Designation: D 4402 – 87 (Reapproved 2000)ε1

Standard Test Method for Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus[1]

This standard is issued under the fixed designation D 4402; 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.

ε[1] NOTE—Editorial changes were made throughout in January 2000.

1. Scope

1.1 This test method outlines a procedure for measuring the apparent viscosity of asphalt from 38 to 260°C (100 to 500°F) using the Brookfield Thermosel apparatus.

1.2 *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.* See 7.6 for specific precautionary information.

2. Referenced Documents

2.1 *ASTM Standards:*

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup[2]

3. Terminology

3.1 *apparent viscosity*—the ratio of shear stress to shear rate for a Newtonian or non-Newtonian liquid.

3.2 *Newtonian liquid*—a liquid for which the rate of shear is proportional to the shearing stress. The constant ratio of the shearing stress to the rate of shear is the viscosity of the liquid. If the ratio is not constant, the liquid is non-Newtonian. Many liquids exhibit both Newtonian and non-Newtonian behavior, depending on the shear rate.

3.3 *viscosity*—the ratio between the applied shear stress and the rate of shear is called the coefficient of viscosity. This coefficient is a measure of the resistance to flow of the liquid. It is commonly called the viscosity. The SI unit of viscosity is the pascal second (Pa·s). The centimetre gram second (cgs) unit of viscosity is the poise (dynes/cm^2) and is equivalent to 0.1 Pa·s. Frequently, centipoise (cP)—equal to one millipascal second (mPa·s)—is used as the viscosity unit.

4. Summary of Test Method

4.1 The Brookfield Thermosel Viscometer described in this procedure can be used to measure the viscosity of asphalt at elevated temperatures. The torque on a spindle rotating in a special thermostatically controlled sample holder containing a small sample of asphalt is used to measure the relative resistance to rotation. A factor is applied to the torque dial reading to yield the viscosity of the asphalt in millipascal seconds.

5. Significance and Use

5.1 This test method can be used to measure the apparent viscosity of asphalts at application temperatures.

5.2 Some asphalts may exhibit non-Newtonian behavior under the conditions of this test, or at temperatures within the range of this method. Since non-Newtonian viscosity values are not unique material properties but reflect the behavior of the fluid and the measurement system, it should be recognized that measurements made by this method may not always predict performance under the conditions of use.

5.3 Comparisons between non-Newtonian viscosity values should be made only for measurements made with similar viscometers under similar conditions of shearing stress and shear history.

6. Apparatus

6.1 *Brookfield Thermosel High Temperature Viscosity Measurement System Using a Standard Brookfield Synchro-Lectric Viscometer*—Depending on viscosity range Model LV, RV, HA, or HB series may be used.[3]

6.2 *Spindles for Brookfield Thermosel Viscometer*.

6.3 *Thermosel System*:

6.3.1 *Thermo Container and Sample Chamber*.

6.3.2 *SCR Controller and Probe*.

6.3.3 *Graph Plotting Equipment*.

7. Procedure for the Brookfield Thermosel

7.1 Read and understand the information in the instrument manufacturer's operating instructions before proceeding.

7.2 Turn on Thermosel power.

[1] This test method is under the jurisdiction of ASTM Committee D-8 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.03 on Surfacing and Bituminous Materials for Membrane Waterproofing and Builtup Roofing.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] Available from Brookfield Engineering Laboratories, Stoughton, MA 02072

7.3 Set the proportional temperature controller to desired test temperature.

7.4 Refer to the operating instructions for calibration of the controller.

7.5 Wait 1.5 h (or until equilibrium temperature is obtained) with the selected spindle in the chamber (check control lamp).

7.6 Remove sample holder and add the volume of sample specified for the spindle to be used. Exercise caution to avoid sample overheating and to avoid ignition of sample with low flash point. Calculate the mass required from specific gravity or density data for the sample. Approximately 8 to 10 mL will be required.

7.7 Do not overfill the sample container. The sample volume is critical to meet the system calibration standard. Thoroughly stir filled asphalt coatings to obtain a representative sample.

7.8 The liquid level should intersect the spindle shaft at a point approximately 3.2 mm (⅛in.) above the upper "conical body"—"spindle shaft" interface.

7.9 Using the extracting tool, put the loaded chamber back into the thermo container.

7.10 Lower the viscometer and align the thermo-container.

7.11 Insert the selected spindle into the liquid in the chamber, and couple it to the viscometer. Proper spindle selection may require testing with more than one spindle.

7.12 Allow the asphalt to come to the equilibrium temperature (about 15 min)

7.13 Start Brookfield models RV, HA, HB viscometer at 20 rpm, LV model at 12 rpm. Observe the meter reading. If it is between 2 and 98 units, proceed with the test.

7.14 Record three readings 60 s apart at each test temperature.

7.15 Follow the procedure for each test temperature required.

7.16 If readings are above 98 units at the lowest test temperature, decrease the spindle rpm setting and continue with the test.

7.17 If the reading is above 98, use the next smaller spindle and repeat the procedure using the sample volume specified, see 7.6.

7.18 Multiply the viscosity factor by the Brookfield reading to obtain viscosity in centipoise.

7.19 Do not change the speed (rpm setting) during a viscosity measurement, as this will change the shear rate.

8. Report

8.1 Report test temperature, spindle number, and speed with results. For example, viscosity at 60°C = 105 mPa with spindle number.

8.2 Plot viscosity value versus actual test temperature for each of the three or more test temperatures and draw a curve.

9. Precision and Bias

9.1 The following criteria shall be used for judging the acceptability of any result (95 % confidence level).

9.1.1 *Repeatability*—Duplicate values by the same operator shall not be considered suspect unless they differ by more than 3.5 %.

9.1.2 *Reproducibility*—The values reported by each of two laboratories, representing the arithmetic average of duplicate determinations, shall not be considered suspect unless they differ by more than 14.5 %.

9.2 *Bias*—The bias of this test method has not been determined.

10. Keywords

10.1 asphalt; Brookfield; Newtonian Liquid; shear stress; viscosity