Designation: ~~D8162 – 20~~ D8162 – 20a

Standard Test Method for Determination of the Apparent Viscosity of Thermoplastic Pavement Marking Materials using a Rotational Viscometer with Temperature Control Heating Unit[1]

This standard is issued under the fixed designation D8162; 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.

1. Scope

1.1 This test method covers the sample preparation and testing procedure needed to determine the apparent viscosity of a thermoplastic pavement marking formulation at elevated temperatures to the specimen.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are customary units and are provided as a courtesy to the user.

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

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics
D7307 Practice for Sampling of Thermoplastic Traffic Marking Materials
D7308 Practice for Sample Preparation of Thermoplastic Pavement Marking Materials
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E284 Terminology of Appearance
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2975 Test Method for Calibration or Calibration Verification of Concentric Cylinder Rotational Viscometers

3. Terminology

3.1 The terms and definitions in Terminology D883 and Terminology E284 apply to this test method.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

Current edition approved ~~June 1, 2020~~Sept. 1, 2020. Published September 2020. Originally approved in 2020. Last previous edition approved in 2020 as D8162 – 20. DOI: ~~10.1520/D8162-20.~~10.1520/D8162-20A.

[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.

3.2.1 *apparent viscosity, n*—the viscosity determined by this test method can be expressed in millipascal seconds, Centipoise, and Poise. Common viscosity units of Poise (P) are related to the SI units by the equivalency 1 cP = 1 mPa·s.

3.2.1.1 *Discussion*—

An apparent viscosity value may vary with the spindle and rotational speed elected for measuring non-Newtonian materials.

3.2.2 *thermoplastic pavement marking (material), n*—a highly filled 100 % total solids highway marking system that when heated to a molten state can be extruded or sprayed onto a road surface. Retroreflective optics are applied (dropped on) to the surface of the molten marking immediately after application to provide, when cooled, a solid durable delineator or thermoplastic pavement marking usually melted to ~218°C (425°F)

3.2.3 *viscosity, n*—the ratio of shear stress to shear rate.

3.2.3.1 *Discussion*—

The viscosity of a liquid is a measure of the resistance to flow of the liquid. The SI unit of dynamic viscosity is the pascal second. For a Newtonian liquid, the viscosity is constant at all shear rates. For a non-Newtonian liquid, viscosity will vary depending on shear rate.

4. Summary of Test Method

4.1 This viscosity method is used to determine the apparent viscosity of thermoplastic pavement marking products at elevated temperatures. Apparent viscosity is determined under temperature equilibrium conditions using a rotating spindle type viscometer. The torque on a spindle rotating in a temperature-controlled sample holder containing a small amount of sample is used to measure the relative resistance to rotation. A factor is applied to the torque reading to yield the viscosity in mPa·s (cP or Poise).

5. Significance and Use

5.1 This test method is used to measure the apparent viscosity of thermoplastic pavement marking at elevated temperatures. Elevated temperature viscosities of thermoplastic pavement marking may be related to the properties of coatings, adhesives, and composite thermoplastics. This method is helpful in determining the flow properties which can be used in determining processability when applied to the road surface.

5.2 Thermoplastic pavement markings may be applied to the road surface in several different ways. Typical methods of application are screed extrude, ribbon extrude, thin film spray, and standard spray. Proper application depends on the viscosity of the thermoplastic material at application temperatures for the method being used. Thin-line applied thermoplastic pavement marking, for example, requires a relatively lower viscosity. Screed extrude applied thermoplastic requires a higher viscosity.

5.3 Materials of the type described in this procedure may be non-Newtonian, and as such, the apparent viscosity will be a function of shear rate under the conditions of test. Although the viscometer described in this test method operates under conditions of relatively low shear rate, differences in shear effect can exist depending upon the spindle and rotational speed conditions selected for the test program. Comparisons between non-Newtonian viscosity values should be made only for measurements made with similar viscometers under conditions of equivalent shear. For this method, “torpedo” spindles are recommended. Spindles considered torpedo spindles are ~1-in. long and come in many diameters with a 45° conical bottom. A diameter that is half the diameter of the thimbles used is recommended. If large glass beads are used in the pavement marking formulation, a smaller diameter spindle may be needed so the beads do not cause an impedance of the spindle due to a jamming between the inside wall of the thimble and the spindle.

6. Interferences

6.1 Thermoplastic pavement marking products can change in viscosity over extended periods of heat history; therefore, it is recommended that these type viscosities be performed on product samples which have the same heat history in order to lower deviation of comparative results.

6.2 Thermoplastic pavement marking products contain glass beads which can settle quickly if the formulation is not stirred constantly. Because of that fact, some formulations may have too low of viscosity to stay homogeneous at the commonly used processing temperature 218°C (425°F) for any length of time for the test sample’s temperature and viscosity to be stable. Therefore, a pre-set time-period may be necessary after the sample is placed in the thimble and heater at which to record the viscosity.

7. Apparatus

7.1 *Viscometer, Rotational*—The essential instrumental required providing the minimum rotational viscometer analytical capabilities include:

7.1.1 A *drive motor*, to apply a unidirectional torque to the specimen constant to ±1 %;

7.1.2 A *force sensor* to measure the torque developed by the specimen readable to within ±1 %;

7.1.3 A *coupling shaft* or other means to transmit the rotational force from the motor;

7.1.4 A *spindle, rotational element, geometry or tool* to fix the specimen between the drive shaft and a stationary position. The spindle has a torpedo shape as in Fig. 1. Note: For this testing we are recommending a nominal length (L) of 33.0 mm and a diameter (D) of 11.8 mm. Different sizes can be chosen to be run with agreement between the buyer and seller of the product. Where more than one spindle is available for the range selected, choose a spindle that produces results nearest the midpoint of the measurable viscosity (or torque or rotational speed) range;

7.1.5 A *specimen container (thimbles)*, matched to the spindle and heating chamber to provide, a shear rate of $0.34s^{-1}$ times the rotational speed in r/min, with a total capacity of 25 ml, to contain the test specimen and spindle during the testing. Can be stainless steel or disposable aluminum. Note: A thimble sample holder/rack should come with the viscometer which helps indicate fill height;

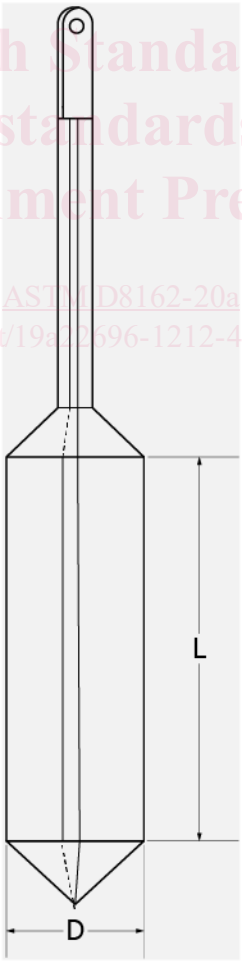

FIG. 1 Spindle

NOTE 1—**Warning—**Care must be taken in the storage and handling of spindles and assemblies. Protect them from scratches, dust, corrosive-deposits, and mechanical abuse. Replace the spindle extension if it is bent. Avoid touching the calibrated section of the spindle with hands. Clean the spindle and sample chamber thoroughly after each use. A recommended cleaning procedure is included in the procedure.

7.1.6 *Data analysis capability* to provide viscosity, stress, shear rate, or other useful parameters derived from measured signals (of torque and rotational speed).

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

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

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

7.1.8 *Temperature Controller and Sample Chamber*, designed for use with the viscometer in 7.1, complete with locating ring, leveling screws, safety guard, spindle extension, insulating cap, upright rod, cooling plus (optional), and extracting tool. The precision temperature controller provides control accuracy of 1.0°C or better through the range from 100 to 150°C (212 to 302°F) and 2.0°C or better through the range from 150 to 300°C (302 to 572°F).

8. Reagents and Materials

8.1 *Safety glasses,*

8.2 *Tongs or small pliers,* and,

8.3 *Insulated gloves.*

9. Hazards

9.1 Safety glasses should be worn when performing this testing since the molten thermoplastic pavement marking is usually tested in the ~218°C (425°F) range. Leather/insulated gloves and tongs should be used when handling the hot spindles, cups, and viscometer accessories.

10. Sampling, Test Specimens, and Test Units

10.1 Sample the thermoplastic pavement marking material per Practice D7307.

10.2 Mix and melt the sampled thermoplastic pavement marking material per Practice D7308.

10.3 A 400-g amount of thermoplastic pavement marking material is an adequate amount for mixing properly before performing this testing.

11. Calibration and Standardization

11.1 Calibration can be performed using the techniques referenced in Test Method E2975. Calibration shall be performed with Newtonian reference materials using experimental conditions such as temperature, viscosity range, and shear rate (rotational speed), as close as practical to those to be used for measurement of test specimens; however, no standard fluid currently exists which is calibrated over 149°C (300°F).

12. Procedure

12.1 Approximately 30 min before testing, turn on heating chamber unit and oven, and set to the required processing temperature.

12.2 Hang the desired spindle on the viscometer and lower into the heating chamber set at the desired temperature.

12.3 Place the insulating cap over the chamber opening.

12.4 Place several stainless steel (or disposable aluminum) sample chambers (thimbles) in the holding rack in an oven set at the required processing temperature (same temperature as the heating chamber for the viscometer).