



Designation: D2983 – 23

Standard Test Method for Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants using a Rotational Viscometer¹

This standard is issued under the fixed designation D2983; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the use of rotational viscometers with an appropriate torque range and specific spindle for the determination of the low-shear-rate viscosity of automatic transmission fluids, gear oils, hydraulic fluids, and some lubricants. This test method covers the viscosity range of 300 mPa·s to 900 000 mPa·s

1.2 This test method was previously titled “Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer.” In the lubricant industry, D2983 test results have often been referred to as “Brookfield² Viscosity” which implies a viscosity determined by this method.

1.3 This test method contains four procedures: Procedure A is used when only an air bath is used to cool samples in preparation for viscosity measurement. Procedure B is used when a mechanically refrigerated programmable liquid bath is used to cool samples in preparation for viscosity measurement. Procedure C is used when a mechanically refrigerated constant temperature liquid bath is used to cool samples by means of a simulated air cell (SimAir)³ Cell in preparation for viscosity measurement. Procedure D automates the determination of low temperature, low-shear-rate viscosity by utilizing a thermoelectrically heated and cooled temperature-controlled sample chamber along with a programmable rotational viscometer.

1.4 There are multiple precision studies for this test method.

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.

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² Brookfield viscometer and accessories are a trademark of AMETEK Brookfield, Inc, 11 Commerce Blvd., Middleboro, MA 02346, <http://www.brookfieldengineering.com>.

³ SimAir is a trademark of Tannas Co., 4800 James Savage Rd., Midland, MI 48642, <http://www.savantgroup.com>.

1.4.1 The viscosity data used for the precision studies for Procedures A, B, and C covered a range from 300 mPa·s to 170 000 mPa·s at test temperatures of –12 °C, –26 °C, and –40 °C. **Appendix X5** includes precision data for –55 °C test temperature and includes samples with viscosities greater 500 000 mPa·s.

1.4.2 The viscosity data used for Procedure D precision study was from 6400 mPa·s to 256 000 mPa·s at test temperatures of –26 °C and –40 °C.

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

1.5.1 The test method uses the SI unit, milliPascal-second (mPa·s), as the unit of viscosity. (1 cP = 1 mPa·s).

1.6 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use Caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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

2. Referenced Documents

2.1 ASTM Standards:⁴

- D341** Practice for Viscosity-Temperature Equations and Charts for Liquid Petroleum or Hydrocarbon Products
 - D2162** Practice for Basic Calibration of Master Viscometers and Viscosity Oil Standards
 - D4175** Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
 - D5133** Test Method for Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature-Scanning Technique
 - D5293** Test Method for Apparent Viscosity of Engine Oils and Base Stocks Between –10 °C and –35 °C Using Cold-Cranking Simulator
 - D6708** Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material
 - D6821** Test Method for Low Temperature Viscosity of Drive Line Lubricants in a Constant Shear Stress Viscometer
 - D7962** Practice for Determination of Minimum Immersion Depth and Assessment of Temperature Sensor Measurement Drift
 - D8210** Test Method for Automatic Determination of Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants Using a Rotational Viscometer
 - D8278** Specification for Digital Contact Thermometers for Test Methods Measuring Flow Properties of Fuels and Lubricants
 - E1** Specification for ASTM Liquid-in-Glass Thermometers
- ### 2.2 ISO Standard:⁵
- ISO 17025** General requirements for the competence of testing and calibration laboratories

3. Terminology

3.1 Definitions:

3.1.1 *apparent viscosity, n*—the determined viscosity obtained by use of this test method. **D4175**

3.1.1.1 *Discussion*—Apparent viscosity may vary with the spindle speed (shear rate) of a rotational viscometer if the fluid is non-Newtonian. See **Appendix X1** for a brief explanation.

3.1.2 *digital contact thermometer (DCT), n*—an electronic device consisting of a digital display and associated temperature sensing probe.

3.1.2.1 *Discussion*—This device consists of a temperature sensor connected to a measuring instrument; this instrument measures the temperature-dependent quantity of the sensor, computes the temperature from the measured quantity, and provides a digital output. This digital output goes to a digital display and/or recording device that may be internal or external to the device.

3.1.2.2 *Discussion*—The devices are often referred to as a “digital thermometers,” however the term includes devices that sense temperature by means other than being in physical contact with the media.

3.1.2.3 *Discussion*—PET is an acronym for portable electronic thermometers, a subset of digital contact thermometers (DCT).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *blank sample, n*—a Newtonian standard reference fluid used to monitor the temperature experienced by the sample in the cold-air cabinet by inserting a thermometric device while placed in the center of the turntable; this fluid shall have a viscosity as low as possible and be changed on a regular basis.

3.2.2 *final test temperature, n*—for the programmable liquid bath is the test temperature at which the liquid bath will be held for the rest of the 16 h after the cooling profile is completed.

3.2.3 *intermediate setpoints, n*—for the programmable liquid bath are the series of setpoints the bath is taken through while the cooling profile is executing. This cooling profile calculated from **A2.2** is automatically executed by the software.

3.2.4 *reference viscosity, n*—the viscosity of Newtonian reference fluid whose values were determined by the use of a master viscometer at one or more temperatures; reference viscosities of typical standard reference fluids used in Procedures A, B, and C are listed in **Appendix X2**.

3.2.5 *initial viscosity, n*—the viscosity measured during the first 5 s to 10 s of spindle rotation.

3.2.5.1 *Discussion*—For Procedure D, which is conducted at multiple speeds, this is 7 s to 9 s of spindle rotation at the indicated speed.

3.2.6 *stabilized viscosity, n*—the viscosity measured after 60 s to 180 s of spindle rotation.

3.2.6.1 *Discussion*—For Procedure D, which is conducted at multiple speeds, this is 160 s to 179 s of spindle rotation at the indicated speed.

3.2.7 *Procedure A*—This test protocol utilizes an air bath for the cooling portion of the test and then requires moving the test cells to either a constant liquid bath or balsa blocks during the viscosity analysis.

3.2.8 *Procedure B*—This test protocol utilizes a programmable liquid bath to cool the samples at a pre-determined rate and then the viscosity analysis is performed in the same bath.

3.2.8.1 *starting temperature, n*—for the programmable liquid bath, used in Procedure B, is the temperature of the liquid bath at which the samples are loaded into the turn table. This is calculated from **A2.2** at zero time. The software provided with the programmable liquid bath automatically calculates this value.

3.2.9 *Procedure C*—This test protocol utilizes a constant liquid bath and Sim-Air cells, which allow the samples to cool at the same rate as the air bath, and be tested within the same constant liquid bath.

3.2.10 *Procedure D*—This test protocol uses a programmable rotational viscometer paired with a thermoelectrically

⁴ 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.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.