Designation: D3346 – 12

Standard Test Methods for Rubber Property—Processability of Emulsion SBR (Styrene-Butadiene Rubber) With the Mooney Viscometer (Delta Mooney)[1]

This standard is issued under the fixed designation D3346; 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 These test methods explain the use of the shearing disk viscometer to obtain an indication of the processability of non-pigmented emulsion styrene-butadiene rubbers (SBR). They may also be used to separate those polymers that are easy to process from those that are difficult to process within a group of polymers of the same type.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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]

D1646 Test Methods for Rubber—Viscosity, Stress Relaxation, and Pre-Vulcanization Characteristics (Mooney Viscometer)

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3896 Practice for Rubber From Synthetic Sources—Sampling

D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

3. Terminology

3.1 *Definitions:*

3.1.1 Δ *Mooney, n*—the difference in Mooney viscosity recorded for a rubber at specified times during a test.

3.1.2 *Mooney viscosity, n*—measure of the viscosity of a rubber or rubber compound determined in a Mooney shearing disk viscometer; viscosity is indicated by the torque required to rotate a disk embedded in a rubber specimen and enclosed in the die cavity under specified conditions.

4. Summary of Test Methods

4.1 In Test Method A, the difference in Mooney viscosity at 100°C (212°F) is determined at two specified times. Either massed or unmassed samples may be used.

4.2 In Test Method B, the Mooney viscosity difference for unmassed samples is determined between the minimum recorded directly after starting the rotor and the subsequent maximum (see Fig. 1).

5. Significance and Use

5.1 These empirical tests have been found to be suitable for ranking a series of unpigmented emulsion SBR in order of processability. They may also be used for comparing a production lot with a standard of known processability characteristics. The difference between Mooney viscosities at two specified times will rank those emulsion SBR polymers that differ appreciably in this property according to their processability. The actual values obtained for a given polymer depend on whether or not the sample was massed, and may vary between laboratories or with the type of machine used, and with the specified times at which Mooney viscosity values were taken.

6. Apparatus

6.1 The apparatus shall be in accordance with the Apparatus section of Test Methods D1646.

6.2 The large rotor shall be used.

7. Sample Preparation

7.1 For sampling procedure, refer to Practice D3896.

7.2 Condition the sample until it has reached room temperature of 23 ± 3°C (73 ± 5.4°F) throughout.

[1] These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and are the direct responsibility of Subcommittee D11.12 on Processability Tests.

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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.

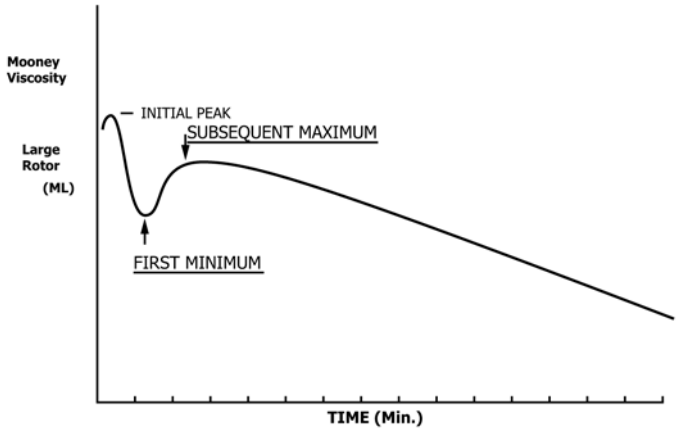

FIG. 1 Typical Mooney versus Time Curve for Processability Test of SBR

7.3 The tests can be performed using specimens taken from either massed or unmassed samples.

7.3.1 To mass a sample, pass 250 ± 5 g of the sample between the rolls of the standard laboratory mill described in Practice D3182. The mill shall have a roll temperature of 50 ± 5°C (122 ± 9°F) and a distance between the rolls of 1.4 ± 0.1 mm (0.055 ± 0.005 in.) as determined by a lead slug. Immediately fold the sample in half and insert the folded end into the mill for a second pass. Repeat this procedure until a total of nine passes have been completed. Immediately insert the rubber without folding into the mill for a tenth pass. Do not allow the sample to rest between passes or to band on the mill rolls at any time.

7.3.2 Allow the massed samples to rest at room temperature for at least 30 min before preparing the specimens and measuring their viscosity.

7.4 Condition unmassed samples until they have attained room temperature throughout before preparing the specimens and measuring their viscosity.

8. Test Temperature

8.1 The test temperature shall be 100 ± 0.5°C (212 ± 9°F). For a description of a suitable temperature-measuring system, refer to 6.1.3 of Test Methods D1646.

9. Calibration of Viscometer

9.1 Calibrate the shearing disk viscometer in accordance with the Calibration section of Test Methods D1646.

10. Specimen Preparation

10.1 The test specimen shall consist of two pieces of the material being tested having a combined volume of 25 ± 3 cm^3. This volume is approximately 1.67 times the volume of the test cavity when the large rotor is used, and ensures that the cavity is completely filled. For convenience the mass of the test specimen of correct volume may be calculated as follows:

$$m = v \times d = 25\ cm^3 \times d \quad (1)$$

where:

m = mass, g.
v = volume in cm^3 = 25 cm^3, and
d = density in Mg/m^3 (g/cm^3).

NOTE 1—Mg/m^3 and g/cm^3 are numerically equivalent.

10.2 The test specimen pieces shall be cut from the prepared sample and shall be of such dimensions that they fit within the die cavity without projecting outside it before the viscometer is closed. A 45-mm (1.75-in.) diameter cutting die may be used to assist in preparing the test pieces. If necessary, it is permitted to stack layers of mill-massed or unmassed sheets to achieve a thickness of approximately 10 mm prior to cutting the test specimen pieces. A hole punched in the center of one of the test pieces facilitates the centering of the rotor stem. It shall not be permissible to slip the test piece around the rotor stem by cutting it edgewise. The test specimen shall be as free of air as it is practical to make it and shall be free of pockets which may trap air against the rotor and die surfaces.

11. Procedure

11.1 Measure the viscosity in accordance with the Procedure section of Test Methods D1646, Part A. The duration of the test shall include a 1 min preheat followed by 15 min for massed samples and 7 min for unmassed samples.

11.2 Use the large rotor.

11.3 Use a rotor speed of 0.21 ± 0.002 rad/s (2.0 ± 0.02 r/min).

11.4 *Test Method A*—When the difference between Mooney viscosity at two specified times is required, calculate as follows:

ML 15 min – *ML* 1.5 min for massed samples, or
ML 7 min – *ML* 1 min for unmassed samples.

11.4.1 Negative numbers that are large in magnitude indicate good processability for the polymers tested.

11.5 *Test Method B*—When the difference required is between the minimum viscosity recorded and the subsequent maximum viscosity, calculate as follows:

$$ML_{max} - ML_{min}$$

where:

ML_{min} = minimum viscosity reached shortly after starting the rotor, and
ML_{max} = subsequent maximum viscosity.

11.5.1 The smaller the magnitude of $ML_{max} - ML_{min}$, the better the processability for the polymers tested.

11.5.2 When $ML_{max} - ML_{min}$ (see Fig. 1) is used as a measure of processability, readings must be taken at a minimum of 5 s intervals during the period when viscosity is rising after a rapid initial fall. The use of a recording device capable of following the complete viscosity-time curve is recommended.

11.6 The same processability ranking is obtained for a series of rubbers using specimens cut directly from the slab, or using massed samples as long as the same procedure is used throughout the series of viscosity tests.