TANNAS CO.
LABORATORY INSTRUMENTS

TBS® 2100E-F

HTHS Tapered Bearing Simulator Viscometer

ASTM D4683, D6616 | CEC L-36-90 | IP 370

Principle

High-Temperature, High Shear Rate Rotational (*Absolute*) Viscosity: The coaxial Rotor/Stator design permits the exact measurement of rotor position and the torque response of the liquid's resistance to flow (viscous friction), which determines the apparent fluid viscosity. The TBS® measures viscosities at multiple shear rates (50,000 to >7 million sec^{-1}) and temperatures (40°C to 200°C). This proves particularly useful with multi-grade oils and their influence on fuel efficiency.

History

Developed in 1979 and under several patents, the TBS® Viscometer became the world's first high shear viscometer. It remains the modern bench-mark 'referee' instrument for HTHS viscometry due to its innovative measurement technique, robust design, and notable operational upgrades.

Innovation

Through several noteworthy instrument advancements, the TBS® 2100*E-F* brings a heightened level of operator ease and productivity for both research and routine laboratory HTHS testing. These innovations include two *optional* Full-Automation modes, constant temperature control, a 12-step motor for simple adjustment of shear rate, quick 'chase-flush' sample exchange, and complete computer control for automatic calibration, sample injection and data reporting.

Features

- Capable of analyzing both 'fresh' and 'used' oils.
- *Full*-Automation Package with 42-position AutoSampler – simply load samples, input desired sample information, start the automation program, and return to retrieve results.
- Adjustable temperature range from 40°C to 200°C with optional cooling device.
- Thin-Film stator heating provides constant and precise temperature control with no external hot oil bath.
- Excellent research tool with broad shear rate range capability via 12 rotor speed selections and Rotor/Stator depth relationship adjustment (50,000 to >7 million sec^{-1}).
- Single sample testing with no requirement for duplication or averaging of sample data.

ASTM D4683
CEC L-36-90, IP 370
JPI-5S-36-03

HTHS viscosity determination of fresh and used engine oils at 150°C and $1x10^6$ sec^{-1} shear rates.

Required for :

- ILSAC GF-2 to GF-6 (A&B) & dexos™ Engine Oil Specifications
- API 'SL', 'SM' and 'SN' categories for modern engine oils
- ACEA Oil Sequences
- SAE *J300* Engine Oil Viscosity Grade Classification

ASTM D6616

HTHS viscosity determination of large, medium speed, automotive, and heavy duty engine oils at 100°C and $1x10^6$ sec^{-1} shear rates.

- Basis for 100°C railroad oil viscosity classification.

Reference Technique:

TBS is the referee instrument for

ASTM D4741, D5481

- 'Chase-Flush' sample replacement technique – no cleaning solution injections between sample runs.
- TBS Reference Oil sets available at temperatures of 80°, 100° and 150°C.
- Applies a constant, linear shear rate profile continually to the fluid. An *absolute* viscometer where 'true' shear rate is calculated from known dimensions and speed of rotation. No need for shear rate correction or the possibility of erroneous results due to clogged capillaries.
- Compatible with MS Windows® 10

The *Full*-Automation Manual Injection Package (with Laptop) incorporates specialized software for automated rotor/stator adjustments and instrument calibrations.

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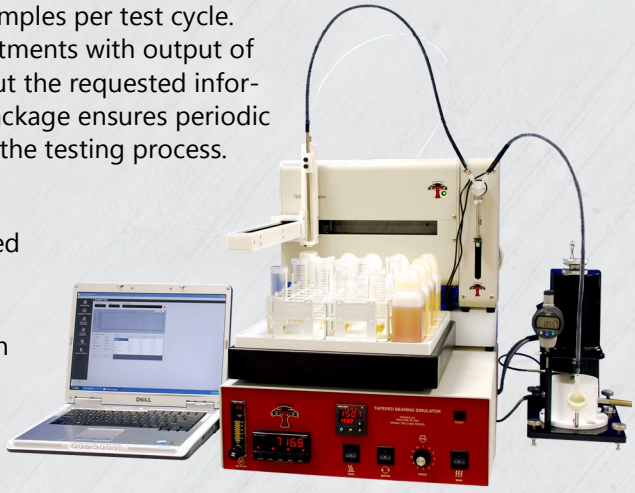
Full Automation Package with AutoSampler

The Full-Automation package with AutoSampler features a multi-position Sampler Tray, Injector, Laptop, and software for analysis of up to 42 samples per test cycle. Computer controlled sample injections and rotor/stator adjustments with output of test results in centipoise (cP). Easily load the sample tray, input the requested information, and start the automatic program. The Automation Package ensures periodic calibration checks and programmed adjustments throughout the testing process.



Specific Features:

- Computer controlled sample injections (samples can be added to AutoSampler Tray during operation).
- Motorized platform and computer controlled rotor height adjustments for automated Operating Position determination and calibration steps.
- Selectable intervals for periodic Non-Newtonian calibration checks throughout rack of samples.
- Continuous on-screen viewing of Viscosity, Sample, and Calibration data throughout analysis.

Full Automation Package with Manual Injection

The *Full*-Automation Package without the AutoSampler incorporates the same features listed above; However, the operator manually injects each fluid as prompted by the computer.

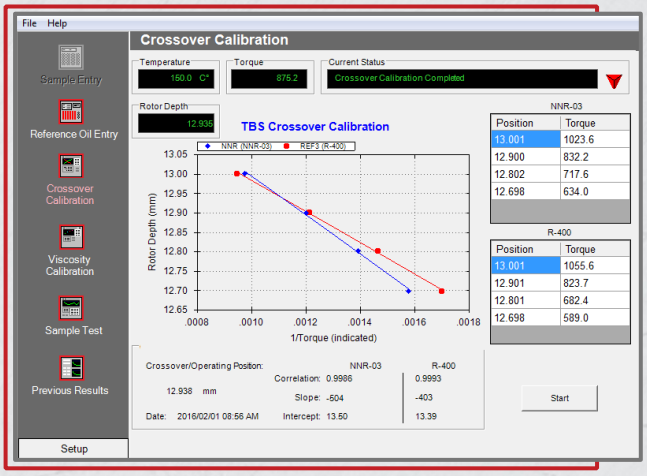
Specific Features:

- Computer instructs the operator to inject samples.
- Computer controls rotor height adjustments throughout calibration steps and printout of sample viscosity report.
- Shear rate range from 50,000 to >7 million sec $^{-1}$ (varies with sample viscosity and temperature).
- Continuous on-screen viewing of Viscosity, Sample, and Calibration data throughout analysis.

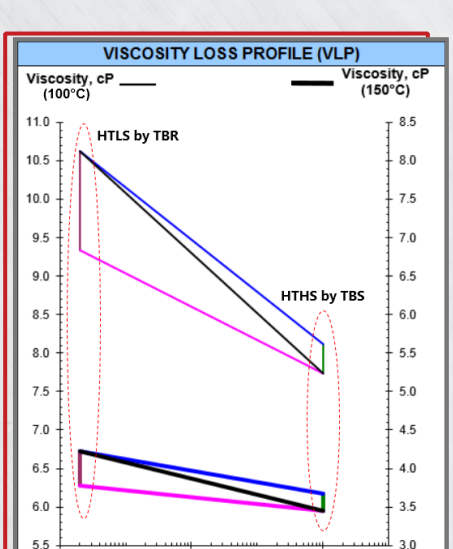
Automated Software Package

The TBS® Auto Software System (w/Laptop) is utilized for both Full-Automation modes of operation. Key features include:

- Computer controlled rotor height adjustments for automated calibrations and viscosity checks.
- Performs and displays Crossover and Viscosity Calibrations and sets Operating Position.
- Saves calibration data for later reference.
- Performs all sample viscosity calculation determinations.
- The new Oil Saver software update incorporates User Adjustable Fields reducing the amount of reference oil usage.



Advanced Applications

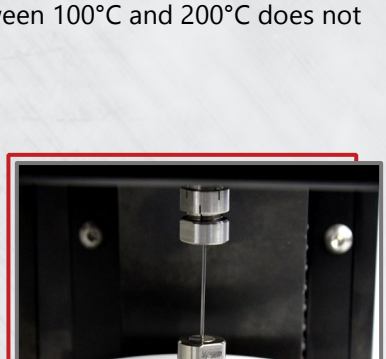


In addition to fresh and used automotive and railroad engine oils, the versatile features and robust precision of the TBS® permit viscosity measurements of organic and aqueous fluids, ATF's, hydraulic fluids, inks and polymeric solutions from 1 to 30 mPa-s (cP).

Unique applications include:

- ***Viscosity Loss Profile (Viscosity Loss Trapezoid)* —** This technique contributes insights into the molecular weight distribution of oil soluble polymers. It also appraises the total viscous influence of VI Improvers, synthetic fluids, and their combinations by comparing HTHS (TBS®) and HTLS (TBR) viscosities both before and after shear degrading the oil.
- ***Viscosity-Fuel Efficiency Index (VFEI)* —** An algorithm, using TBS® values at 100°C and 150°C, determines viscosity-related fuel-efficiency contributions of engine oils using the sum of the power loss of the major sites in the engine, each multiplied by the calculated viscosity of the oil at that site.
- ***Multi-High Shear Rate Modeling* —** The ability to precisely and accurately control the speed of the Rotor and adjust its height in the Stator during operation permits a wide range of shear rates to be applied to the sample. The ability to scan the shear rates provides insights for improving fuel efficiency, while gaining information for appraising viscosity protection of shear-thinning engine oils associated with hydrodynamic lubrication in the automotive journal bearing.
- ***HTHS at Lower Temperatures* —** With the need in the industry to further appraise the fuel-efficient benefits of engine oils, the TBS® operates at a variety of temperatures that account for the different environments within an operating engine. When equipped with an external chiller to control viscous heating effects, the TBS® can measure viscosities from 80°C to as low as 40°C. Routine HTHS testing between 100°C and 200°C does not require a chiller.

The TBS® Advantage



As a rotational 'absolute' viscometer, the TBS® directly measures the sample viscosity by applying a constant shear rate to the fluid while maintaining a defined sample temperature – resulting in a 'true' shear rate that is highly accurate, precise, and calculated from known Rotor/Stator dimensions and speed of rotation.

In contrast, capillary viscometers can only give an empirical 'average' value calculated from an assumed range of shear rates that vary across the capillary. Viscosity values generated by rotational viscometers, that provide a constant shear rate across the fluid-filled gap of the Rotor/Stator (linear shear profile), are used to determine the correction factor for the high shear rate capillary viscometer. The testing of 'used' oils in capillary viscometers is also difficult because of particulates plugging the fine capillaries needed for high shear rate fluid flow.

The TBS® allows for the adjustment and knowledge of the Rotor/Stator gap to establish precision shear rate determinations during operation. This unique application of Newtonian laws of fluid motion to define the absolute gap, is necessary to determine and establish other conditions of analysis from non-Newtonian fluids. Thus, the TBS® is the reference HTHS instrument for the industry, and the only high-shear rate viscometer capable of producing non-Newtonian calibration oils. This permits other *relative* viscometers to evaluate non-Newtonian lubricants.

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ISO 9001:2015 QMS

Parts & Accessories

TBS® 2100*E-F* Instrument:

300100: 120 VAC, 50/60 Hz Power
300200: 220 VAC, 50/60 Hz Power

Full Automation Package Option:

300199: TBS Full Auto Software
300850: T42C AutoSampler

Spare Parts & Consumables:

300252: Conventional Rotor/Stator Set (Calibrated)
300288: Stator Housing Assembly w/Lids
300175: TBS® Shield Enclosure
300315: TBS® 2100*E* Siamese™ Collet Assembly
300319: Collet Assembly Tool
300263: RTD Assembly (Temperature Sensor)
300273: Thin-Film Heater Assembly
300949: Collet Shaft (5/pack)
300512: O-ring: Stator Housing (5/pack)
300520: O-ring: Stator Support (5/pack)
300514: Disposable AutoSampler Vials (50/pack)
300130: Reference Oil Bottle Set, AutoSampler
300513: Disposable Syringe (20/pack)
300569: Glass Syringe
300547: Filter Holder
300548: Filter Paper (50/pack)
300124: AutoSampler Plastic Rack (Holds 21 Samples)
300493: Alignment Tool

Accessories for Low Temperature Operation:

300250: Recirculating Chiller
300253: Modified Rotor/Stator Set (Calibrated)
300289: Modified Stator Housing Assembly

Instrument Specifications

Dimensions (W x D x H)	Viscometer: 18 x 30.5 x 35.5 cm | (7 x 12 x 14 inches) Console: 46 x 46 x 15 cm | (18 x 18 x 6 inches) w/AutoSampler: 46 x 51 x 61 cm | (18 x 20 x 24 inches)
Weight	Viscometer: 15.5 kg | (34 lbs.) Console: 9 kg | (20 lbs.) AutoSampler: 25.4 kg | (56 lbs.)
Voltage	120 VAC or 220-240 VAC Power Draw - 6 amp.
Frequency	50/60 Hz.
Viscosity Range	1 to 30 mPa•s (cP)
Sample Volume	Recommended 50 mL for 'chase-flush' technique
Sample Test Time	Approximately 5-7 minutes per sample
Sample Capacity	Up to 42 (with AutoSampler)
Operating Temperatures	Constant Temperature Control: 40°C to 200°C (± 0.1°C) Replaceable internal Thin-Film heating
Shear Rates	50,000 sec^{-1} to >7 million sec^{-1} Variable 12-speed DC motor (800-8000 rpm)
Read-out	Torque: In-line transducer to LED torque meter (0-1 VDC) Temperature: Continuous dual LED reading (actual & set) Automation: Computer USB communication & display
Safety	Over-temperature Cut-off Fuse | Power failure protector Programmable Temperature limit *CE* Marked
Shipping Weight	Manual System: ~ 68 kg | (150 lbs.) Auto System: ~ 72.5 kg | (160 lbs.)
Shipping Dimensions (W x D x H)	Manual System: 61 x 81 x 89 cm | (24 x 32 x 35 inches) Auto System: 61 x 81 x 127 cm | (34 x 32 x 50 inches)

Additional TANNAS CO. Precision Laboratory Instruments

Tannas Foam *Air* Bath (TFAB®)
- ASTM D892, D6082, IP146
- Non-liquid bath
- 24°C to 150°C range

Tannas Noack S2® Volatility Test
- ASTM D5800, Evaporation Loss
- Phosphorus Volatility
- non-Wood's metal heating system

***Quantum*® Oxidation Tester**
- ASTM D2272, D2112, D4742, D942, IP229
- RPVOT, TFOUT, Grease Oxidation
- Non-liquid 'dry cylinder' sample heating

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