



Kinematic Viscosity Instrumentation and ASTM D445 Methodology

Critical Components for Achieving
the Best Precision

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Kinematic Viscosity & ASTM D445

- Experimentally derived by Hagen & Poiseuille in 1838, it is still one of the most precise viscosity measurements known – it relies on gravity!
- Critical physical property in hundreds of petroleum and petrochemical material specifications
- ASTM D445 is the most widely used method in all of ASTM main committee D02 on petroleum
- Key parameter for custody transfer
- Ability to measure viscosity accurately has a direct impact on materials meeting specification and on industry financials

5 Key Factors Impacting Precision

1. Temperature Control of the Sample
2. Properly Calibrated Viscometer Tubes
3. Timing Accuracy, and Minimum Flow Times
4. Operator Technique and Training
5. Preparation of the Sample

1. Temperature Control of the Sample

- Petroleum materials are very sensitive to temperature – changing viscosity 2% to 3% per degree C
- Viscometer must be placed in a uniformly iso-thermal constant temperature bath
- ASTM D445 requires the bath control to be ± 0.02 °C for bath temperatures between 15 °C and 100 °C and ± 0.05 °C outside this range
- Accurate Temperature Measurement
 - Use of a digital RTD is recommended with a resolution of 0.01 °C and an ISO 17025 traceable calibration of ± 0.02 °C



2. Properly Calibrated Viscometers

- ASTM D445 requires that a viscometer tube meet the dimensions noted in the D446 specification
- The viscometer tube shall be calibrated using certified viscosity reference standards (CVRS) which were certified in an ISO 17025 accredited laboratory following the ASTM D2162 master viscometer test method
- Manual viscometers shall be calibrated in an ISO 17025 accredited laboratory while automated viscometers can be calibrated on-site using CVRS oils



3. Timing Accuracy and Flow Times

- Manual glass viscometers shall be selected so that a **MINIMUM** flow time of 200 s is achieved
 - Minimizes the effect of hand-eye timing error
 - Eliminates the need for kinetic energy correction
- Automated viscometers can use flow times down as low as 30 s provided their timing accuracies are at least 0.01 s and they use the kinetic energy correction in the calibration equation. Kinetic energy correction must be less than 3%.

4. Operator Technique and Training

- Recent ASTM inter-laboratory round robin studies have found that manual precision is getting worse¹
- Manual precision is as much as two times worse than automated viscometers¹
- Most of the variation in precision can be attributed to improper temperature, poorly calibrated manual viscometers, and manual timing errors¹

¹“2014 ASTM Research Reports RR:D02-1787 and RR:D02-1788”

5. Preparation of the Sample

- Some samples require careful preparation and handling to ensure accurate viscosity measurement
- Preheating helps to remove thermal history
- Preheating and shaking to improve homogeneity – such as with residual fuel oils and asphalts
- Keeping the sample closed to atmosphere helps to avoid the loss of volatile components
- Filtering removes particulates which are greater than twice the diameter of the viscometer capillary

Manual vs. Automated

Parameter	Manual	Automated
Temperature Control	Some baths only +/- 0.1 °C	+/- 0.01 °C
Washing / Drying	Done manually	Fully automatic
Timing Accuracy	+/- 0.2 s	+/- 0.001 s
Minimum Flow Times	200 s	30 s with kinetic energy correction
Range per tube	5-10 fold (mm ² /s)	10-100 fold (mm ² /s)
Labor Time	High	Very Low
Operator to Operator Test Variability	High	Very Low

The New CANNON CAV[®] 4.2

**THE MOST
ADVANCED AND
PRECISE
VISCOMETER
AVAILABLE**



- ASTM D 445, Fully Automated
- 15 °C to 150 °C – Dual Baths
- 0.5 mm²/s to 10,000 mm²/s
- 100-fold viscosity range
- D446 Ubbelohde style tube
- Cycle times 3 min to 15 min.
- Color Touchscreen Interface
- Built-in Quad solvent
- Thermistor sensors – for both opaque and transparent samples
- VISCPRO[®] software w/LIMS

Kinematic Viscosity Applications

- CANNON automated viscometers have programmable test methods in the software which allow adjustment of instrument parameters to fine tune for specific sample types
 - Programmable sample pre-heat temperature and time
 - Configurable wash/dry sequence with up to 6 different solvents
 - Multiple determinations to meet D445
 - Adjustable thermal soak times



Muito Obrigado !
Thank You !