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PRECISION KINEMATIC VISCOSITY TESTING: FROM ASTM D445 COMPLIANCE TO HIGH-THROUGHPUT AUTOMATION

Kinematic Viscosity is one of the most critical properties in petroleum product quality control and specification. From aviation turbine fuel to heavy residual oil, viscosity grade determines pumpability, combustion performance, lubricating film strength, and regulatory acceptance. Getting it wrong — by even 1–2% — can mean product rejection, delivery disputes, or field equipment failure.

Torontech's kinematic viscosity tester lineup covers every level of laboratory automation and throughput — from single-bath fully automatic ASTM D445 systems to dual-bath simultaneous testing, Houillon-type fast-cycle instruments, heavy oil configurations, four-channel high-throughput platforms, and combined kinematic viscosity-plus-density testers.

Every system is engineered to **comply with the applicable international viscosity testing standards**, including ASTM D445, ASTM D7279, ISO 3104, and related regional methods, with full traceability and digital data management.

HOW THE KINEMATIC VISCOSITY TESTER WORKS

METHOD 1:

Standard Capillary Method ASTM D445 / ISO 3104

A precise volume of oil is injected into a calibrated glass capillary tube held at a controlled temperature. The oil flows under gravity, and precision optical sensors record the time for the meniscus to travel between two marks. Kinematic viscosity is calculated as $v = C \times t$ (tube constant $\times$ flow time).

①

Load

Sample loaded into autosampler; preheat begins.



②

Stabilize

Bath holds $\pm 0.005^\circ\text{C}$; sample equilibrates to test temp.



③

Inject

Precise volume pumped into calibrated glass capillary.



④

Time Flow

Optical sensors record meniscus passing 2 timing marks.



⑤

Calculate

$v = C \times t$
Report in mm^2/s (cSt).



⑥

Clean

Auto solvent flush; ready for next sample.

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METHOD 2:

Houillon Z-Tube Method

ASTM D7279: 60–90 sec per test

Oil fills a Z-shaped capillary tube and flows by self-siphoning action — no pump required. Optical or thermal sensors detect the meniscus crossing and record the flow time precisely. The same $v = C \times t$ formula applies. The Z-tube geometry produces results 3–5× faster than conventional U-tube capillary methods.

①

Fill

Oil fills the Z-tube capillary via the sample cup.

②

Siphon

Self-siphoning flow begins through the capillary.



④

Calculate

$v = C \times t$;
result in 60–90 sec.

③

Detect

Optical or thermal sensor times meniscus crossing.



METHOD 3:

Combined KV + Density

ASTM D445 + ASTM D4052 / ISO 3104 + ISO 12185

A single oil sample is measured for kinematic viscosity and density at a controlled temperature, allowing dynamic viscosity to be calculated directly as $\eta = v \times \rho$. This method eliminates the need for an external densitometer and ensures both properties are measured under the same thermal conditions.

①

Load

Single oil sample loaded for both measurements.

②

KV Test

Capillary flow timed
 $\rightarrow v = C \times t$



④

Report

$\eta = v \times \rho$
calculated directly;
one result record.

③

Density

Oscillating U-tube or float sensor $\rightarrow \rho$
at same temp.





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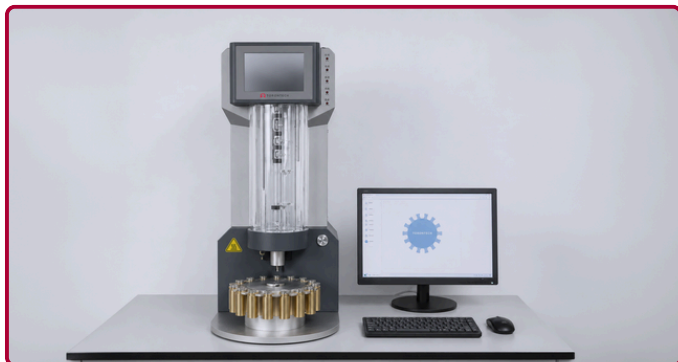
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PRODUCT HIGHLIGHTS

Full Automatic KV Tester

TT-445Z (Single Bath)



Measures kinematic viscosity of transparent and opaque petroleum products per ASTM D445. Features a 16-position autosampler for continuous unattended operation.

Features/Advantages:

- › **16-position Autosampler:** Supports fully continuous operation with intelligent preheating, injection, measurement, cleaning, drying, and result calculation – unattended.
- › **Peltier Refrigeration Built-in:** Fast cooling from test temperature without an external chiller; self-adaptive liquid level balance technology maintains constant immersion depth across temperature swings.
- › **Built-in Windows OS + LIMS Connectivity:** Connect to barcode scanners for automatic sample ID input; export to LIMS for audit-ready traceability.
- › **Temperature Precision $\pm 0.005^{\circ}\text{C}$:** PT1000 sensor with double-blade stirrer and double-glass bath construction ensures thermostat stability throughout each run.
- › **Automatic Calibration Suite:** Automated calibration of viscometer constants, temperature, and timing with automatic Engler viscosity conversion and Viscosity Index calculation.

Full Automatic KV Tester

TT-445Z-1 (Dual Baths)



Dual-bath configuration enables simultaneous testing at two temperatures – the fastest path to Viscosity Index calculation per ASTM D2270 without sequential sample re-loading.

Features/Advantages:

- › **Dual-Bath Simultaneous Operation:** One bath tests while the other cleans or holds at a second temperature – eliminates idle time between the 40°C and 100°C runs required for VI calculation.
- › **Measuring Range $0.3\text{--}10,000\text{ mm}^2/\text{s}$:** 10,000-fold measuring span of the dual viscometer tube pair covers base oils, additives, finished lubricants, and low-viscosity fuels.
- › **Temperature Precision $\pm 0.005^{\circ}\text{C}$ Per Bath:** Independent PT1000 sensors and double-blade stirrers in each glass bath maintain stability in both channels simultaneously.
- › **Intelligent Dual-Solvent Cleaning:** Customizable cleaning modes for each bath; waste liquid and solvent level monitoring with automatic safety prompts.
- › **Timing Verification Port:** Connect a standard time calibrator for traceable timing accuracy verification during accredited laboratory audits.



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Full Automatic Dual Tube with Houillon Viscometer

ToronVT™ FA-DT



Automated Houillon-type viscometer for rapid kinematic viscosity determination of transparent petroleum products – using less than 1 mL of sample per test.

Features/Advantages:

- **Houillon Z-tube Design per ASTM D7279:** Capillary measurement with automatic detection; average run time under 90 seconds per sample – 3–5× faster than conventional U-tube capillary methods.
- **Sub-Milliliter Sample Volume:** <1 mL required per test – critical for precious or limited-volume samples in R&D and used-oil verification programs.
- **Dual-Tube Parallel Processing:** Two Houillon tubes operate simultaneously, doubling throughput over single-tube configurations without adding operator time.
- **Automatic Cleaning and Drying Cycle:** Solvent-based cleaning sequence runs automatically between samples – eliminates manual tube handling and reduces cross-contamination risk.
- **Measuring Range 0.3–6,000 mm²/s:** Covers the full range from low-viscosity fuels (gasoline, jet fuel) to SAE 40 gear oils.

Heavy Oil Houillon Viscometer

ToronVT™ AH-HO



Purpose-built Houillon viscometer for high-viscosity and opaque petroleum products – residual oils, heavy base stocks, bunker fuels, and bituminous materials.

Features/Advantages:

- **Extended Viscosity Range for Heavy Products:** Designed to handle high-viscosity, dark, and opaque samples that cause detection errors in standard optical Houillon systems.
- **Pre-Heat System for Heavy Oil Injection:** Controlled heating ensures accurate dosing of viscous samples without pipetting errors or bubble formation.
- **Dual Detection Technology:** Selects the appropriate optical or thermal sensor mode for the sample type – reliable timing for both transparent light oils and opaque heavy stocks.
- **Temperature Range Up to 100°C:** Thermostatic bath stable at any set point between 20°C and 100°C for accurate high-temperature viscosity determination of residual products.
- **Automatic Solvent Flushing:** Removes heavy oil residue between tests to minimize carryover.



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Auto-Detection Dual-Tube with Houillon Viscometer

ToronVT™ AD-DT



Intelligent auto-detection Houillon viscometer that automatically identifies whether the incoming sample is transparent or opaque – eliminating manual mode selection between sample types.

Features/Advantages:

- **Automatic Sample Transparency Detection:** Optical sensors classify each sample on injection; instrument selects photoelectric or thermal timing without operator input – critical in service labs with mixed sample types.
- **Dual-tube Simultaneous Testing:** Two Houillon tubes process samples in parallel, maintaining throughput regardless of whether samples require different detection modes.
- **Reduced Operator Intervention:** Auto-detection removes the most common source of manual error in mixed-fleet oil analysis programs – wrong detector mode selection.
- **Fast Cycle Time:** Houillon Z-tube geometry with automatic detection completes each run in under 2 minutes per sample including auto-cleaning.
- **Compatible with Used Engine Oils:** Handles in-service samples with variable opacity, soot content, and contamination without pre-screening or pre-classification.

Four-Channel Fast Automatic Kinematic Viscosity Tester

ToronVT™ FC 4



Four independent measurement channels run simultaneously – quadrupling throughput versus single-channel instruments and enabling rapid multi-grade viscosity profiling in a single instrument footprint

Features/Advantages:

- **Four Simultaneous Independent Channels:** Each channel has its own capillary tube, optical detector, thermostat, and timing circuit – true parallel operation, not sequential multiplexing.
- **High-Throughput Petroleum QC:** Ideal for lubricant blenders, refinery QC labs, and commercial oil analysis services that process 50–100+ samples per shift.
- **Individual Temperature Control Per Channel:** Each channel can be set to a different temperature – enabling multi-grade or multi-product simultaneous testing.
- **Automated Injection And Cleaning On All Channels:** Intelligent sample handling cycles run independently on each channel for maximum continuous throughput.
- **Centralized Data Management:** All four channels report to a single controller with combined result logging, batch statistics, and export to LIMS or printer.



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Dual Tube KV Tester with Houillon Viscometer

ToronVT™ AH-DT



Entry-level dual-tube Houillon viscometer for transparent petroleum products. Fast cycle times, low sample volume, and straightforward operation for routine fuel and lubricant QC.

Features/Advantages:

- ▶ **Dual Houillon Tube Design:** Two capillary tubes process consecutive samples efficiently — each tube covering a defined viscosity sub-range with a combined span of 0.3–6,000 mm²/s.
- ▶ **Low Solvent Consumption:** Compact cleaning circuit uses minimal solvent per cycle — reducing running costs and waste disposal requirements in high-cycle-rate labs.
- ▶ **Simple Touchscreen Operation:** Clear parameter entry, result display, and automatic result storage — minimal training required for technicians moving from conventional capillary baths.
- ▶ **Fast Result Cycle:** Houillon geometry delivers first result in 60–120 seconds versus 10–20 minutes for conventional U-tube tests — significantly improving lab throughput.
- ▶ **Built-in Statistics and Reporting:** Batch averages, repeatability checks, and printout or USB export for routine QC documentation.

High Precision KV + Density Tester

ToronVT™ VD-HP



Combines kinematic viscosity and density measurement in a single instrument — delivering dynamic viscosity calculation directly without a separate densitometer.

Features/Advantages:

- ▶ **Integrated KV + Density in One Run:** Simultaneously measures kinematic viscosity and density for direct dynamic viscosity calculation in a single run.
- ▶ **High Precision Density Measurement:** Density sensor resolution to 0.0001 g/cm³ minimizes errors associated with separate density measurements.
- ▶ **Extended Temperature Range:** Both viscosity and density determined at the same thermostatic temperature — critical for accurate dynamic viscosity at non-standard temperatures.
- ▶ **Single Sample Loading For Dual Results:** One sample injection yields two certified measurements — reduces sample handling time and pipetting errors in combined-property test requests.
- ▶ **Built-in Statistics and Reporting:** Batch averages, repeatability checks, and printout or USB export for routine QC documentation.



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Did You Know?

Before the **Houillon method**, automated viscosity testing relied primarily on conventional U-tube capillary viscometers, which struggled to accurately detect the liquid meniscus in dark or opaque oils.

The **Houillon Z-tube design** solved this challenge with a self-siphoning flow path that made automated measurements faster, more reliable, and suitable for routine used oil analysis.

Recognizing these advantages, **ASTM International** published **ASTM D7279** in 2006, establishing the Houillon viscometer as a standardized method for measuring the kinematic viscosity of transparent and opaque liquids.

Today, it is widely used in lubricant quality control, condition monitoring, and petroleum testing laboratories worldwide.

Why Choose Torontech

for Kinematic Viscosity Testing?

- ▶ **Complete Automation Portfolio:** From single-bath and dual-bath Houillon systems to four-channel, heavy-oil, and KV+density configurations—all within the Torontech complete portfolio.
- ▶ **ASTM & ISO Compliant:** Designed to meet ASTM D445, ASTM D7279, and ISO 3104 requirements for reliable petroleum QC and specification testing.
- ▶ **Scalable Throughput:** From 10 to 200+ samples per day, with single-bath, four-channel, and dual-bath systems to match your laboratory workload.
- ▶ **Traceable Results:** Supports viscosity constant calibration, PT1000 temperature verification, timing validation, and optional LIMS connectivity.

Complete Your **Kinematic Viscosity Testing Program** with Torontech

Torontech's kinematic viscosity tester lineup helps petroleum QC laboratories, lubricant manufacturers, refinery labs, and oil analysis services achieve precise, repeatable ASTM D445-compliant results — with the right level of automation for every throughput requirement. Explore the full lineup: <https://www.torontech.com/product/kinematic-viscosity-testing/>

For expert guidance on selecting the right instrument for your test methods and throughput: sales@torontech.com

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