Designation: D4279 – 95 (Reapproved 2022)

Standard Test Methods for Water Vapor Transmission of Shipping Containers—Constant and Cycle Methods[1]

This standard is issued under the fixed designation D4279; 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 determination of water vapor transmission rates for bulk shipping containers, as follows:

1.1.1 Method A, for Reclosable Containers, and

1.1.2 Method B, for Containers Not Designed for Reclosing.

1.2 Within each procedure details are given for the constant and cycle methods of test atmosphere.

1.3 The test may be applied to the container as packed, or after one or more performance tests such as drum (Method D782), vibration (Methods D999), drop (Test Method D5276), impact resistance (Test Methods D880, D4003, and D5277), or performance tests (Practice D4169), as required.

1.4 For small shipping containers requiring greater accuracy in weighing, the water vapor transmission may be determined in accordance with Test Method D895 or Test Method D1251.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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.*

1.7 *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]

D782 Test Method for Shipping Containers in Revolving Hexagonal Drum (Withdrawn 1999)[3]

D880 Test Method for Impact Testing for Shipping Containers and Systems

D895 Test Method for Water Vapor Permeability of Packages (Withdrawn 1999)[3]

D996 Terminology of Packaging and Distribution Environments

D999 Test Methods for Vibration Testing of Shipping Containers

D1251 Test Method for Water Vapor Permeability of Packages by Cycle Method (Withdrawn 1999)[3]

D4003 Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems

D4169 Practice for Performance Testing of Shipping Containers and Systems

D5276 Test Method for Drop Test of Loaded Containers by Free Fall

D5277 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester

3. Terminology

3.1 *Definitions*—General definitions for the packaging and distribution environments are found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *water vapor transmission rate of a shipping container (constant atmosphere method), n—for the purpose of this test method*, the rate at which water is transmitted into the container from the test atmosphere (normally of 90 % ± 2 % relative humidity and a temperature of 100 °F ± 2 °F (37.8 °C ± 1.1 °C) surrounding it while a desiccant is sealed within.

3.2.2 *water vapor transmission into a container (cycle atmosphere method), n*—for this test method, the amount of

[1] These test methods are under the jurisdiction of ASTM Committee D10 on Packaging and are the direct responsibility of Subcommittee D10.21 on Shipping Containers and Systems - Application of Performance Test Methods.

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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] The last approved version of this historical standard is referenced on www.astm.org.

water transmitted into the container from the test atmosphere during one cycle while a desiccant is sealed within.

3.2.3 *cycle, n*—one series of test atmospheres to which the test specimens are exposed. Normally one cycle will consist of 1 week of exposure to a temperature of 0 °F ± 5 °F (−17.8 °C ± 2.8 °C) to be followed by 3 weeks of exposure at a temperature of 100 °F ± 2 °F (37.8 °C ± 1.1 °C) and a relative humidity of 90 % ± 2 %.

4. Significance and Use

4.1 These test methods are normally used for the following purposes:

4.1.1 To evaluate materials and constructions for a specific type of container,

4.1.2 To compare performance of different types of containers,

4.1.3 To determine adequacy of protection for a specific product or application, and

4.1.4 To maintain quality control.

METHOD A—RECLOSABLE CONTAINERS

5. Apparatus

5.1 *Desiccant*—A desiccant shall be used that has a powerful affinity for water and a high drying efficiency, that is, a low vapor pressure after absorbing a large amount of water. The desiccant shall be in the form of small lumps that will pass a No. 8 (2.36 mm) sieve and be free from fines that will pass a No. 30 (600 µm) sieve. Anhydrous calcium chloride and anhydrous magnesium perchlorate have been found suitable. When the test is made to determine the suitability of a specific container for a particular product, that product may be used inside the test specimen instead of the desiccant, in which case the specimen shall be filled to normal capacity.

5.2 *Weighing Balance*—A weighing balance accurate to within 1 g shall be used. When the required amount of desiccant is greater than can be weighed on a balance of this sensitivity, two or more receptacles shall be used and weighed individually. When product tests are made, a regular laboratory balance and drying oven or other appropriate equipment are required for making standard moisture determinations peculiar to the product.

5.3 *Receptacle for Desiccant*—A nonmoisture-absorptive receptacle ¾ in. to 1½ in. (19 mm to 38 mm) deep shall be used for holding the desiccant within the container being tested. It should be equipped with a cover that will rest on the top rim of the receptacle to protect the desiccant from picking up moisture while being weighed. The size of the weighing receptacle or receptacles shall be such that the exposed area of desiccant is not less than 10 % of the area of the test specimen. For testing large containers, this may require using two or more weighing receptacles.

5.4 *Test Chamber*—A test room or cabinet provided with conditioned air that is continuously circulated around the specimens under test. The conditions in the chamber shall be such that no condensation occurs on the specimens except during that portion of the cycle when the exposure is changed from a low temperature to a high temperature.

6. Test Specimens

6.1 Test specimens shall be representative of the containers being tested, and shall be closed and sealed in the normal manner.

6.2 The performance shall be based on tests of not less than two representative specimens of a given size and type of container.

7. Procedure

7.1 Locate the weighing receptacle or receptacles centrally within the test specimen, using a nonabsorptive support when required. Place the selected quantity of the desiccant in the receptacle sufficient to uniformly cover the area of the receptacle to a depth of not less than ½ in. (13 mm). Cover, and after weighing, immediately transfer into the test specimen. Uncover the receptacle and close and seal the specimen in the normal manner. The desiccant may require one or more replacements if it becomes noticeably moist during the test.

NOTE 1—When the test is conducted to determine the water vapor transmission of the shipping container for research, development, manufacturing control, specification acceptance, etc., a desiccant shall be used as the water absorbing medium. When the test is used to determine the suitability of the shipping container with respect to water vapor resistance for a particular product, the product shall be used in lieu of the desiccant.

7.2 Place the specimen inside the test room or cabinet in a position where free access of the conditioned circulating air is provided on all surfaces of the container according to the following:

7.2.1 *Constant Atmosphere Method*—Normally surrounding conditions are 90 % ± 2 % relative humidity and a temperature of 100 °F ± 2 °F (37.7 °C ± 1.1 °C).

7.2.2 *Cycle Atmosphere Method*—Place the specimen in the low temperature test room or cabinet (normally maintained at 0 °F (−17.8 °C) for a period of 1 week. Follow immediately by 3 weeks of exposure to the high temperature and humidity (normally 100 °F (37.8 °C) and 90 % relative humidity).

7.3 Make successive weighings of the receptacle at suitable intervals and plot the mass gained against time using these schedules:

7.3.1 *Constant Method*—Accuracy of the test is adversely affected by too frequent weighings. For highly permeable containers a minimum weighing frequency of 3 days is recommended. For containers having a low rate of transmission, a weighing frequency of biweekly to monthly is recommended.

7.3.2 *Cycle Method*—Make successive weighings of the receptacle at the completion of each cycle. It is suggested that the test be carried on for a minimum of three complete cycles.

7.4 The weighing procedure, which should be conducted as rapidly as possible, shall be as follows: Remove the specimen from the test chamber, open, remove the receptacle, and place the cover on the receptacle. Temporarily close the specimen to prevent the entrance of moisture from the surrounding atmosphere. Weigh the receptacle, open the specimen, and return the receptacle. Uncover the receptacle, reclose the specimen, and return it without delay to the test room or cabinet. Continue until a constant rate of gain is attained as indicated by at least

three successive points in a straight line. The slope of this portion of the curve will furnish a measure of water vapor transmission.

NOTE 2—In instances where tests are made in which specific products are used in place of the standard desiccant, a constant rate of gain may not be attainable. Therefore, for product tests, the container is filled to its normal capacity and the moisture content determined from a composite sample taken at the start of the test.

For the Constant Method the specimen is placed in the test room for a predetermined period (usually one month), removed, and the average moisture content determined from a composite sample taken at the end of this period).

For the Cycle Method the specimen shall be subjected to one exposure cycle for a predetermined period, removed, and the average moisture content determined from a composite sample taken at the end of this period.

In either method the test can be continued by immediately closing and resealing, after which the specimen is returned without delay to the test room or cabinet.

METHOD B—CONTAINERS NOT DESIGNED FOR RECLOSING

8. Apparatus

8.1 The apparatus shall consist of a desiccant, balance, and test chamber in accordance with 5.1, 5.2, 5.4 respectively, also desiccant receptacles in accordance with 5.3 if it is not practicable to weigh the entire container with the desiccant inside.

9. Test Specimens

9.1 Test specimens shall be representative of the containers being tested, and shall be closed and sealed in the normal manner. For containers that cannot be weighed to the accuracy prescribed in 5.2 with desiccant inside, an auxiliary opening large enough to permit inserting the desiccant receptacle shall be cut in one face. A means of sealing the opening during the test shall be provided that will permit repeated opening and reclosing during the test. Closure of this handhole can be accomplished with a piece of sheet metal, or other impervious sheeting somewhat larger than the opening, sealing it in place with wax (Note 3), or forming an equally impervious seal by other means.

NOTE 3—A satisfactory wax for this purpose consists of a mixture of 60 % microcrystalline wax and 40 % refined crystalline paraffin wax.

10. Procedure

10.1 For specimens that can be weighed accurately to the requirements prescribed in 5.2, place the selected quantity of desiccant or product inside the specimen, which shall then be closed and sealed in the normal manner. Place the specimen in the test atmosphere as described in 7.2 and make successive weighings at suitable intervals until a constant rate of gain is established as described in 7.3.

10.2 For specimens that are not practicable to weigh as described in 10.1 proceed exactly as in Section 7 except use the auxiliary opening described in Section 9 as the access opening. The regular closure is to remain sealed throughout the test.

REPORT AND PRECISION

11. Report

11.1 The report shall include the following:

11.1.1 Identification of container including data on closure, liners, etc., and whether Method A or B was used,

11.1.2 Desiccant used or identification of contents if a product is used. When a desiccant is used, the mass and area exposed shall be specified, and

11.1.3 Number or specimens tested.

11.2 If the Constant Method is used, record the following:

11.2.1 Temperature and relative humidity at which the test was conducted. If the tolerance of 2 % relative humidity or 2°F (±1.1°C) temperature is exceeded, the variation shall be specified, and

11.2.2 Water vapor transmission reported as grams of water per 30 days for the container as a unit.

11.3 If the Cycle Method is used record the following:

11.3.1 Temperature, relative humidity, and time for each test atmosphere of the cycle at which the test was conducted, and

11.3.2 Water vapor transmission reported as grams of water per cycle for the package as a unit.

11.4 The water vapor transmission rate calculation shall be made for the period of constant rate of gain. If a product is used instead of a desiccant, the moisture content at the start and completion of each cycle shall be given, together with the net weight of contents, from which data the actual amount of water pick up can be calculated.

12. Precision and Bias

12.1 *Precision*—Based on limited information from one laboratory, the repeatability coefficient of variation for the constant atmosphere method is approximately 6 %.

12.2 *Bias*—The procedure in this test method has no bias because the value is defined only in terms of this test method.

13. Keywords

13.1 constant rate of gain; cycle method; desiccant; reclosable containers; water vapor permeability