



Standard Test Methods for Water Vapor Transmission of Shipping Containers— Constant and Cycle Methods¹

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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 D 782), vibration (Methods D 999), drop (Test Method D 5276), impact resistance (Test Methods D 880, D 4003, and D 5277), or performance tests (Practice D 4169), 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 D 895 or Test Method D 1251.

1.5 *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 782 Method of Testing Shipping Containers in Revolving Hexagonal Drum²

D 880 Method of Incline Impact Test for Shipping Containers²

D 895 Test Method for Water Vapor Permeability of Packages²

D 996 Terminology of Packaging and Distribution Environments²

D 999 Methods for Vibration Testing of Shipping Containers²

D 1251 Test Method for Water Vapor Permeability of Packages by Cycle Method²

D 4003 Methods of Controlled Horizontal Impact Test for

Shipping Containers²

D 4169 Practice for Performance Testing of Shipping Containers and Systems²

D 5276 Test Method for Drop Test of Loaded Containers by Free Fall²

D 5277 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester²

3. Terminology

3.1 *Definitions*—General definitions for the packaging and distribution environments are found in Terminology D 996.

3.2 *Definitions of Terms Specific to This Standard: Descriptions of Terms Specific to This Standard:*

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

3.2.2 *water vapor transmission into a container (cycle atmosphere method)*—for this test method, the amount of water transmitted into the container from the test atmosphere during one cycle while a desiccant is sealed within.

3.2.3 *cycle*—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 $0^\circ \pm 5^\circ\text{F}$ ($-17.8^\circ \pm 2.8^\circ\text{C}$) to be followed by 3 weeks of exposure at a temperature of $100^\circ \pm 2^\circ\text{F}$ ($37.8^\circ \pm 1.1^\circ\text{C}$) and a relative humidity of $90 \pm 2\%$.

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

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



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- μ m) 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 $\frac{3}{4}$ to $1\frac{1}{2}$ in. (19 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 $\frac{1}{2}$ 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 $100^\circ \pm 2^\circ\text{F}$ ($37.7^\circ \pm 1.1^\circ\text{C}$).

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.