



Designation: D3187 – 06

Standard Test Methods for Rubber—Evaluation of NBR (Acrylonitrile-Butadiene Rubber)¹

This standard is issued under the fixed designation D3187; 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 various types of acrylonitrile-butadiene rubber (NBR).

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

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

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

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

3. Significance and Use

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

3.2 These test methods may be used to obtain values for customer control acceptance of rubber.

4. Standard Test Formula

4.1 *Standard Formula*—See **Table 1**.

5. Sample Preparation

5.1 For tests intended for referee purposes obtain and prepare the test samples in accordance with Practice **D3896**.

6. Mixing Procedures

6.1 The compound may be prepared either on a mill, in a miniature internal mixer, or a lab internal mixer, although slightly different results may be obtained.

6.2 Mill Procedure:

6.2.1 For general mixing procedure refer to Practice **D3182**.

6.2.1.1 Mix with the mill roll temperature maintained at $50 \pm 5^\circ\text{C}$ ($122 \pm 9^\circ\text{F}$). The indicated mill openings are desired and should be maintained in so far as possible to provide uniformity in the breakdown of the rubber due to milling. Necessary adjustments may be made to maintain a good working bank.

¹ These test methods are under the jurisdiction of ASTM Committee **D11** on Rubber 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.

TABLE 1 Standard Formula

Material	NIST SRM/IRM No.	Quantity, Parts by Mass
NBR	...	100.00
Zinc oxide	A	3.00
Sulfur, coated ^B	...	1.50
Stearic acid	A	1.00
Oil furnace black	SRB-B4	40.00
TBBS ^C	A	0.70
Total		146.20
Batch factor for mill mix ^D		4.0
Batch factor for MIM mix (Cam Head ^E)		0.50
Batch factor for MIM mix (Banbury Head) ^E		0.43

^AUse current IRM/SRM.

^BThe use of 2 % MgCO₃ coated sulfur is recommended. Standard 2 % MgCO₃ coated sulfur (Lot No. M-266573-P) is available from the C. P. Hall Co., 4460 Hudson Drive, Stow, OH 44224.

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

^DFor mill and lab BB mixes, weigh the rubber and carbon black to the nearest 1.0 g, the sulfur and accelerators to the nearest 0.02 g, and all other compounding materials to the nearest 0.1 g.

^EFor MIM batches, weigh the rubber and material, blend to the nearest 0.1 g. If individual compounding materials are used, blend to the nearest 0.001 g. For the MIM procedure, it is recommended that a blend of compounding materials, excluding black, be prepared to improve accuracy in the weighing of these materials. The 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.

6.2.2 Mixing Cycle—See Table 2.

6.2.2.1 After mixing according to Table 2, measure and record the batch mass. If it differs from the theoretical value by more than 0.5 %, discard the batch.

6.2.2.2 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.

6.2.2.3 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.

6.3 Miniature Internal Mixer (MIM) Procedure:

6.3.1 For general mixing procedure refer to Practice D3182.

6.3.1.1 Mix with the head temperature of the miniature internal mixer maintained at 60 ± 3°C (140 ± 5°F) and the rotor speed at 6.3 to 6.6 rad/s (60 to 63 r/min).

6.3.2 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 that will give an approximately 5 mm (0.2 in.) thick sheet. Cut the sheet into strips that are approximately 25 mm (1 in.) wide.

6.3.3 Mixing Cycle—See Table 3.

6.3.3.1 After mixing according to Table 3, turn off the motor, raise the ram, remove the mixing chamber and discharge the batch. Record the maximum batch temperature indicated, if desired.

6.3.3.2 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.

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

6.3.3.4 If required, cut samples from the batch to allow testing of compound viscosity and processability in accordance

TABLE 2 Mill Procedure: Mixing Cycle

NOTE—Do not cut the batch while free carbon black is evident in the bank or on the milling surface. Be certain to return to the batch any ingredients that drop through the mill.

	Duration, min	Accumulative, min
Set the mill opening at 1.4 mm (0.055 in.) and band the rubber on the slow roll.	2	2
Add stearic acid and zinc oxide together, followed by sulfur and accelerator together. Make the addition slowly and evenly across the mill, without cutting.	3	5
Make three ¾ cuts from each side.	2	7
Add half of the carbon black evenly across the mill at a uniform rate.	5	12
When this portion of the carbon black has been completely incorporated, open the rolls to 1.65 mm (0.065 in.) and make three ¾ cuts from each side.	2	14
Add the remaining carbon black evenly across the rolls at a uniform rate.	5	19
When all carbon black has been incorporated, make three ¾ cuts from each side	2	21
Set the rolls at 0.8 mm (0.032 in.), pass the rolled stock endwise between the rolls six times.	3	24
Open the mill to give a minimum batch thickness of 6 mm (0.25 in.) and pass the stock through the rolls four times, folding it back on itself each time.	1	25