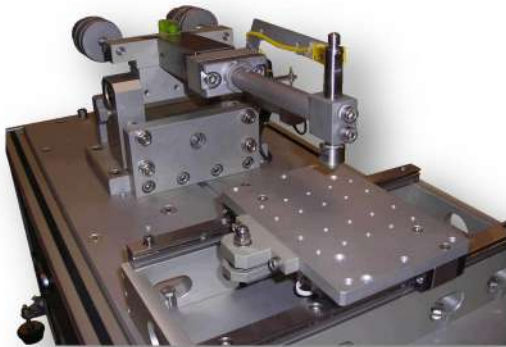
Linear Wear Module

Linear Wear option allows tribometer MT to reproduce linear movement typical from a high variety of real mechanisms. This option allows also the measurement of the friction force during the tests with different acquisition



options.

This technique ("reciprocating") results very useful for the study of frictional coefficient variation in time compared with frictional coefficient measured in pin-on-disk disposition. Most contact geometries are suitable to be simulated with tribometer MT including "pin-on-plate", "ball-on-plate" y "flat-on-plate"².



Even more, optionally, reciprocating module could be completed with a heater device for a wide temperature range.

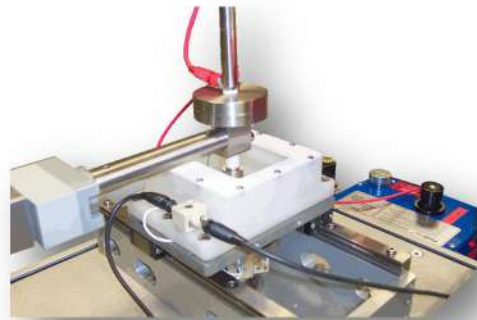
Linear speeds that are suitable to be achieved allow the user to test at ranges from 0 to 8-15 Hz (alternatively 40 Hz in high frequency version) with a set of different amplitudes up to 40 mm stepped in³ 5 mm or continuously variable.

²Other values upon request

Contact Resistance Module

With an automatic variable resolution to measure contact resistance from 10^{-4} to $10^8 \Omega$. This special option includes the following elements:

- ➔ Set of electronically isolated pin or ball holders.
- ➔ Measuring contact points connected by means of rotating connector previously installed³
- ➔ UB communication between software



- ➔ and measuring unit to allow resistance contact signal recording during tests. Multimeter Keithley 2100 with $6\frac{1}{2}$ digits for measuring contact resistance. Resistance range up to $10^8 \Omega$ (auto-range). Minimum resolution of 0.1 m Ω (at 100 m Ω range). This multimeter allows the user to measure other different electrical parameters⁴.



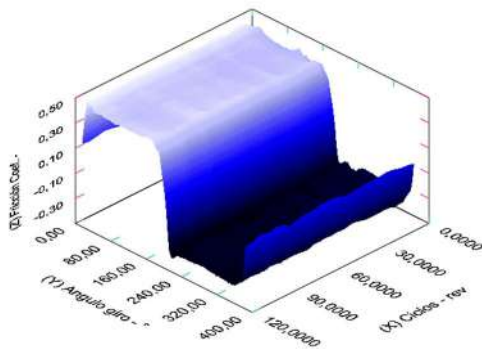
Triboscopic Module

This option allows the user the recording of an "image" of the results in 2D or 3D charts showing the evolution in the time of the measured values. This system includes multipoint cycle acquisition (for instance 360 points per cycle) at desired turning speed, e.g. 120 rpm, over full range of channels (frictional,

³ Rotative contact option

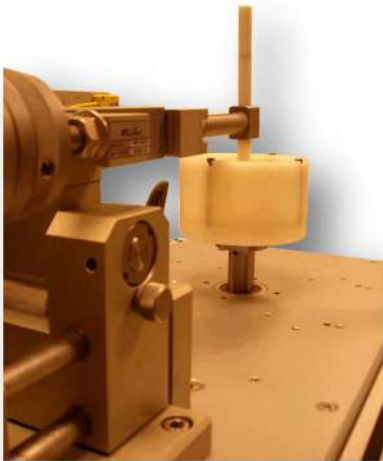
⁴ Just for room temperature. High temperatures under request

angular position, temperature, etc.) Sample rate of at least 1k sample/channel/s) That optional pack incorporates an extra high speed data acquisition card, and an optical sensor as "index" signal to properly synchronize the starting angular position and the trigger point for the beginning of each acquisition. The default software has been also modified to allow the recording of calculated channel during this type of recordings: frictional force, angular position, turning radius, etc., and also temperature, contact resistance, etc. if these options are installed.



Tribo-Corrosion Module ⁵

Tribo-corrosion set includes (over basic tribometer):

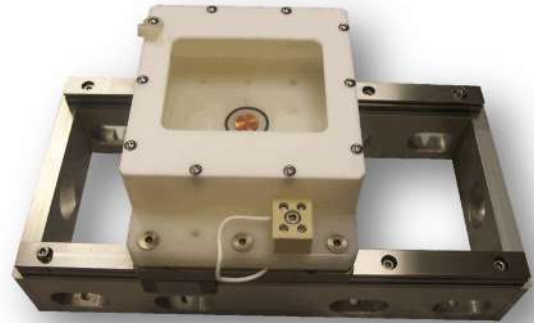


- ➔ Set of pin / ball housing electrically isolated
- ➔ Typical force ranges: from: 10 N (same final prize for 30 N capacity)
- ➔ Prolonged tribometer arm made of stainless steel ⁶

⁵ Maximum temperature 80 °C

⁶ Elements belong that option are not suitable to be used under high temperature conditions

- ➔ Sample plate made of polymeric material coupled to motor set: disc size (diameter 100 mm) for specimens from 60 to 80 mm diameter dimension (others under request). For thick specimen ranged between from 1 to 15 mm. Specimen's plate holder is modified to avoid metallic contact. It has the possibility to incorporate an electrode in contact with the specimen.



- ➔ Special "cup" made of PTFE and suitable seal in Viton for hosting corrosive liquid. Supplied with upper cover. The cup is assembled over the turning specimen's holder.
- ➔ Ball and pin holders are made of polymeric materials and electrically isolated (standard balls and pins range from 3 to 10-12 mm diameter, pin modified for an easy thermocouple incorporation (included))

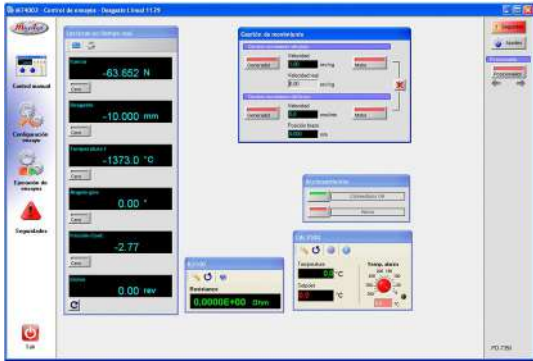


- ➔ This option incorporates a mercury two pole electrical rotating connector (up to 1200 rpm): for driving signals from test area until acquisition board properly. Maximum contact resistance less than 1 mΩ.
- ➔ A set for temperature measurement is included (thermocouple and signal conditioner).

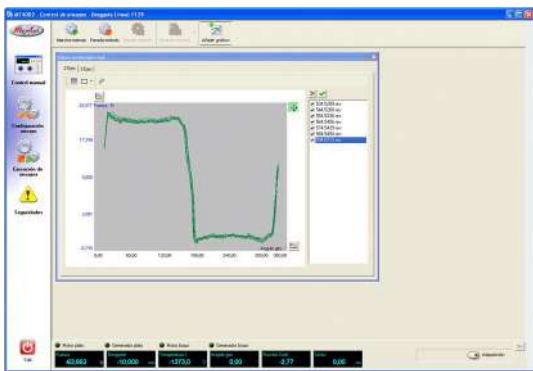
NOTE: Maximum turning speed depends on fluid test characteristics.

Specific software features

Specific software TRIBOTESTER MT includes a complete set of customized tools for tests run with MT test equipment.



- ➔ Real time acquisition of horizontal force, frictional coefficient, wear rate, changes on contact resistance, and temperatures⁷
- ➔ Accurate turning radius selection
- ➔ Fine control over rotational axis speed
- ➔ Accurate control through TRIBOTESTER MT software of each channel
- ➔ Pre-installed sequences for rotational and/or linear wear test
- ➔ Easy programming and configuration of tests sequences.
- ➔ Full customization for each user
- ➔ User control Access.
- ➔ Powerful report generator.
- ➔ Direct link with Microsoft® Excel for further test analysis

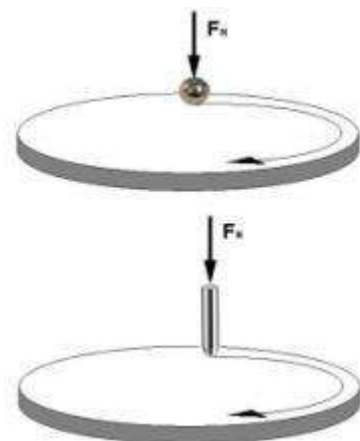


Possible applications

- ➔ Semiconductor technology
 - Passivation layers
 - Metallization
 - Bond pads
- ➔ Wear resistant coatings
 - TiN, TiC, DLC
 - Cutting tools
- ➔ Electric resistance
 - Brushes
 - Contactors
 - Electrical pins
- ➔ Optical components
 - Eye glass lenses
 - Optical scratch-resistant coatings
 - Contact lenses
- ➔ General engineering
 - Rubber resistance
 - Sliding bearings
 - Self lubricant systems
- ➔ Data storage
 - Magnetic disks
 - Protective coatings on CDs y DVDs

Applicable standards

- ➔ ASTM G99 “Wear testing method for wear testing with pin-on-disk apparatus”
- ➔ ASTM G133 “Linearly reciprocating ball-on-flat sliding wear”
- ➔ ASTM G40 “Wear and erosion”
- ➔ ASTM D3702 “Wear rate and coefficient of friction of materials self-lubricated rubbing contact using a thrust washer testing machine”



⁷ See optional elements



Technical specifications

MT Series Pin-on-Disk Tribometer	
Normal force range	10 N, 30 N , 60 N, 80 N,100 N, 200 N ⁸
Dead weights (std.)	1 N, 2 N, 5 N, 10 N, 20 N, 40 N ⁹
Extended values (lower forces)	20 mN, 50 mN, 100 mN, 200 mN, 500 mN
Max. Typ. Horizontal force range (friction)	20N to 200 N
Horizontal force resolution (friction)	0.2 mN (10 N range), 5 mN (200 N range)
Maximum specimen dimensions	Φ 80 -100 mm x 15 mm thick
Rotational speed	0.1 to 2000 rpm
Φ contact balls or pins	Typ. 3 to 12.5 mm ⁹
Axis Z speed (motorized radius option)	50 mm/min
Linear or Capacitive sensor range	2 or 4 mm
Capacitive sensor resolution	0.1 μm
Machine general dimensions (depending on the capacity)	800 x 700 x 530 mm (typ. table top)
Approximate weight (depending on the capacity)	55 kg to 150 kg
Maximum Wear track radius	50 – 75 mm ⁹
Software	TriboTester

*Specifications by default may be subject to change caused by normal test equipment evolution.
MT Tribometers can also be adapted to custom requirements.*



MICROTEST, S.A., C/ Valle de Tobalina, 10, 28021 Madrid, Spain
Tel.: +34 91 796 33 32 - Fax: +34 91 796 32 36 | microtest@microtest-sa.com - www.microtest-sa.com

⁸ Others under demand

⁹ Other optional weight values available