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Standard Test Methods for Rubber—Evaluation of SBR (Styrene-Butadiene Rubber) Including Mixtures With Oil¹

This standard is issued under the fixed designation D3185; 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 cover the standard materials, test formulas, mixing procedures, and test methods for the evaluation of emulsion polybutadiene (EBR) and styrene-butadiene rubbers (SBR) including the emulsion polybutadiene oil masterbatch rubbers, SBR oil masterbatches, and partially cross-linked and high Mooney rubbers.

1.2 These test methods are also applicable to certain types of solution SBR and solution SBR oil masterbatches that are used in applications requiring vulcanization.

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

1.4 *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.*

1.5 *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

[D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension](#)

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

¹ These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and are the direct responsibility of Subcommittee D11.23 on Synthetic Rubbers.

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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.

[D2084 Test Method for Rubber Property—Vulcanization Using Oscillating Disk Cure Meter](#)

[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](#)

[D5289 Test Method for Rubber Property—Vulcanization Using Rotorless Cure Meters](#)

[D6204 Test Method for Rubber—Measurement of Unvulcanized Rheological Properties Using Rotorless Shear Rheometers](#)

2.2 *ISO Standard:*

[ISO 2322 Rubber, Styrene-Butadiene \(SBR\)—Emulsion-Polymerized General-Purpose Type—Test Recipe and Evaluation of Vulcanization Characteristics](#)³

3. Summary of Test Methods

3.1 These test methods include the standard test formulas, mixing procedures, and test methods for evaluating the following types of synthetic rubbers:

3.1.1 *Non-Oil-Extended Types*, mill and Miniature Internal Mixer (MIM) mixing procedures.

3.1.2 *Oil Masterbatch Types*, mill and Miniature Internal Mixer (MIM) mixing procedures.

3.2 No correlation between results for mill and MIM mixing procedures is implied.

4. Significance and Use

4.1 These test methods are mainly intended for referee purposes but may be used for quality control of synthetic rubber production. They may also be used in research and development work and for comparison of different rubber samples in a standard formula.

4.2 These test methods may also be used to obtain values for customer acceptance of rubber.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

5. Standard Test Formulas

5.1 Standard Formulas for Non-Oil-Extended Types—See Table 1.

5.1.1 For the MIM procedure it is recommended that a blend of compounding materials, excluding carbon black, be prepared to improve accuracy in the weighing of these materials. The compounding material blend is prepared by blending a proportional mass of each material in a dry powder blender such as a biconical blender or vee blender. A mortar and pestle may be used for blending small quantities.

5.1.2 Formula 1A shall apply to the general-purpose nonpigmented, non-oil-extended rubber types. It is also specified in International Standard ISO 2322 for evaluation of general purpose, nonpigmented, non-oil-extended rubbers. Formula 2A shall apply to the partially crosslinked and high-Mooney rubber (>90 ML 1 + 4 at 100°C) for example, SBR 1009, 1018, and 1012 types.

5.2 Standard Formulas for Oil Masterbatch Types—See Table 2.

5.2.1 Formulas 1B to 6B shall apply to the general purpose nonpigmented oil-extended rubber types according to the oil content of the rubber. Formula 1A may be used as an alternative to Formulas 1B to 6B. International Standard ISO 2322 specifies Formula 1A for evaluation of general purpose, nonpigmented, oil-extended SBR.

5.2.2 For the MIM procedure it is recommended that a blend of compounding materials, excluding carbon black, be prepared to improve accuracy in the weighing of these materials. The pigment blend is prepared by blending a proportional mass of each material in a dry powder blender such as a biconical blender or vee blender. A mortar and pestle may be used for blending small quantities.

6. Sample Preparation

6.1 Obtain the test samples in accordance with Practice D3896.

7. Mixing Procedures

7.1 Three mixing procedures are provided:

7.1.1 Method A—Mill mix (7.2).

7.1.2 Method B—Miniature internal mixer (MIM) mix (7.3).

7.1.3 Method C—Internal mixer mix (7.4).

NOTE 1—These mixing methods may not obtain comparable results.

7.2 Method A—Mill Mix Procedure:

7.2.1 For general mixing procedures refer to Practice D3182.

7.2.2 Mix with the mill roll temperature maintained at 50 ± 5°C (122 ± 9°F). The indicated mill openings are desired and should be maintained insofar as possible to provide uniformity in the breakdown of the rubber due to milling.

7.2.3 Mixing Cycle—See Table 3.

7.2.3.1 After mixing according to Table 3, measure and record the batch mass. If it differs from the theoretical value by more than 0.5 %, discard the batch.

7.2.3.2 If required, cut samples from the batch to allow testing of compound viscosity and processability in accordance with Test Methods D1646 or D6204, and vulcanization characteristics in accordance with Test Methods D2084 or D5289.

7.2.3.3 If tensile stress strain tests are required, sheet off to a finished thickness of approximately 2.2 mm (0.087 in.) and condition the compound according to Practice D3182.

7.3 Method B—Miniature Internal Mixer Procedure:

7.3.1 For general mixing procedures refer to Practice D3182. Mix with the head temperature of the miniature internal mixer maintained at 60 ± 3°C (140 ± 5°F) and the unloaded rotor speed at 6.3 to 6.6 rad/s (60 to 63 rpm).

7.3.2 Prepare the rubber by passing it through a mill one time with the temperature set at 50 ± 5°C (122 ± 9°F) and an opening of 0.5 mm (0.02 in.). Cut the sheet into strips that are approximately 25 mm (1 in.) wide, if desired.

7.3.3 Mixing Cycle—See Table 4.

7.3.3.1 After mixing according to Table 4, turn off the motor, raise the ram, remove the mixing chamber, and discharge the batch. Record the maximum batch temperature indicated, if desired.

7.3.3.2 Immediately pass the discharge from the mixer twice through a standard mill maintained at 50 ± 5°C (122 ± 9°F) with a roll separation of 0.5 mm (0.020 in.) once, then twice at a separation of 3 mm (0.12 in.) in order to dissipate heat. Pass the rolled batch endwise through the mill six times with an opening of 0.8 mm (0.31 in.) to enhance the dispersion.

7.3.3.3 Measure and record the batch mass. If it differs from the theoretical value by more than 0.5 %, discard the batch.

7.3.3.4 If required, cut samples from the batch to allow testing of compound viscosity and processability in accordance with Test Methods D1646 or D6204, and vulcanization characteristics in accordance with Test Methods D2084 or D5289.

7.3.3.5 If tensile stress strain tests are required, sheet off to a finished thickness of approximately 2.2 mm (0.087 in.) and condition the compound according to Practice D3182.

7.4 Method C—Internal Mixer:

7.4.1 For general mixing procedure refer to Practice D3182.

7.4.2 Mixing Cycle—Initial Mix—See Table 5.

TABLE 1 Standard Non-Oil Extended SBR Test Formulas

Material	IRM-SRM No.	Quantity, Parts by Mass	
		1A	2A
SBR or masterbatch	...	100.00	100.00
Zinc oxide	A	3.00	3.00
Sulfur	A	1.75	1.75
Stearic acid	A	1.00	1.00
Oil furnace black ^B	A	50.00	35.00
TBBS ^C	A	1.00	1.00
Total		156.75	141.75
Batch factor for mill mix ^D		3.0	3.3
Batch factor for MIM mix ^E :			
Cam head		0.47	0.49
Banbury head		0.41	0.46

^A Use Current IRM/SRM.

^B The current Industry Reference Black (IRB), which has been dried for 1 h at 125 ± 3°C.

^C *N-tert*-butyl-2-benzothiazolesulfenamide.

^D For mill batches, weigh the rubber and carbon black to the nearest 1.0 g, the sulfur and accelerator to the nearest 0.02 g, and the other compounding materials to the nearest 0.1 g.

^E For MIM batches, weigh the rubber and carbon black to the nearest 0.1 g, the compounding material blend to the nearest 0.01 g, and the individual compounding materials, if used, to the nearest 0.001 g.