Designation: D7279 – 16

Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids by Automated Houillon Viscometer[1]

1. Scope*

1.1 This test method covers the measurement of the kinematic viscosity of transparent and opaque liquids; such as base oils, formulated oils, diesel oil, biodiesel, biodiesel blends, residual fuel oils, marine fuels, and used lubricating oils using a Houillon viscometer in automated mode.

1.2 The range of kinematic viscosity capable of being measured by this test method is from 2 mm^2/s to 2500 mm^2/s (see Fig. 1). The range is dependent on the tube constant utilized. The temperature range that the apparatus is capable of achieving is between 20 °C and 150 °C, inclusive. However, the precision has only been determined for the viscosity range; 2 mm^2/s to 478 mm^2/s at 40 °C for base oils, formulated oils, diesel oil, biodiesel, and biodiesel blends; 3 mm^2/s to 106 mm^2/s at 100 °C for base oils and formulated oils; 25 mm^2/s to 150 mm^2/s at 40 °C and 5 mm^2/s to 16 mm^2/s at 100 °C for used lubricating oils; 25 mm^2/s to 2500 mm^2/s at 50 °C and 6 mm^2/s to 110 mm^2/s at 100 °C for residual fuels. As indicated for the materials listed in the precision section.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
D2162 Practice for Basic Calibration of Master Viscometers and Viscosity Oil Standards
D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance
D6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products and Lubricants
D6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
D6792 Practice for Quality System in Petroleum Products and Lubricants Testing Laboratories
E1137 Specification for Industrial Platinum Resistance Thermometers

2.2 *ISO Standards:*

ISO 5725 Accuracy (Trueness and Precision) of Measurement Methods and Results[3]
ISO/EC 17025 General Requirements for the Competence of Testing and Calibration Laboratories[3]

2.3 *NIST Standard:*

NIST Technical Note 1297 Guideline for Evaluating and Expressing the Uncertainty of NIST Measurement Results[4]

3. Summary of Test Method

3.1 The kinematic viscosity is determined by measuring the time taken for a sample to fill a calibrated volume at a given temperature. The specimen is introduced into the apparatus and then flows into the viscometer tube which is equipped with two detection cells. The specimen reaches the test temperature of

---

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.07 on Flow Properties.

Current edition approved June 1, 2016. Published July 2016. Originally approved in 2006. Last previous edition approved in 2014 as D7279 – 14a. DOI: 10.1520/D7279-16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

***A Summary of Changes section appears at the end of this standard**

Sample Volume (μL)	Tube constant	Viscosity (mm2/s)																										
		Min	Max	2	3	7	10	15	20	30	35	45	50	60	70	75	100	120	150	200	210	250	300	450	500	700	1000	1500
90	0.07	2	7	■	■	■																						
	0.1	3	10		■	■	■																					
180	0.2	7	20			■	■	■	■																			
	0.3	10	30				■	■	■	■	■																	
	0.5	15	50					■	■	■	■	■	■															
	0.7	20	70						■	■	■	■	■	■	■													
	1	30	100							■	■	■	■	■	■	■	■											
	1.2	35	120								■	■	■	■	■	■	■	■										
360	1.5	45	150									■	■	■	■	■	■	■	■	■								
	2	60	200											■	■	■	■	■	■	■	■							
	2.5	75	250													■	■	■	■	■	■	■						
	3	100	300														■	■	■	■	■	■	■					
	5	150	500																■	■	■	■	■	■	■			
540	7	210	700																		■	■	■	■	■	■		
	10	300	1000																				■	■	■	■	■	
	15	450	1500																					■	■	■	■	■

■ Most practical viscosity range

NOTE 1—Viscosity range of a Houillon tube is based on most practical flow time of 30 s to 200 s.

FIG. 1 Houillon Viscometer Typical Viscosity Range of Tube Constants

the viscometer bath and when the leading edge of the specimen passes in front of the first detection cell, the automated instrument starts the timing sequence. When the leading edge of the specimen passes in front of the second detection cell, the instrument stops timing the flow. The time interval thus measured allows the calculation of the kinematic viscosity using a viscometer tube constant determined earlier by calibration with certified viscosity reference standards.

3.2 The kinematic viscosity is calculated using the formula:

$$\nu = C \times t \tag{1}$$

where:

ν = the kinematic viscosity in mm^2/s,
C = the viscometer tube constant in mm^2/s, and
t = the flow time in s measured during the test.

4. Significance and Use

4.1 Many petroleum products and some non-petroleum products are used as lubricants in the equipment, and the correct operation of the equipment depends upon the appropriate viscosity of the lubricant being used. Additionally, the viscosity of many petroleum fuels is important for the estimation of optimum storage, handling, and operational conditions. Thus, the accurate determination of viscosity is essential to many product specifications.

4.2 The viscosity of used oils is a commonly determined parameter in the oil industry to assess the effect of engine wear on the lube oils used, as well as the degradation of the engine parts during operation.

4.3 The Houillon viscometer tube method offers automated determination of kinematic viscosity. Typically a sample volume of less than 1 mL is required for the analysis.

5. Apparatus

5.1 *Automated Viscometer*—The system shall consist of the following components:

5.1.1 *Viscometer Bath:*

5.1.1.1 *Bath,* to ensure optimal thermal equilibration of the system, the bath is filled with mineral or silicone oil and equipped with a stirring device.

5.1.2 *Temperature Regulation System,* to control the bath temperature to within 0.02 °C.

5.1.3 *Houillon Viscometer Tubes,* made of glass with a calibrated volume which varies depending on the tube size (see Fig. 2). This technique allows the viscosity to be measured over a wide range of values (see Fig. 1).

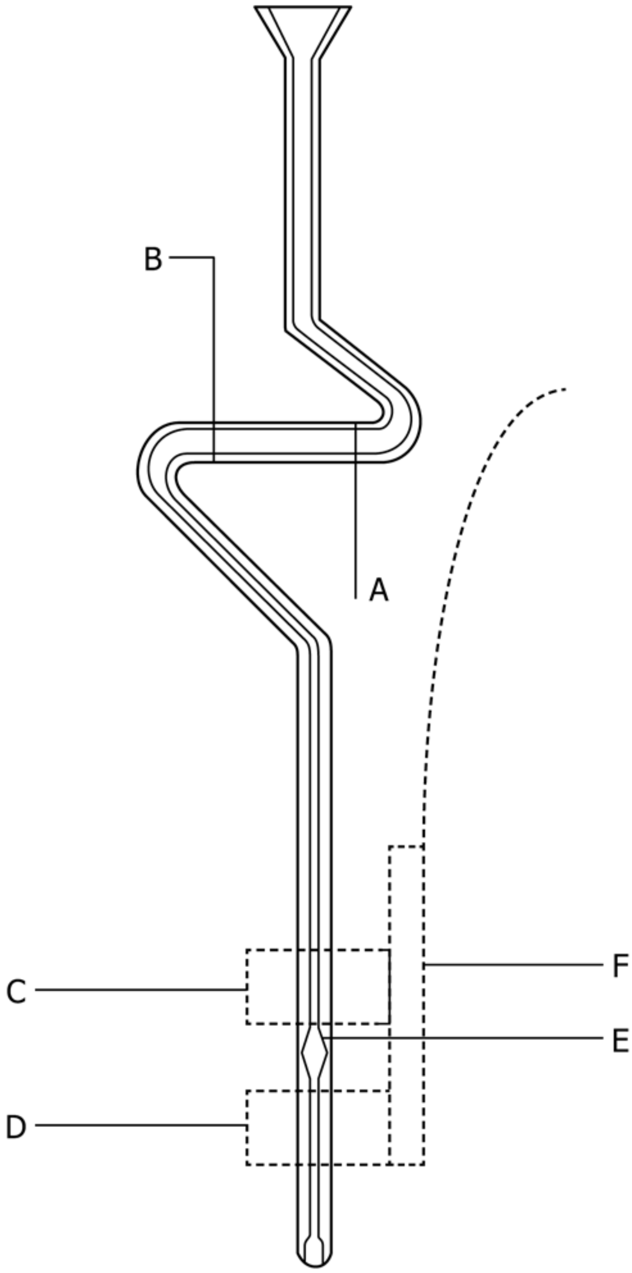
5.1.4 *Cleaning/Vacuum System,* consisting of one or more solvent reservoirs to transport the solvent(s) to the viscometer tubes, dry the viscometer tubes after the flushing cycle, to remove the sample, and for drainage of waste products.

5.1.5 *Automated Viscometer Control System*—Suitable electronic processor capable of operating the apparatus, controlling the operation of the timers, regulating the bath temperature, cleaning the viscometer tubes, and recording and reporting the results.

5.1.6 *PC-compatible Computer System,* may be used for data acquisition, as per manufacturer's instructions.

5.1.7 *Temperature Measuring Devices*—Use either calibrated liquid-in-glass thermometers, of an accuracy after correction of ±0.02 °C or better, or other thermometric devices such as a digital contact thermometer as described in 5.1.7.1 with equal or better accuracy.

5.1.7.1 When using a digital contact thermometer (DCT) the following shall apply: (*1*) The only acceptable sensors are a resistance temperature device (RTD), such as a platinum resistance thermometer (PRT) or a thermistor. (*2*) A minimum display resolution of 0.01 °C. (*3*) A combined (display and probe) minimum accuracy of ±0.02 °C. (*4*) A response time of less than 6 s as defined in Specification E1137. (*5*) A drift of less than 10 mK (0.01 °C) per year. (*6*) Linearity of 10 mK over the range of intended use. (*7*) The DCT shall have a report of temperature calibration traceable to a national calibration or metrology standards body issued by a competent calibration



A and B = sample reservoir
C and D = calibrated volume—measurement zone
E = bulb
F = detection cell

Tube Filling Volume for a Measurement
The filling volume is OK when:
At the beginning of a measurement:
Sample lower meniscus is on C (start timing)
Sample upper meniscus should be below A
At the end of a measurement:
Sample lower meniscus is on D (stop timing)
Sample upper meniscus should be above B

FIG. 2 Houillon Tube Schematic Diagram

laboratory with demonstrated competency in temperature calibration. (*8*) The calibration report shall include data for the series of test points which are appropriate for its intended use.

(1) For a constant temperature bath employed in manual viscosity measurements, the probe shall be immersed at least 100 mm below the liquid level of the bath but no less than three times the sensor element length. The end of the probe sheath shall not extend past the bottom of the viscometer.

(2) It is preferable for the center of the sensing element to be located at the same level as the lower half of the working capillary as long as the minimum immersion requirements are met.

(3) In the case of constant temperature baths used in instruments for automatic viscosity determinations, the user is to contact the instrument manufacturer for the correct DCT that has performance equivalence to that described here.

5.1.8 *Timing Devices*—Use any timing device that is capable of taking readings with a discrimination of 0.01 s or better with an accuracy within ±0.07 % of the reading when tested over the minimum and maximum intervals of expected flow times.

5.1.9 *Volume Delivery Device,* such as a micropipette, capable of delivering a sufficient volume of sample to the Houillon tube being used. (See Fig. 1 for approximate sample volumes.)

6. Reagents and Materials

6.1 Certified viscosity reference standards shall be certified by a laboratory that has been shown to meet the requirements of ISO/EC 17025 by independent assessment. The certified viscosity reference standards shall be traceable to master viscometer procedures described in Test Method D2162.

6.1.1 The uncertainty of the certified viscosity reference standard shall be stated for each certified value (k = 2 @ 95 % confidence). See ISO 5725 or NIST 1297.

6.2 Non-chromium-containing, strongly oxidizing acid cleaning solution. (**Warning—**Non-chromium-containing, strongly oxidizing acid cleaning solutions are highly corrosive and potentially hazardous in contact with organic materials, but do not contain chromium which has special disposal problems.)

6.3 Solvent(s) for cleaning, drying, reagent grade. Refer to manufacturer's recommendations. Filter before use if necessary. Typical solvent(s) include:

6.3.1 Toluene. (**Warning—**Flammable. Vapor harmful.)

6.3.2 Petroleum spirit or naphtha. (**Warning—**Flammable. Health hazard.)

6.3.3 Acetone. (**Warning—**Extremely flammable. Health hazard.)

6.3.4 Heptane. (**Warning—**Flammable. Health hazard.)

6.4 Technical grade silicone oil or white oil of appropriate viscosity (for example, about 100 mm^2/s @ 25 °C or equivalent) to maintain the test temperature.

7. Sampling and Test Specimens

7.1 Obtain a representative test specimen in accordance with Practice D4057 or Practice D4177.

7.2 *Instructions for Residual Fuel Oils*—(**Warning—**Exercise care as vigorous boil-over can occur when opaque liquids that contain high levels of water are heated to high temperatures. Wear appropriate personal protective equipment for handling hot materials.)

7.2.1 Place the first batch of resid samples to be analyzed for the day in their original containers in a sample pre-heat apparatus that is held between 60 °C and 65 °C for 1 h. Ensure the cap on each container is tightly closed.

7.2.2 Rigorously stir each sample for approximately 20 s with a glass or steel rod of sufficient length to reach the bottom of the container.

7.2.3 Remove the stirring rod and inspect for sludge or wax adhering to the rod. If there is sludge or wax adhering to the rod, continue stirring until the sample is homogeneous.

7.2.4 Recap each container tightly and shake vigorously for 1 min. Then loosen the cap, retighten to finger tight, then back off ¾ turn to a full turn and place back into the sample pre-heat apparatus.

7.2.5 Upon completion of 7.2.4 for all samples in the batch, increase the sample pre-heat apparatus temperature to between 100 °C and 105 °C and continue heating for 30 min.

7.2.6 Remove each container from the sample pre-heat apparatus, close tightly, and shake vigorously for 60 s.

7.2.7 Using a volume delivery device such as a micropipette, introduce sufficient volume of the sample into the selected Houillon tube. The volume to be used is a function of the viscometer tube constant. The volume delivery device may be pre-warmed to facilitate transfer of highly viscous samples. (See Section 10.)

7.2.8 Analysis of all samples in the batch must be completed within 1 h from completion of 7.2.6.

8. Preparation of Apparatus

8.1 Place the automated viscometer on a stable and level horizontal surface. Make appropriate piping, drainage, and vacuum connections. Refer to the manufacturer's instructions.

8.2 If not already mounted, install the detection cells.

8.3 After installing and securing all viscometer tubes in the bath, fill the bath with appropriate amount of bath fluid (see 6.4).

8.4 Add the appropriate amount of solvent(s) to the solvent reservoir(s).

8.5 Follow the manufacturer's instructions for the operation of the instrument.

8.6 Select a clean, dry, and calibrated viscometer tube having a range covering the estimated kinematic viscosity of the specimen to be tested, if known. The appropriate viscometer tube to use depends on the estimated viscosity of the sample to be tested. The calculation in 8.6.1 may be used to decide which tube to use.

8.6.1 Using Eq 1, the viscometer tube should be chosen so that its constant C falls between $\nu/200 < C < \nu/30$ to give flow times, T, between 30 s and 200 s.

NOTE 1—In the interlaboratory study[5] conducted for the development of this test method, the flow times were between 30 s and 200 s.

8.6.2 If a viscosity estimate is not known, a second analysis may be necessary using a different viscometer tube after a first trial analysis.

9. Calibration

9.1 Calibrate according to the manufacturer's instructions. Calibrated tubes may be purchased but shall be verified as per 9.4.

9.2 Use certified viscosity reference standards (see 6.1).

9.3 Refer to Section 10 for general operation of the automated viscometer and to the manufacturer's instructions.

9.4 The determined kinematic viscosity should match the certified value within ±0.5 %. If it does not, then reanalyze the standard. If the value is still out of range, then check all control system settings for the viscometer tube, and recheck each step in the procedure, including the temperature measuring device, and viscometer calibration to locate the source of error.

NOTE 2—The most common sources of error are caused by particles of dust lodged in the capillary bore of the viscosity tube (particularly for used oils) and temperature measurement errors. Modification of the cleaning constants by increasing the number of cycles and increasing the aspiration time before and after passage of the solvent (see Section 11) may be required.

10. General Procedure for Kinematic Viscosity

10.1 Set and maintain the automated viscometer bath at the required test temperature.

10.1.1 Thermometers, if used, shall be held in an upright position under the same conditions of immersion as when calibrated.

10.2 Introduce a sufficient volume of sample to the Houillon tube, using a volume delivery device (see 5.1.9) such as a micro-pipette. The specimen volume to be used is a function of the viscometer tube constant (see Fig. 1). Fig. 2 shows the correct specimen levels during a measurement.

NOTE 3—Use a volume delivery device that is capable of introducing the entire specimen volume in one operation.

10.3 Introduce the specimen into the viscometer tube. Start the measurement sequence.

10.4 The automated viscometer processing system will measure the flow times, calculate the viscosity according to Eq 1, and record the result.

10.5 Start the cleaning sequence (see Section 11).

10.6 Allow the viscometer tube to reach the bath temperature (about 5 min) before performing a new measurement.

NOTE 4—In some units, the equilibration time required may be much less than 5 min.

11. Cleaning of Viscosity Tubes

11.1 The viscometer tubes are cleaned by vacuuming the specimen residue left in the viscometer tube followed by the use of a solvent to remove any traces of the specimen on the viscometer tube walls. The solvent is then removed by vacuum. Some units use a second solvent for drying the tube. This operation is repeated several times until the viscometer tube is clean. Periodically, the viscometer tube calibration constant should be checked.

---

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1604.

11.2 The solvent(s) should have a boiling point appropriate for the bath temperature.

11.2.1 The solvent flow must be sufficient to clean the entire internal section of the viscometer tube. This can be achieved by adjusting the solvent flow(s) and the flow rate using appropriate controls.

11.3 The cleaning of one tube shall not be carried out while a test is being performed in another tube in the same bath.

NOTE 5—Some multiple tube systems, although not included in the interlaboratory study[5] conducted to obtain the precision and bias of this test method, are designed to clean tubes while other tubes are performing viscosity measurements. Hence, this cleaning does not interfere with the validity of the tests underway in the instrument.

11.4 To ensure good operation, regularly check the viscometer tubes for damage and cleanliness. The latter can be done by checking with the reference oils suitable for the particular tube being used. Use these check oils like regular samples. If the results obtained are different from the certified values of these oils, it is necessary to carry out a more vigorous cleaning of the tubes in question. Non-chromium containing cleaning solution (see 6.2) may have to be used.

11.5 The frequency at which the tubes should be checked using reference oils depends on the frequency with which the tubes are used for measurements.

12. Quality Control/Quality Assurance (QC/QA)

12.1 Confirm proper performance of the instrument and the test procedure by analyzing a QC sample.

12.2 If a suitable QC oil sample is not available, prepare the QC material by replicate analyses of a batch of oil sample and statistically analyze the data to assign a mean value and uncertainty limit to the sample.

12.3 When QC/QA protocols are already established in the testing facility, these may be used when they confirm the reliability of the test result.

12.4 When there is no QC/QA protocol established in the testing facility, Appendix X1 can be used as the QC/QA system. Further guidance can be obtained from Guide D6792.

13. Report

13.1 Report the test results for the kinematic viscosity to four significant figures, together with the test temperature and reference to this test method.

14. Precision and Bias

14.1 *Precision for Used Oils*—Based on an interlaboratory study performed in 2004 using 10 used and 5 fresh oil samples (viscosity range 25 mm^2/s to 150 mm^2/s at 40 °C and 5 mm^2/s to 16 mm^2/s at 100 °C) and 15 laboratories, the following precisions were obtained.[5]

14.1.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty.

14.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following value only in one case in twenty.

Temperature	Repeatability	Reproducibility	Range
40 °C	0.68 %	3.0 %	25 mm^2/s to 150 mm^2/s
100 °C	1.6 %	5.6 %	5 mm^2/s to 16 mm^2/s

where precision is expressed relative to the average of two results in mm^2/s.

14.2 *Precision for Base Oil, Formulated Oil, Distillate Fuel, Biodiesel, and Biodiesel Blends at 40 °C*—Based on an interlaboratory study performed in 2008 using 26 samples of base oil, formulated oil, distillate fuel, biodiesel, and biodiesel blends at 40 °C (viscosity range 2 mm^2/s to 480 mm^2/s) and 7 laboratories using this test method, the following precisions were obtained.[6]

14.2.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty.

14.2.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following value only in one case in twenty.

Temperature	Repeatability	Reproducibility	Range
40 °C	1.07 %	1.51 %	2 mm^2/s to 480 mm^2/s

where precision is expressed relative to the average of two results in mm^2/s.

14.3 *Precision for Base Oil, and Formulated Oil at 100 °C*—Based on an interlaboratory study performed in 2008 using 23 samples of base oil and formulated oil at 100 °C (viscosity range 3 mm^2/s to 106 mm^2/s) and 6 laboratories using this test method, the following precisions were obtained.[6]

14.3.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty.

14.3.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following value only in one case in twenty.

Temperature	Repeatability	Reproducibility	Range
100 °C	0.95 %	2.01 %	3 mm^2/s to 106 mm^2/s

where precision is expressed relative to the average of two results in mm^2/s.

14.4 *Precision for Residual Fuel Oil and Residual Marine Fuel 50 °C*—Based on an interlaboratory study performed in

---

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1775. Contact ASTM Customer Service at service@astm.org.

2015 using 10 samples of residual fuels at 50 °C (viscosity range 25 mm^2/s to 2500 mm^2/s) and 10 laboratories using this test method, the following precisions were obtained.[7]

14.4.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty.

14.4.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following value only in one case in twenty.

Temperature	Repeatability	Reproducibility	Range
50 °C	10.0 %	17.5 %	25 mm^2/s to 2500 mm^2/s

where precision is expressed relative to the average of two results in mm^2/s.

NOTE 6—The degrees of freedom associated with the reproducibility estimate from this interlaboratory study for Test Method D7279 on residual fuels are 29. Since the minimum requirement of 30 (in accordance with Practice D6300) is not met, users are cautioned that the actual reproducibility may be significantly different than these estimates.

14.5 *Precision for Residual Fuel Oil and Residual Marine Fuel 100 °C*—Based on an interlaboratory study performed in 2015 using 10 samples of residual fuels at 100 °C (viscosity range 6 mm^2/s to 110 mm^2/s) and 11 laboratories using this test method, the following precisions were obtained.[7]

14.5.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty.

14.5.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following value only in one case in twenty.

Temperature	Repeatability	Reproducibility	Range
100 °C	7.5 %	11.1 %	6 mm^2/s to 110 mm^2/s

where precision is expressed relative to the average of two results in mm^2/s.

14.6 Bias has not been determined since no accepted reference material suitable for determining the bias for the procedure in this test method is available.

14.7 *Relative Bias of Used Oils:*[5]

14.7.1 Based on an interlaboratory study performed in 2004 using 10 used and 5 fresh oil samples (viscosity range 25 mm^2/s to 150 mm^2/s at 40 °C and 5 mm^2/s to 16 mm^2/s at 100 °C) and 15 laboratories using this test method, 10 laboratories for Test Method D445, the following relative bias statements were obtained:

14.7.1.1 The degree of expected agreement between viscosity results measured in this ILS by this test method and Test Method D445 has been assessed in accordance with Practice D6708 as shown in the following equations:

$$\text{At } 40\ °\text{C}\ \ D445_{\text{predicted}} = (\text{Houillon Viscosity Result}) - 0.290 \quad (2)$$

$$\text{At } 100\ °\text{C}\ \ D445_{\text{predicted}} = (\text{Houillon Viscosity Result}) - 0.133 \quad (3)$$

NOTE 7—In accordance with Practice D6708, use of these equations will significantly improve the agreement between these two test methods.

14.8 *Relative Bias of Base Oil, Formulated Oil, Distillate Fuel, Biodiesel, and Biodiesel Blends at 40 °C:*[6]

14.8.1 Based on an interlaboratory study performed in 2008 using 26 samples of base oil, formulated oil, distillate fuel, biodiesel, and biodiesel blends at 40 °C (viscosity range 2 mm^2/s to 480 mm^2/s) and 7 laboratories using this test method, and 6 laboratories for Test Method D445, the degree of expected agreement between results by this test method and results by Test Method D445 has been assessed in accordance with Practice D6708.

14.8.2 No bias-correction considered in Practice D6708 can further improve the agreement between results from Test Method D7279 and Test Method D445, for material types and property ranges studied. No sample-specific bias, as defined in Practice D6708, was observed.

14.8.3 Differences between results from Test Method D7279 and Test Method D445, for the sample types and property ranges studied, are expected to exceed the following Between Methods Reproducibility (R_{xy}), as defined in Practice D6708, about 5 % of the time.

$$\text{Between Methods Reproducibility } (R_{xy}) = (0.5\ R_x^2 + 0.5\ R_y^2)^{0.5} \quad (4)$$

where:

R_{D7279} = in the range 2 mm^2/s to 480 mm^2/s, and
R_{D445} = in the range 2 mm^2/s to 480 mm^2/s.

14.9 *Relative Bias of Base Oil, and Formulated Oil at 100 °C:*[6]

14.9.1 Based on an interlaboratory study performed in 2008 using 23 samples of base oil and formulated oil at 100 °C (viscosity range 3 mm^2/s to 106 mm^2/s) and 6 laboratories using this test method, and 8 laboratories for Test Method D445, the degree of expected agreement between results by this test method and results by Test Method D445 has been assessed in accordance with Practice D6708.

14.9.2 The degree of agreement between results from Test Method D7279 and Test Method D445 can be further improved by applying the bias-correction outlined in Eq 5. Sample specific bias, as defined in Practice D6708, was observed for some samples after applying the bias correction for material types and property ranges studied.

$$(D445)_{\text{predicted}} = (D7279) \times 0.9951 \quad (5)$$

14.9.3 Differences between results from Test Method D7279 and Test Method D445, for the sample types and property ranges studied, are expected to exceed the following Between Methods Reproducibility (R_{xy}), as defined in Practice D6708, about 5 % of the time.

$$\text{Between Methods Reproducibility } (R_{xy}) = (4.92\ R_x^2 + 4.968\ R_y^2)^{0.5} \quad (6)$$

---

[7] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1834. Contact ASTM Customer Service at service@astm.org.

where:

R_{D7279} = in the range 3 mm^2/s to 106 mm^2/s, and
R_{D445} = in the range 3 mm^2/s to 106 mm^2/s.

14.10 *Relative Bias of Residual Fuel Oil and Residual Marine Fuel 50 °C*[7]:

14.10.1 Based on an interlaboratory study performed in 2015 using 10 samples of residual fuels at 50 °C (viscosity range 25 mm^2/s to 2500 mm^2/s) and 10 laboratories using this test method, and 10 laboratories for Test Method D445, the degree of expected agreement between results by this test method and results by Test Method D445 has been assessed in accordance with Practice D6708.

14.10.2 The degree of agreement between results from Test Method D7279 and Test Method D445 can be further improved by applying the bias-correction outlined in Eq 7. No sample-specific bias, as defined in Practice D6708, was observed after the bias-correction for the materials and property range listed below.

$$(\mathrm{D445}_{\mathrm{predicted}}) = (\mathrm{D7279}) \times 0.97 \tag{7}$$

14.10.3 Differences between results from Test Method D7279 and Test Method D445, for the sample types and property ranges studied, are expected to exceed the following Between Methods Reproducibility (R_{xy}), as defined in Practice D6708, about 5 % of the time.

$$\text{Between Methods Reproducibility}(R_{xy}) = (0.47R_x^2 + 0.5 \quad R_y^2)^{0.5} \tag{8}$$

where:

R_{D7279} = in the range 25 mm^2/s to 2500 mm^2/s, and
R_{D445} = in the range 25 mm^2/s to 2500 mm^2/s.

14.11 *Relative Bias of Residual Fuel Oil and Residual Marine Fuel 100 °C*[7]:

14.11.1 Based on an interlaboratory study performed in 2015 using 10 samples of residual fuels at 100 °C (viscosity range 6 mm^2/s to 110 mm^2/s) and 11 laboratories using this test method, and 10 laboratories for Test Method D445, the degree of expected agreement between results by this test method and results by Test Method D445 has been assessed in accordance with Practice D6708.

14.11.2 No bias-correction considered in Practice D6708 can further improve the agreement between results from Test Method D7279 and Test Method D445, for material types and property ranges studied. Sample-specific bias, as defined in Practice D6708, was observed.

14.11.3 Differences between results from Test Method D7279 and Test Method D445, for the sample types and property ranges studied, are expected to exceed the following Between Methods Reproducibility (R_{xy}), as defined in Practice D6708, about 5 % of the time.

$$\text{Between Methods Reproducibility } (R_{xy}) = (0.55\ R_x^2 \ + 0.56\ R_y^2)^{0.5} \tag{9}$$

where:

R_{D7279} = in the range 6 mm^2/s to 110 mm^2/s, and
R_{D445} = in the range 6 mm^2/s to 110 mm^2/s.

15. Keywords

15.1 Houillon viscometer; kinematic viscosity; used oils

APPENDIX

(Nonmandatory Information)

X1. QUALITY CONTROL (QC)

X1.1 Confirm the performance of the instrument or the test procedure by analyzing a QC sample.

X1.2 Prior to monitoring the measurement process, the user of this test method needs to determine the average value and control limits of the QC sample. See Practices D6299, D6792, and MNL 7.[8]

X1.3 Record the QC results and analyze by control charts or other statistically equivalent technique to ascertain the statistical control status of the total testing process. See Practices D6299, D6792, and MNL 7.[8] Investigate any out-of-control data for root cause(s). The results of this investigation may, but not necessarily, result in instrument recalibration.

X1.4 In the absence of explicit requirements given in the test method, the frequency of QC testing is dependent on the criticality of the quality being measured, the demonstrated stability of the testing process, and customer requirements. Generally, a QC sample is analyzed each testing day with routine samples. The QC frequency should be increased if a large number of samples are routinely analyzed. However, when it is demonstrated that the testing is under statistical control, the QC testing frequency may be reduced. The QC sample precision should be checked against the ASTM test method precision to ensure data quality.

X1.5 It is recommended that, if possible, the type of QC sample that is regularly tested be representative of the materials routinely analyzed. An ample supply of the QC sample material should be available for the intended period of use, and must be homogenous and stable under the anticipated storage conditions. See Practices D6299, D6792, and MNL 7,[8] or a combination thereof, for further guidance on QC and control charting techniques.

---

[8] ASTM Manual MNL 7, *Manual on Presentation of Data and Control Chart Analysis*, 6th edition. Available from ASTM Headquarters, West Conshohocken, PA.

SUMMARY OF CHANGES

Subcommittee D02.07 has identified the location of selected changes to this standard since the last issue (D7279 – 14a) that may impact the use of this standard. (Approved June 1, 2016.)

(1) Revised subsections 1.1 and 1.2 in Scope.
(2) Revised Section 7, adding new subsection 7.2.
(3) Revised Section 14, adding new subsections 14.4, 14.5, 14.10, and 14.11.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/