



Standard Test Method for Air Permeability of Tire Fabrics, Tire Cord Fabrics, Tire Cord, and Yarns¹

This standard is issued under the fixed designation D2692/D2692M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This test method covers the determination of longitudinal air permeability for tire fabrics, tire cord fabrics, tire cords, or yarns embedded in cured rubber compound. This test method is designed to demonstrate the effectiveness of fabric treatments intended to prevent air permeability. This test method is applicable to fabrics made from all types of fibers with all types of rubber compound.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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. See the Note in 11.1.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D123 Terminology Relating to Textiles

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

D6477 Terminology Relating to Tire Cord, Bead Wire, Hose Reinforcing Wire, and Fabrics

3. Terminology

3.1 Definitions:

¹ This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.19 on Industrial Fibers and Metallic Reinforcements.

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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.

3.1.1 For definitions of terms relating to tire cord, bead wire, hose wire, and tire cord fabrics, refer to Terminology D6477.

3.1.1.1 The following terms are relevant to this standard: air permeability, chafer fabric, test panel, in air permeability test, tire cord, tire cord fabric, tire fabric, vulcanization, wickproof, in tire fabric, tire cord fabric, tire cord, or yarn.

3.1.2 For definitions of other terms related to textiles, refer to Terminology D123.

3.1.2.1 The following terms are relevant to this standard: skein and yarn.

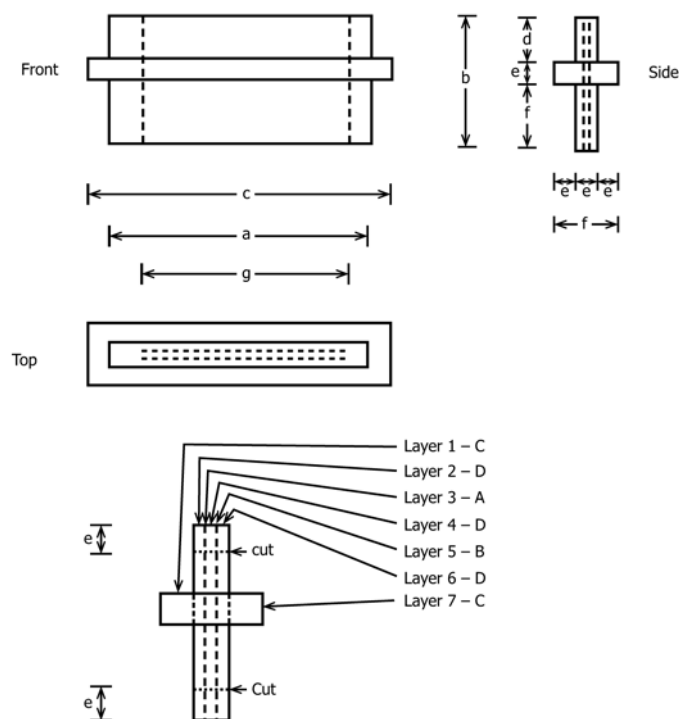
4. Summary of Test Method

4.1 Fabric specimens are embedded in a rubber compound and air pressure is applied to freshly exposed yarn ends. Detergent solution is applied to the opposite end of the yarns which have also been freshly exposed. Air permeability is indicated by continuous formation of air bubbles in the detergent solution due to air passing along the axis of a yarn.

5. Significance and Use

5.1 This test method is considered satisfactory for the acceptance testing of commercial shipments of tire fabrics since this test method has been used extensively in the trade for acceptance testing. This test method is also considered satisfactory for quality control.

5.1.1 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories may be compared using appropriate statistical analysis and an acceptable probability level chosen by the two parties before the testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.



DIMENSIONS

	a	b	c	d	e	f	g
Inches	3.0	1.5	3.5	0.5	0.25	0.75	2.25
Millimetres	76	38	89	12.6	6.4	19	57

NOTE 1—Lower case letters refer to dimensions. Capital letters refer to pieces prepared as outlined in 10.2.

FIG. 1 Test Panel

5.2 This test method is applicable for testing the air permeability of any fabric that is embedded in a rubber compound, but is particularly useful when testing chafer fabrics to be used in a tubeless tire construction. In tubeless tires, chafer fabric yarns that are air permeable represent potential channels for air to pass through, and thus, this test method provides a prediction of chafer permeability.

5.3 Evaluation of air permeability in other fabric and cord components in such products as tires, rubber brake diaphragms, and pneumatic hoses, is useful.

6. Apparatus and Materials

6.1 *Test Panel Mold*—A fixed dimension mold designed to produce a test panel of dimensions and shape shown in Fig. 1.³

6.2 *Test Chamber*—An air chamber and test panel holder similar to the device shown in Fig. 2.³

6.3 *Rubber Compound*—The test compound in Table 1 shall be used as standard unless otherwise agreed upon between the purchaser and the supplier.

6.4 *Air Supply*—Compressed air, to be controlled at a test pressure agreed upon between the purchaser and the supplier. Commercially available compressed air or dry nitrogen gas is preferred since these products are clean and dry.

6.5 *Vulcanization Press*—For vulcanizing the test panel in the test panel mold. See Practice D3182.

6.6 *Detergent Solution*—Mix 10 g of nonionic detergent with 100 g of tap water. An ethoxylated alkyl phenol, having 10 to 30 mol of ethylene oxide, is the recommended nonionic detergent.⁴

7. Sampling Tire Fabric

7.1 *Lot Sample*—Tire fabrics are shipped in continuous lengths of several hundred metres each, and testing frequency will be as agreed upon between the purchaser and the supplier. In the absence of an applicable material specification for sampling frequency, consider each roll to be a sampling unit for tire fabric.

7.2 *Laboratory Samples*—For acceptance testing, take from each roll a full-width swatch, 1 m [1 yd] long, after first discarding a minimum of 1 m [1 yd] of fabric from the very outside of the roll.

³ The Burlington Diffusion Tester and Test Piece Mold covered by U.S. Patent 3,034,336 has been found satisfactory. Blueprints for the fabrication of the tester and mold may be obtained from Manager of Process Technology, Highland Industries Inc., 215 Drummond Street, Kernersville, NC 27284.

⁴ Common laundry detergent has been found satisfactory for this purpose.



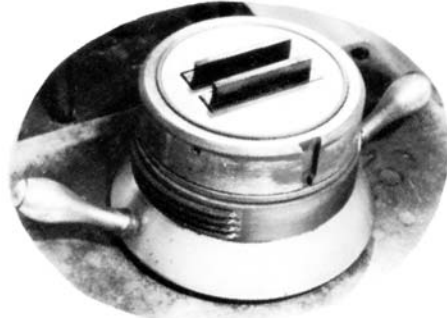
A. Bottom Plate



B. Top Plate in Place



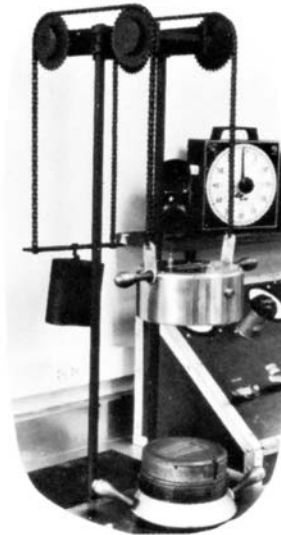
C. Top on Bottom Plate Showing Sample Chamber



D. Test Sample Blocks in Bottom Plate



E. Samples in Place



F. Test Unit with Counter Weight (Note timer, gages and control valve)

FIG. 2 Testing Chamber

7.3 Test Specimen—Cut two fabric specimens from each laboratory sample, each being 38 by 57 mm [1.5 by 2.25 in.]. Space the specimens from a laboratory sample along a diagonal line so that each specimen will contain different warp ends and filling picks. Cut one specimen with the warp ends parallel to

the 38 mm [1.5 in.] side (A), and one specimen with the filling picks parallel to the 38 mm [1.5 in.] side (B). See Fig. 1.

7.3.1 When it is necessary to differentiate air permeability in the warp direction from air permeability in the filling direction, it is recommended that two specimens be cut in the warp

**TABLE 1 Recipe—Air Permeability Test Rubber Compound**

Peptized SMR—20	60 parts by mass
SBR—1502	40
Zinc oxide	5
Stearic acid	2
6 PPD	1
Aromatic Hydrocarbon Resin	5
HA Oil	10
N-330 black	50
Precipitated silica	20
PEG	1
TBBS	1.25
TMTD	0.5
Sulfur	2
PVI	0.3

Cure: 30 ± 2 min at 145 ± 2°C [293 ± 4°F].

Compound to be stored in a cool dry area—refrigeration is preferred.

direction, and two in the filling direction, and that a separate test panel be made for each fabric direction.

8. Sampling Tire Cord Fabric

8.1 *Lot Samples*—Tire cord fabrics are shipped in continuous lengths of several hundred metres each, and testing frequency will be as agreed upon between the purchaser and the supplier. In the absence of an applicable material specification for sampling frequency, consider each roll to be a sampling unit for tire fabric.

8.2 *Laboratory Sample*—For acceptance testing, take from each roll a full-width swatch, 1 m [1 yd] long, after first discarding a minimum of 1 m [1 yd] of fabric from the very outside of the roll. From the 1 m [1 yd] swatch, randomly remove three tire cords. Take the tire cords no nearer to the selvage than one tenth the width of the fabric.

8.3 *Test Specimens*—From the laboratory sample, cut six 500 mm [20 in.] lengths of tire cord. The six lengths of tire cord are one test specimen. Tire cord fabrics are tested in the warp direction only.

9. Sampling Tire Cords and Yarns

9.1 *Lot Samples*—Tire cords and yarns are shipped on spools in cases or on beams. Testing frequency will be as agreed upon between the purchaser and the supplier, or, in the absence of an applicable material specification, consider each case or beam of tire cord or yarn to be a sampling unit.

9.2 Laboratory Samples:

9.2.1 *Cases*—For acceptance testing, take at random one spool from each case and take one 3 m [3 yd] sample, after first discarding a minimum of 10 m [10 yd] of tire cord or yarn from the outside of the spool, plus any additional tire cord having a disturbed wind.

9.2.2 *Beams*—For acceptance testing, reel at random five skeins, 3 m [3 yd] long, from each beam.

9.3 Test Specimens:

9.3.1 *Cases*—From the laboratory sample, cut six 500 mm [20 in.] lengths of tire cord or yarn. The six lengths of tire cord or yarn are one test specimen. Tire cord and yarn are tested in the warp direction only.

9.3.2 *Beams*—From the laboratory sample, cut six 500 mm [20 in.] lengths from each of the five skeins. The six lengths of tire cord or yarn are one test specimen.

10. Preparation of Test Panels

10.1 *Tire Fabric Test Panel Preparation*—Embed the fabric specimens in a 38 by 76 by 6.4 mm [1.5 by 3.0 by 0.25 in.] cured rubber compound test panel which is bounded by a 6.4 by 6.4 mm [0.25 by 0.25 in.] flange, perpendicular to the 38 mm [1.5 in.] test panel dimension. The test panel is trimmed to expose yarn ends for testing. See Fig. 1.

10.1.1 Cut two pieces of rubber compound (C) 6.4 by 6.4 by 89 mm [0.25 by 0.25 by 3.5 in.].

10.1.2 Cut three sheets of rubber compound (D) 2.3 by 76 by 38 mm [0.09 by 3 by 1.5 in.]. Preassemble the test panel in the following order (refer to letter designation in Fig. 1): D, A, D, B, D. Locate fabric specimens (A) and (B) to ensure the fabric is centered in the 38 by 76 mm [1.5 by 3.0 in.] test panel plane. Roll the composite with a stitching wheel or other comparable device to minimize entrapped air.

10.1.3 The mass of the test panel, including flange strips, must exceed 35 g [1.23 oz]. If a rubber compound other than that given in Table 1 is used, the density of the rubber compound may differ, and the minimum mass of the test panel will also differ. If necessary, additional rubber compound can be applied to the flange strip to obtain the required mass.

10.2 *Tire Cord or Yarn Test Panel Preparation* (Including Cords from Tire Cord Fabrics or Yarns):

10.2.1 From one to three tire cord or yarn specimens can be placed in one test panel. If more than one specimen is placed in a test panel, then mark the specimen locations on the outside of the test panel. Place each specimen in location (A) only of the test panel, so that the yarn ends protrude equally from both sides of the test panel. Fill location (B) with a 2.3 by 76 by 38 mm [0.09 by 3 by 1.5 in.] sheet of rubber compound.

10.2.2 The mass of the test panel, including flange strips, must exceed 35 g [1.23 oz]. If a rubber compound other than that given in Table 1 is used, the density of the rubber compound may differ, and the minimum mass of the test panel will also differ. If necessary, additional rubber compound can be applied to the flange strip to obtain the required mass.

10.3 Test Panel Vulcanization:

10.3.1 Preheat a cold mold and vulcanizing press to the temperature specified for the rubber compound in use.

10.3.2 Insert the two 6.4 by 6.4 by 89 mm [0.25 by 0.25 by 3.5 in.] flange strips (C) in the corresponding slots in the preheated mold. Insert the test panel into the mold and press it to the bottom of the cavity.

10.3.3 Insert the mold between press platens and adjust the pressure to at least 3.45 MPa [500 psi] with reference to the top surface of the mold. Leave the mold in the press under pressure for 30 min or the vulcanizing time specified for the rubber compound in use. Withdraw the mold and remove test panels from the mold. Allow the test panels to cool to room temperature by exposure to air or immersion in water before proceeding to the next step.

10.4 *Post Vulcanization Setup*—Using a sharp knife or die, cut 6.4 mm [0.25 in.] from each 76 mm [3.0 in.] edge of the test panel to expose yarn ends. See Fig. 1. The test panel must be tested within 6 h of the time the yarns are exposed. If more than 6 h elapse before the panel is tested, expose fresh yarn ends by trimming away an additional 1 mm [0.04 in.] strip from the 76 mm [3.0 in.] edge.

11. Procedure

11.1 Place the test panel between the plates of the test chamber and secure the two plates. Apply detergent solution to the exposed yarn ends. Apply air pressure as specified in the purchase agreement. Maintain air pressure as specified and observe yarn ends to detect air bubbles, which indicate air passage through the test specimen. The duration of time covering the test will be agreed upon between the purchaser and the supplier and may be selected from the following:

- 11.1.1 A. Two minutes at 0.7 MPa [100 psig], + 5 %, – 0 %
- 11.1.2 B. Two minutes at 1.4 MPa [200 psig], + 5 %, – 0 %
- 11.1.3 C. One minute at 2.1 MPa [300 psig], + 5 %, – 0 %
- 11.1.4 D. One minute at 2.8 MPa [400 psig], + 5 %, – 0 %

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NOTE 1—**Precaution:** Test panels should only be tested in apparatus that has safety shields to protect the operator.

12. Report

12.1 State that the tests were made as directed in Test Method D2692. Describe the materials or products sampled and the method of sampling used.

12.2 Report the following information:

12.2.1 Air pressure used and duration of testing, and
12.2.2 Whether or not air permeability was noted in the testing.

12.2.3 If a rubber compound other than that given in Table 1 is used, this will be reported.

13. Precision and Bias

13.1 No information is presented about either the precision or the bias of this test method since the test result is nonquantitative.

14. Keywords

14.1 air permeability; chafer fabrics; tire fabrics