

Test Method for Water Vapor Transmission of Textiles

Foreword

This test method is similar in concept to other “upright cup” methods; however, it was developed specifically to evaluate comfort of vapor permeable textiles used in outdoor products. The temperature differential between the heated bath and the ambient air creates a driving force to promote water vapor transmission. This driving force is likely greater than in actual use, but it serves as an effective condition to differentiate materials by their water vapor transmission performance. Measuring water vapor transmission through test fabric as a percentage of transmission through control paper improves precision of the results, even with small fluctuations in test time or temperature. The control paper can also serve as a verification tool to ensure consistent results.

1. Purpose and Scope

1.1 This test method is used to determine the relative rate of water vapor transmission of textiles.

2. Principle

2.1 Test and control specimens are attached to water-filled canning jars where the fabric replaces the flat lid. The jars are weighed and suspended in a water bath at 54°C (129°F) for 24 h. The amount of water vapor that passes through the specimens is determined by re-weighing each jar at the end of the 24 h test and subtracting from the original weights. Vapor transmission through test specimens is reported as a percentage of the average loss through control specimens. Vapor transmission may also be reported in units of g/m²/24 h.

3. Referenced Documents

NOTE: Use current versions of all publications unless otherwise specified.

3.1 ASTM C168, Standard Terminology Relating to Thermal Insulation (see 15.1).

3.2 ASTM D1776, Standard Practice for Conditioning and Testing Textiles (see 15.1).

4. Terminology

4.1 **control paper**, *n.*— for liquid moisture management testing, a standard filter paper able to transmit a consistent volume of water vapor under controlled

conditions.

4.2 **moisture management**, *n.*—for liquid moisture management testing, the engineered or inherent transport of aqueous liquids such as perspiration or water (relates to comfort) and includes both liquid and vapor forms of water.

4.3 **water vapor transmission rate**, *n.*—the steady water vapor flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface. [ASTM C168].

5. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

5.1 Follow good laboratory practices (GLP). Wear safety glasses in all laboratory areas.

6. Uses and Limitations

6.1 This test method may not be applicable to materials that depend on direct contact with water for vapor transmission.

7. Apparatus (see 15.2)

7.1 Water bath, with a thermostat that can be set to maintain a water bath temperature of 54 ± 2°C (129 ± 5°F) (see 15.3).

7.2 Stainless steel plate, 11 or 12 gauge, with a minimum of seven 88.3-mm (3.5-in.) diam holes. The plate must be stiff enough to suspend jars slightly above the bottom of the bath. The plate will also cover the water bath to minimize evaporation.

7.3 Wide-mouth pint (nominal 16 oz) canning jars, or other glass jars with nominal 83 mm (3.25 in) diam opening and 121 mm (4.75 in.) inside depth, to fill all holes in the stainless steel plate.

7.4 Canning jar bands, or other means of securing specimens over jar mouths.

7.5 Balance, accurate to ± 0.1 g (± 0.001 oz).

7.6 Distilled water.

7.7 Timer.

7.8 Thermometer, suitable for measuring water temperature at 54 ± 2°C (129 ± 5°F).

7.9 AATCC vapor transmission control paper (see 15.4), 3 sheets.

7.10 Anemometer, with precision to measure air flow at 0.1 m/s.

8. Specimens

8.1 Cut all specimens at least 100 ± 5 mm (4 ± 0.2 in.) away from the selvage. If testing garments, cut specimens at least 100 ± 5 mm (4 ± 0.2 in.) from all seams and stitching.

8.2 Take specimens such that each contains different warp yarns or wales and different fill yarns or courses.

8.3 Cut four specimens approximately 108 mm (4.5 in.) in diam. Specimens should be large enough to cover the jar opening and be secured by the band, but exact size and shape are not critical to the test.

8.4 Control specimens are pre-cut filter paper (see 7.9).

9. Conditioning

9.1 Prior to testing, precondition and condition all specimens and control papers as directed in ASTM D1776. (Use conditions indicated in Table 1 for Textiles, general. Estimate conditioning time as indicated in Table 2 for the appropriate fiber content.) Lay each test and control specimen, separately, on a screen or perforated shelf of a conditioning/drying rack.

9.2 Perform all tests in the standard atmosphere for textile testing, 21 ± 2°C (70 ± 4°F) and 65 ± 5% RH.

9.3 Perform tests in still air, with a maximum air flow of 0.1 m/s (0.33 ft/s). Greater air flow will result in higher values for vapor transmission. Use an anemometer, following manufacturer's instructions, to verify maximum air flow in test area does not exceed 0.1 m/s (0.33 ft/s).

10. Preparation of Apparatus and Specimens

10.1 Clean and dry the canning jars.

10.2 Number each jar. The number must remain legible after wetting.

10.3 Fill the water bath approximately three quarters full with distilled water. Cover with the metal plate.

10.4 Heat and maintain the water bath at 54 ± 2°C (129 ± 5°F).

10.5 Place the first jar on the balance and tare. Add 390 ± 1 g distilled water to

the tared jar.

10.6 Repeat for a total of 7 jars (3 control, 4 test).

10.6.1 If multiple samples are being tested simultaneously, only one set of control jars is required.

10.7 Place one control specimen, face up, over the opening of jar number “1” and secure with a band.

10.8 Repeat for jars numbered “2” and “3.”

10.9 Place test specimens from a sample over the openings of jars numbered “4” through “7,” face side up, and secure with jar bands (see Fig. 1).

10.9.1 If multiple samples are being tested simultaneously, secure specimens from the second sample on jars numbered “8” through “11.” Continue to secure all specimens, keeping specimens from each sample on consecutively numbered jars.

11. Procedure

11.1 Tare empty balance and weigh the first filled and covered jar assembly. Record the jar number and total original weight of the assembly.

11.2 Weigh each remaining jar assembly, recording the jar number and total weight.

11.3 Place the prepared jars through the holes in the metal plate. Handle carefully to avoid wetting the specimens. If control paper gets wet during preparation, replace with a dry specimen and reweigh. Distribute test and control specimens evenly across the length and width of the plate (see Fig. 2).

11.3.1 If there are more holes than specimens, place empty jars in the unused holes. Add water or other ballast to the jars as needed to prevent floating. If water is used, place flat lids and bands on the jars to avoid creating excess humidity in the test environment.

11.3.2 Jars should be approximately three-quarters submerged in the water bath.

11.4 Set the timer for 24 h and start.



Fig. 1—Jar assembly prepared for testing.



Fig. 2—Test apparatus with 8 test specimens, 3 control specimens, and 4 empty jars (see 11.3.1).

11.5 After 24 h, remove the jars from the water bath. Avoid dripping on other specimens.

11.6 Dry the outsides of the jars.

11.7 Weigh each jar assembly, recording the jar number and total final weight.

11.8 Carefully unscrew bands and remove each specimen. Note any condensation on the underside of the specimen.

12. Calculations

12.1 Calculate the water vapor transmitted through each specimen by subtracting the final weight from the corresponding original weight of each jar assembly.

$$T_n = O_n - F_n \quad (\text{Eq. 1})$$

where:

T = water vapor transmitted, g

n = jar number

O = original weight of jar assembly, g

F = final weight of jar assembly, g

12.2 Calculate the average water vapor transmitted through the control specimens.

$$T_{\text{control avg}} = (T_1 + T_2 + T_3)/3 \quad (\text{Eq. 2})$$

12.3 Divide each value for water vapor transmission through test fabric by the average water vapor transmitted through control samples and multiply by 100% to get the percent of control paper vapor transmission.

$$T_{4\%} = 100\% * (T_4/T_{\text{control avg}}) \quad (\text{Eq. 3})$$

12.4 Calculate the average percent of control paper vapor transmission for each sample.

$$T_{\text{avg}\%} = (T_{4\%} + T_{5\%} + T_{6\%} + T_{7\%})/4 \quad (\text{Eq. 4})$$

12.5 Optional: Calculate the individual and average vapor transmission through test specimens in units of g/m²/24 h. For canning jar bands, exposed specimen area is 0.004243 m² (inside

diam of lid ring = 73.5 mm). Test duration is 24 h.

13. Report

13.1 Describe or identify the fabric tested.

13.2 Report that the sample was tested using AATCC TM204-2019.

13.3 Report the testing conditions and preliminary data:

13.3.1 Original and final weights of all the test and control jar assemblies (O_n , F_n).

13.3.2 Weight of water vapor transmitted through each specimen (T_n). Review the range of this data to determine the need for retesting.

13.4 Report the test results:

13.4.1 Report the individual and average percent of control paper vapor transmission for test specimens from each sample ($T_{n\%}$, $T_{\text{avg}\%}$).

13.4.2 Optional: Report the individual and average vapor transmission through test specimens in units of g/m²/24 h.

13.4.3 Report any condensation observed on the underside of specimens after testing.

13.5 Describe any modification(s) of the published method.

14. Precision and Bias

14.1 Precision

14.1.1 In 2014, an interlaboratory study was completed, which included five laboratories with single operators, testing four specimens of each of six fabrics. No prior assessment was made of the participating laboratories on performance of the test method (see Table I).

14.1.2 Analysis of the data yielded critical differences shown in Table II. Differences between two averages of (n) speci-

Table I—Precision Study Results

Fabric	n	Mean	St Dev
A	20	79.365	3.065
B	20	88.598	4.819
C	20	74.860	2.100
D	20	81.621	2.103
E	20	89.186	2.403
F	20	71.343	5.531

Table II—Critical Differences for Averages, 95% Probability

n	Within-Laboratory	Between-Laboratories
1	1.366	7.460
2	0.967	5.283
3	0.789	4.307
4	0.683	3.730
5	0.611	3.336
6	0.558	3.046