Designation: ~~D2556 – 11~~ D2556 – 14

Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry[1]

This standard is issued under the fixed designation D2556; 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 measurement of the apparent viscosity of shear-rate-dependent ~~adhesives.~~adhesives using a rotational viscometer.

1.2 The values stated in SI units are to be regarded as standard. ~~The values given in parentheses are for information only.~~No other units of measurement are included in this standard.

1.3 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D907 Terminology of Adhesives

3. Terminology

3.1 *Definitions:*

3.1.1 Many terms in this test method are defined in Terminology D907.

3.1.2 *Newtonian behavior, n*—the property of a liquid in which its viscosity is constant over a stated range of strain rates. (Compare *non-Newtonian behavior*.)

3.1.3 *non-Newtonian behavior, n*—the property of a liquid in which its viscosity is not constant over a stated range of strain rates.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent viscosity, n*—resistance to shear at a given rate of shear, expressed as viscosity in ~~absolute units.~~ mPa·s.

NOTE 1—The SI unit of mPa·s is equivalent to cP.

3.2.2 *thixotropic index, n*—the ratio of apparent viscosities at two rotational speeds.

4. Significance and Use

4.1 The principle of measurement is based upon a reversible isothermal change in apparent viscosity with change in rate of ~~shear.~~shear produced by a change in rotational speed.

4.2 Measurement is performed with a ~~spindle, disk, T-bar, or coaxial cylinder~~ rotational viscometer under standardized conditions with rigid control of the time intervals of measurement. ~~Readings~~ Viscosity readings are obtained ~~on the viscometer dial scale~~ at the end of 1 min for each rotational speed. Changes from the lowest speed to the highest speed, and return to the lowest speed, are made without stopping the instrument.

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.10 on Working Properties.
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[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.

5. Apparatus

5.1 *Rotational Viscometer*—The ~~apparatus consists of a spindle,~~essential instrumentation required providing ~~disk, T-bar, or coaxial-type viscometer with appropriate spindles, disks, T-bars, or cylinders. Do not use a scored, warped, or otherwise damaged spindle, disk, T-bar, or cylinder. Except when using the coaxial cylinder-type viscometer, the size of container to be used is determined by mutual agreement. Some instruments have two concentric scales, and care is to be taken to read the pointer on the correct scale.~~the minimum rotational viscometer analytical capabilities include:

5.1.1 A *drive* motor, to apply a unidirection rotational displacement to the specimen at a rate of 0.2 revolutions per minute to 60 rev/min constant to within ±1%.

5.1.2 A *force sensor* to measure the torque developed by the specimen to within ±1%.

5.1.3 A *coupling* shaft or other means to transmit the rotational displacement from the motor to the specimen.

5.1.4 A *spindle, geometry, tool, or rotational element* to fix the specimen between the drive shaft and a stationary position.

NOTE 2—Each rotational element typically covers a range of 1.5 decades of viscosity. The rotational element may be a spindle, disk, T-bar, coaxial cylinder of other configuration selected by mutual agreement among the parties involved.

NOTE 3—Do not use a scored, warped, or otherwise damaged rotational element.

5.1.5 A specimen *container* with capacity to contain the test specimen during testing.

NOTE 4—The size of the container used is determined by the size and design of the rotational element used. The container used may be specified by mutual agreement among the parties involved.

5.1.6 A *guard* to protect the geometry from mechanical damage.

5.1.7 A *temperature sensor* to provide an indication of the specimen temperature in the range from 21 to 25°C readable to within ±0.2°C.

NOTE 5—Other temperatures may be used but shall be reported.

5.1.8 A *data collection* device to provide a means of acquiring, storing and displaying measured or calculated signals, or both. The minimum output signals required for rotational viscometry are torque, rotational speed, temperature and time.

5.1.9 A *stand* to support, level, and adjust the height of the drive motor, shaft and rotational element.

5.1.10 Auxiliary instrumentation considered necessary or useful in conducting this method includes:

5.1.10.1 *Data analysis capability* to provide viscosity, stress or other useful parameters derived from the measured signals.

5.1.10.2 A *level* to indicate the vertical plumb of the drive motor, shaft, and spindle.

~~5.2 *Supporting Stand*[4]—Use a support for the viscometer which consists of a suitable stand with a supporting arm capable of being lowered or raised either manually or mechanically.~~

~~5.3 *Thermometer*—Use a precision thermometer, with graduations not greater than 0.2°C (0.5°F), for temperature measurements.~~

6. Conditioning

6.1 Condition the adhesive sample and instrument at 23 ± 0.5°C ~~(73.4 ± 1.0°F) (or other temperature agreed upon between the adhesive vendor and the purchaser)~~ for at least 16 ~~h. If~~h (see Note 5~~special conditioning methods are necessary, such as the use of a circulating water bath, they shall be noted in the report, see~~).~~8.1.4.~~

7. Procedure

7.1 Select a rotational viscometer and ~~spindle (see~~rotational element ~~Table X1.1), disk, T-bar, or cylinder~~ suited to the viscosity range of the test material such that the ~~model-speed-rotational~~ rotational speed and rotational element combination will give ~~dial readings~~ a torque reading between 20 and 80 % of the ~~full-scale reading. Firmly fit the rotational element into the shaft extension which goes down through the center of the dial casing. Place the viscometer on the supporting stand so that the rotational element is vertical. Slowly immerse the rotational element in the sample to the depth recommended by the manufacturer of the apparatus or, where this is not clearly indicated, to a depth agreed upon between the adhesive vendor and the purchaser. Take care as the rotational element is lowered into the solution to ensure that no air is trapped under or around it. See~~ full scale.~~Appendix X1~~ ~~for example of spindle selection.~~

7.2 Assemble the motor, shaft, and rotational element and mount them vertically plumb on the stand over the container.

7.3 Pour a quantity of the test specimen into the container sufficient to cover the immersed rotational element.

7.4 Slowly immerse the rotational element in the test specimen to the depth recommended by apparatus manufacturer.

NOTE 6—Other immersion depths may be used but shall be reported.

NOTE 7—Take care as the rotational element is lowered into the solution to ensure that no air is trapped under or around it.

7.5 ~~With the rotational element immersed in the adhesive, start the motor of the viscometer~~ Start the viscometer motor at the lowest rotational speed. Maintain this speed for ~~exactly 1 min. Without stopping the motor, increase the speed to the next indicated measure of rotation, etc., at 1-min (±2 s) intervals, until the maximum readable rotation has been achieved. At the end of 1 min~~