



# Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids by Automated Houillon Viscometer<sup>1</sup>

This standard is issued under the fixed designation D 7279; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the measurement of the kinematic viscosity of transparent and opaque liquids such as fresh and used lubricating oils using a Houillon viscometer in automated mode.

1.2 The range of kinematic viscosity covered by this test method is from 0.2 to 1000 mm<sup>2</sup>/s in the temperature range between 20°C and 150°C; however, the precision has only been determined for the materials, viscosity range, and temperatures as stated in the precision section (viscosity range 25 to 150 mm<sup>2</sup>/s at 40°C and 5 to 16 mm<sup>2</sup>/s at 100°C).

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:*<sup>2</sup>
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
  - D 2162 Practice for Basic Calibration of Master Viscometers and Viscosity Oil Standards
  - D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products
  - D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
  - D 6299 Practice for Applying Statistical Quality Assurance Techniques to Evaluate Analytical Measurement System Performance

- D 6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
- D 6792 Practice for Quality System in Petroleum Products and Lubricants Testing Laboratories
- D 7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

### 2.2 ISO Standards:

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

### 2.3 NIST Standard:

- NIST Technical Note 1297 Guideline for Evaluating and Expressing the Uncertainty of NIST Measurement Results<sup>4</sup>

## 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 injected into the apparatus and then flows into the viscometer tube which is equipped with two detection cells. The specimen reaches the test temperature of 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:

$$\nu = C \times t \quad (1)$$

where:

- $\nu$  = the kinematic viscosity in mm<sup>2</sup>/s,
- $C$  = the viscometer tube constant in mm<sup>2</sup>/s, and

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.07 on Flow Properties.

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<sup>2</sup> 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.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>4</sup> Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 3460, Gaithersburg, MD 20899-3460.

$t$  = 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. 1). This technique allows the viscosity to be measured over a wide range of values (see Fig. 2).

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.

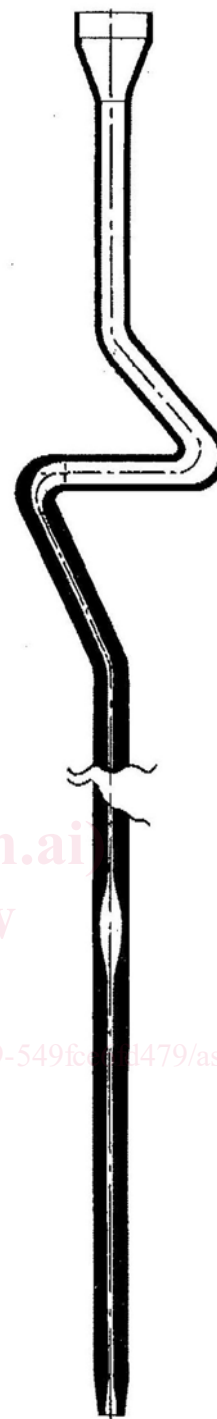
5.1.7 *Temperature Measuring Devices*—Use either calibrated liquid-in-glass thermometers, of an accuracy after correction of  $\pm 0.02^\circ\text{C}$  or better, or other thermometric devices of equal or better accuracy.

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  $\pm 0.07\%$  of the reading when tested over the minimum and maximum intervals of expected flow times.

5.1.9 *Micropipette*, of a volume range from 50 to 250  $\mu\text{L}$  with an absolute precision of  $\pm 2.5\ \mu\text{L}$ .

#### 6. Reagents and Materials

6.1 Certified viscosity reference standards shall be certified by a laboratory that has been shown to meet the requirements



**FIG. 1 Houillon Tube Schematic Diagram**

of **ISO/EC 17025** by independent assessment. The certified viscosity reference standards shall be traceable to master viscometer procedures described in Test Method **D 2162**.

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