Designation: D 3816/D3816M – 96 (Reapproved 2003)

Standard Test Method for Water Penetration Rate of Pressure-Sensitive Tapes[1]

This standard is issued under the fixed designation D 3816/D3816M; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method provides one procedure for measuring the water penetration rate of 2-in. or wider pressure-sensitive tape.

1.2 The values stated in either SI or inch-pound units are to be regarded separately as standard. The values stated in each system may not be equivalent; therefore, each system must be used independently, without combining values in any way.

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:*

D 996 Terminology of Packaging and Distribution Environments[2]

D 3715/D3715M Practice for Quality Assurance of Pressure-Sensitive Tapes[2]

D 4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing[2]

E 122 Practice for Calculating Sample Size to Estimate, With a Specified Tolerable Error, the Average for a Characteristic of a Lot or Process[3]

3. Terminoloy

3.1 *Definitions*—General terms in this test method are defined in Terminology D 996.

4. Summary of Test Method

4.1 The pressure-sensitive tape to be tested is secured by its adhesive to a test cup containing a desiccant. The assembly is weighed, then reweighed following submersion under a specified head of water for a specified period of time. The gain in weight is used to calculate the water penetration rate.

5. Significance and Use

5.1 The results of this test method will indicate the relative permeability by water of the tape through its smallest dimension (generally normal to the tape's backing).

5.1.1 The pathway for the water parallel to the adhesive-cup interface is great compared to the tape's thickness and the latter is usually the nearly exclusive source of transmitted water.

5.1.2 Some tape types allow a relatively free path in a direction normal to the backing or along backing pathways parallel to the adhesive-cup interface, allowing the adhesive to become the principal barrier.

5.2 If the adhesive does not continue to adhere to the cup flange during the exposure periods, allowing unintended pathways for water to occur, the measurement should be considered as not having been made. Consequently, the tape might be considered as being inappropriate for use on surfaces like the cup flange under moisture conditions approximating those of the test.

NOTE 1—It may be that the interest is simply in the tape material as a water barrier. In this case how well the tape adheres to the cup flange may be of little consequence and steps to prevent any edge effects are in order. These are referred to in Section 10.

6. Apparatus

6.1 *Test Cups*,[4] made from materials that are nonhygroscopic. The cup shall have a *zero* water vapor transmission rate (WVTR). The cups shall be rectangular with a flat, smooth, rigid flange and shall have the following dimensions:

Flange:
Outside–50.8 by 152.4 ± 0.5 mm [2.0 by 6.0 ± 0.02 in.].
Inside (opening)–25.4 by 101.6 ± 0.5 mm [1.0 by 4.0 ± 0.02 in.].
Body:
Inside–25.4 by 101.6 by 38.1 (depth) ± 0.5 mm [1.0 by 4.0 by 1.5 (depth) ± 0.02 in.].

The mass shall not exceed 80 % of the balance capacity used in weighing.

6.2 *Desiccant*, calcium chloride, anhydrous, passing a No. 8 [2.36-mm] sieve.

NOTE 2—Regenerate calcium chloride to a sufficiently anhydrous state by heating it for 2 h at approximately 392°F [200°C].

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.14 on Tape and Labels.

Current edition approved March 10, 1996. Published May 1996. Originally published as D 3816 – 79. Last previous edition D 3816 – 88 (1993)$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] Available from Chemsultants International, 9349 Hamilton Dr., Mentor, OH 44061–1118.

6.3 *Water Container*—Any vessel allowing for sufficient water depth to cover the test specimen assemblies with a 25-mm [1.0-in.] head of water.

6.4 *Water*, distilled or deionized, in sufficient quantity to supply the water head within the container.

6.5 *Balance*, accurate to ±1 mg.

6.6 *Oven*, air-circulating, maintained at 49 ± 1°C [120± 2°F].

7. Sampling

7.1 *Acceptance Sampling*—Sampling shall be in accordance with Practice D 3715/D 3715M.

7.2 *Sampling for Other Purposes*—The sampling and the number of test specimens depends on the purpose of the testing. Practice E 122 is recommended. It is common to test at least five specimens of a particular tape. Test specimens should be taken from several rolls of tape and whenever possible, among several production runs of a tape. Strong conclusions about a specific property of a tape cannot be based on test results of a single unit (roll) of a product.

8. Test Specimens

8.1 Prepare three specimens for each sample or sample roll.

8.2 Specimens shall be 50 minus 2.5 mm [2.0 minus 0.1 in.] wide and 155 minus 2.5 mm [6.0 minus 0.2 in.] long from the sample material.

8.3 When the sample material is pressure-sensitive tape wound in roll form, unwind and discard at least three, but no more than six, outer wraps of tape from the sample roll before taking specimens for testing.

8.4 Remove specimens from a freely rotating roll at the rate of 500 to 750 mm [20 to 30 in.]/s. Where width or other factors causing high adherence to backing make it impossible to remove the specimen at the prescribed rate, remove it at a rate as close to 500 mm [20 in.]/s as possible.

9. Conditioning

9.1 Weigh in the standard conditioning atmosphere as described in Practice D 4332.

10. Procedure

10.1 Prepare each specimen assembly individually.

10.2 Fill the test cup to within approximately 3 mm [⅛ in.] of the opening with the anhydrous calcium chloride and make sure it will not come into contact with the adhesive of the specimen.

10.3 Apply the specimen to the flange, adhesive against it, allowing no bubbles or wrinkles. Use finger pressure to achieve this. When the sample material is larger than the specimen dimension, trim it to the edges of the flange.

10.3.1 When the adhesive is lacking or has insufficient bonding strength to the flange to maintain a seal during the exposure period, and when the parties concerned are interested exclusively in the barrier properties for pathways normal to the surface of the tape backing, a sealing material such as aluminum foil-backed pressure-sensitive tape can provide assurance that only the 25.4 by 101.6-mm [1.0 by 4.0-in.] area at the flange opening is exposed and all edges are sealed.

10.4 Prepare the remaining assemblies in the same way as the first.

10.5 Heat the assemblies in the oven at 49°C [120°F] for 30 min.

10.6 Cool at standard conditions (Section 9) for 30 min and weigh to the nearest 5 mg. This will be W_1 for the equation in Section 11.

10.7 Submerge the assemblies under 23 to 25 mm [0.9 to 1.0 in.] of water (6.4) at 23 ± 2°C [73.4 ± 3.6°F] for 48 h.

10.7.1 On removal from the water, use a lintless absorbent cloth or paper to remove visible water from the assemblies.

10.8 Place the assemblies in the oven at 49°C [120°F] for 30 min.

10.9 Cool at standard conditions (Section 9) for 30 min and weigh to the nearest 5 mg. This will be W_2 for the equation in Section 11.

11. Calculation

11.1 Calculate the water penetration rate (WPR) for each specimen in g/m^2[g/100 in.^{2}] of tape area in 24 h to the nearest 0.05 g as follows:

$$WPR = \frac{(W_2 - W_1)\,2400}{T \times A} \quad (1)$$

where:

W_1 = weight from 10.6, g,
W_2 = weight from 10.9, g,
T = time of exposure between W_1 and W_2, h, and
A = area of cup opening, 0.0028 m^2[4 in.^{2}].

12. Report

12.1 The report shall include the following:

12.1.1 Statement that this test method was used. Indicate any deviations from this test method as written.

12.1.2 Whether the edges were sealed or unsealed.

12.1.3 Manufacturer's name and designation for the tape.

12.1.4 Report the results found in Section 11 as the average and the standard deviation. Report the number of samples.

13. Precision and Bias [5]

13.1 *Precision*:

13.1.1 An interlaboratory evaluation of two types of pressure-sensitive tape by four laboratories has been conducted. The following summary presents the standard deviations as percentages of the mean. These may be larger or smaller for any particular tape type or any particular manufacturer. Careful treatment of outliers (individual extreme datum) may reduce the reported measures of precision.

Residual (within roll and replication error)	110.9 %
Between rolls (of one tape type)	18.7 %
Between people (testers in one laboratory)	09.1 %
Between laboratories	25.8 %

13.1.2 These may be combined in several ways to obtain the desired estimate of precision. Since the repeatability (within-laboratory replication error) can be determined by a laboratory

[5] Supporting data are available from ASTM Headquarters. Request RR: D10-1002, Report 2.

for a particular tape, this information can be used with the reported information to obtain more meaningful estimates of precision.

13.2 *Bias*—No measure of bias is possible with this test method because an accepted reference or referee value is not available.

14. Keywords

14.1 pressure-sensitive tape; water penetration rate