

AUTOMATIC FOUR BALL TRIBOMETER - FRICTION AND WEAR TESTER



Automatic Four Ball Tribometer - Friction and Wear Tester - Toron4B10A™

Toron4B10A™ Automatic Four Ball Tribometer is a precision, microcomputer-controlled friction and wear testing instrument designed to evaluate the load-carrying capacity and anti-wear performance of lubricating fluids and greases under extreme-pressure, concentrated point-contact conditions.

The four ball tribometer method employs one rotating upper ball pressed under controlled load against three stationary lower balls arranged in a triangular cradle — creating a highly localized Hertzian contact stress zone that replicates the worst-case tribological conditions found in gearboxes, bearings, and sliding mechanical interfaces. The Toron4B10A™ measures and reports the three internationally recognized extreme-pressure indicators: maximum non-seizure load (PB), weld load (PD), and comprehensive wear index (ZMZ).

Unlike manual-lever systems, the Toron4B10A™ uses fully automatic, stepless load application from 60N to 10kN, eliminating human loading variability. Spindle speed is continuously adjustable between 200 and 2000 rpm, and the integrated heating system controls bath temperature from ambient up to 200°C — covering the complete operational temperature range of industrial lubricants.

With its microcomputer control platform, the instrument automates the entire four ball tribometer test protocol: load ramp, timed exposure, friction force acquisition, temperature regulation, and result logging — delivering ASTM-compliant friction and wear testing data with minimal operator involvement.

10 kN	300 N	2000 rpm	200°C
MAX NORMAL FORCE	MAX FRICTION FORCE	MAX SPINDLE SPEED	MAX TEMPERATURE

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Applications

The Toron4B10A™ four ball tribometer serves a broad range of friction and wear testing applications in lubricant research, quality control, and compliance testing:

Extreme-Pressure Lubricant Qualification	Determines PB (non-seizure load) and PD (weld load) of gear oils, hydraulic fluids, and metalworking lubricants, qualifying EP additive packages for industrial applications per ASTM D2783.
Grease Wear Performance Testing	Measures wear scar diameter (WSD) and wear-preventive characteristics of lubricating greases under standard four ball tribometer conditions per ASTM D2266.
Lubricating Fluid Anti-Wear Screening	Evaluates anti-wear performance of engine oils, transmission fluids, and specialty lubricants via the four ball wear method (ASTM D4172) for product development and QC programs.
Long-Duration Anti-Wear Endurance	Performs extended friction and wear testing up to 99 hours of continuous operation, enabling lubricant film durability studies and shelf-life characterization.
Friction Coefficient Measurement	Continuously measures and records dynamic friction coefficient throughout the test cycle, providing tribological data for lubricant formulation optimization.
R&D and Lubricant Formulation	Provides fast, standardized four ball tribometer screening data for developing new base oils, additive systems, and synthetic lubricant blends.

Compliant Standards

The Toron4B10A™ is designed and validated to comply with the following internationally recognized ASTM test standards for four ball tribometer friction and wear testing:

Standard	Title	Description
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ASTM D2783-03 (2009)	Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)	Defines the four ball tribometer procedure for determining load-carrying capacity of lubricating oils, yielding the PB (non-seizure load), PD (weld load), and ZMZ (comprehensive wear index) performance indicators.
ASTM D2266-01 (2015)	Standard Test Method for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method)	Specifies friction and wear testing conditions — 1200 rpm, 75°C, 40 kgf, 60 min — for evaluating wear scar diameter of lubricating greases.
ASTM D4172-94 (2010)	Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)	Governs the four ball wear test protocol for lubricating oils and fluids; 1200 rpm, 75°C, 40 kgf, 60 min; wear scar diameter is the primary anti-wear performance metric.

FEATURES

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Key Features

Microcomputer Automatic Control	The fully integrated microcomputer manages all test parameters — load, speed, temperature, timing, and data acquisition — without manual intervention, delivering consistent, operator-independent friction and wear testing results.
Stepless Automatic Load Application (60N-10kN)	Normal force is applied automatically across the full 60N to 10kN range with stepless, continuously variable control — eliminating manual lever inconsistency and ensuring ASTM-compliant force accuracy at every test stage.
Wide Spindle Speed Range (200-2000 rpm)	Continuously adjustable, stepless spindle speed covers all ASTM D2783, D2266, and D4172 requirements and enables custom non-standard speed protocols for research applications.
High-Capacity Normal Force (10kN)	The 10kN maximum normal load allows characterization of high-performance EP additives and extreme-duty gear lubricants requiring elevated contact pressures to reach weld or seizure conditions.
Precise Temperature Control (RT-200°C, ±2°C)	Heated ball cup assembly maintains lubricant bath temperature from ambient to 200°C within ±2°C, enabling accurate temperature-dependent tribological characterization.

High-Sensitivity Friction Force Measurement (300N)	300N friction force capacity provides sensitive detection across the full range of lubricant performance states, from hydrodynamic to boundary lubrication.
Flexible Test Duration (1 second to 99 hours)	Programmable test time accommodates rapid EP step-load sequences through extended long-duration anti-wear endurance tests without hardware reconfiguration.
Three EP Indicators: PB, PD, ZMZ	Directly generates the three internationally recognized extreme-pressure performance metrics: non-seizure load PB, weld load PD, and comprehensive wear value ZMZ.
Real-Time Friction Coefficient Monitoring	Continuous friction coefficient measurement and logging detects lubrication regime transitions and quantitatively assesses anti-friction additive effectiveness throughout the test.

THEORY & METHOD

Theory & Test Method

The four ball tribometer test method is based on the principle of extreme-pressure, concentrated Hertzian contact between a single rotating steel ball (the "drive ball") and three stationary steel balls locked in a cup below. This geometry creates a tetrahedral contact arrangement producing the highest possible local contact stress for a given normal load — replicating conditions in hypoid gears, rolling element bearings, and highly loaded sliding pairs.

The lubricant sample is immersed in the ball cup, fully flooding all four contact zones. As the spindle rotates the upper drive ball against the three stationary lower balls, the lubricant film is progressively stressed. The Toron4B10A™ monitors and records friction force in real time throughout the friction and wear testing cycle, capturing the transition from full film lubrication through mixed film to boundary and ultimately seizure conditions.

For EP characterization (ASTM D2783), load is incrementally increased in a defined step sequence. Wear scar diameter on the three lower balls is measured post-test at each load. The non-seizure load PB is the highest load at which no welding occurs; PD is the weld point; and ZMZ integrates wear scar data across all load steps into a single lubricant quality number.

For anti-wear evaluation (ASTM D2266/D4172), a fixed load, speed, temperature, and test duration are applied, and wear scar diameter is precisely measured — typically by optical microscopy — as the quantitative result of the friction and wear testing protocol.

The Toron4B10A's microcomputer-based automatic load control eliminates the step-load variability inherent in manual lever systems, ensuring compliance with ASTM-specified load tolerances at every test stage. The four ball tribometer combination of simplicity, reproducibility, and international standardization makes it the global reference method for lubricant EP and anti-wear screening.

Test Method Steps

- Sample Loading — Fill the ball cup with the lubricant sample and lock three Ø12.7 mm steel balls in position. Mount the upper drive ball on the spindle chuck.
- Temperature Stabilization — Set the target bath temperature (RT to 200°C). The integrated heating system stabilizes to within $\pm 2^{\circ}\text{C}$ before test initiation.
- Speed & Load Configuration — Program spindle speed (200–2000 rpm, stepless) and normal force profile (60N–10kN, automatic). Set test duration (1 second to 99 hours).
- Automated Test Execution — The microcomputer runs the test protocol: spins the drive ball, applies load automatically, and continuously measures friction force throughout the cycle.
- Friction Force Acquisition — Maximum friction force up to 300 N is captured in real time. The system logs friction coefficient throughout the full friction and wear testing duration.
- Result Calculation & Reporting — The system calculates and reports PB, PD, ZMZ (for EP tests), wear scar diameter, and friction coefficient data in standard-compliant format.

TECHNICAL SPECIFICATIONS

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Technical Specifications

MECHANICAL & LOAD SYSTEM	
Normal Force Range	60 N – 10 kN (stepless adjustable)
Normal Force Loading Method	Automatic loading (microcomputer-controlled)
Maximum Friction Force	300 N
DRIVE SYSTEM	
Spindle Speed Range	200 – 2000 rpm (stepless adjustable)
THERMAL SYSTEM	
Temperature Control Range	Room temperature – 200°C
Temperature Control Error	±2°C
TEST CONTROL	
Time Control Range	1 second – 99 hours
TEST CONSUMABLES	
Steel Ball Diameter	Ø 12.7 mm
PERFORMANCE OUTPUTS	
EP Indicators	Maximum non-seizure load PB; Sintering/weld load PD; Comprehensive wear value ZMZ
Anti-Wear Outputs	Wear scar diameter (WSD); Friction coefficient
APPLICABLE STANDARDS	
Standards Compliance	ASTM D2783-03(2009); ASTM D2266-01(2015); ASTM D4172-94(2010)



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