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Test Method for Measuring Condensation on Textiles in a Humid Microclimate

1. Foreword

1.1 While several test methods exist to measure the effectiveness of moisture transport mechanisms through fabric, they do not measure the amount of water condensation created within the microclimate of the textile product. This method provides a measure of the fabric contribution to the end-product condensation accumulation.

2. Purpose and Scope

2.1 This test method measures the water condensation accumulation on the innermost (back) surface of fabrics in a humid microclimate, with and without simulated precipitation on the outermost (face) fabric surface.

2.2 The method is applicable to fabrics or multi-layer fabric systems.

3. Principle

3.1 The test method measures the amount of water condensation produced in 15 min. on a specimen placed in a humid microclimate created by controlling temperature and relative humidity of chambers on either side of the specimen. Specimens are tested with a sprinkler to simulate rain, and with no sprinkler.

3.1.1 The amount of water is calculated as the mass gain of a piece of pre-weighed filter paper after absorbing the condensation from the specimen.

3.2 Results are reported as g/m², where a higher value indicates more water condensation. Area and time are constant for all specimens.

4. Referenced Documents

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

4.1 ASTM D1776, Standard Practice for Conditioning and Testing Textiles.

4.2 ASTM E1402, Standard Guide for Sampling Design.

5. Terminology

5.1 **back**, *n*—*in textiles*, the side of a fabric that is intended to be the inner surface in an end product.

NOTE: *Back* is the opposite of *face*.

5.2 **face**, *n*—*in textiles*, the side of a fabric that is intended to be the outer, visible surface in an end product.

NOTE: The technical face of the fabric

is defined by production processes but may *not* be the side selected as face in the end product.

5.3 **microclimate**, *n*—*in textiles*, the air layer immediately adjacent to one side of a textile.

NOTE: In apparel, the microclimate typically refers to the air layer between skin and clothing.

5.4 **water condensation**, *n*—liquid water droplets formed when airborne water vapor contacts a colder surface.

6. Safety Precautions

6.1 The safety precautions specified in the method are ancillary to the testing procedures and are not intended to be all inclusive.

6.2 It is the user's responsibility to reference applicable safety data sheets, use safe and proper techniques, and wear appropriate personal protective equipment in handling materials in this standard.

6.3 Users MUST consult manufacturers for specific details such as safety data sheets, equipment operating instructions, and other recommendations. Consult and follow all applicable health and safety regulations (e.g., OSHA standards and rules).

7. Limitations

7.1 While this method may be used for any textile fabric, results will vary based on absorbency as well as vapor permeability (see Appendix B).

7.2 This test method measures condensation accumulation at a specific time-point (15 min humidity exposure). Because accumulation is not linear nor infinite, this result cannot be used to predict accumulation at other timepoints (see Appendix B).

7.3 This test method does not address phenomena such as rain penetration, ventilation, wind resistance, air permeability or breathability.

8. Apparatus and Materials (see 17.1)

8.1 Apparatus with inner and outer chambers to simulate the microclimate between human skin and clothing (including headwear and footwear), and sprinklers to simulate precipitation. See Appendix A for apparatus specifications.

8.2 Specimen mounting rings.

8.2.1 Inner mounting rings (4): 165.1

mm inside diameter, 171.5 mm outside diameter, 12.7 mm height.

8.2.2 Outer clamping rings with splash guards (2): 172.7 mm inside diameter, 177.8 mm outside diameter, 12.7 mm height.

8.2.3 Outer clamping rings (2): 172.7 mm inside diameter, 177.8 mm outside diameter, 12.7 mm height.

8.3 Distilled water, for sprinkler system reservoir and water vaporization plate reservoir.

8.4 Filter paper, Grade 1 qualitative, 163-mm circles (see 17.2).

8.5 Balance, minimum resolution of 0.01 g.

8.6 Stopwatch, minimum resolution of 0.1, accuracy of ± 0.1 s.

8.7 Weight, 2 kg, 163-mm diameter.

9. Sampling

9.1 Test results are valid only when the samples are statistically representative (see ASTM E1402).

9.2 Sampling must be random. Every unit of product must have a mathematically equal chance of becoming a sample; and every portion of each sample must be equally likely to become a test specimen.

9.3 All specimens must be alike within the variations due to pure chance. There must be no differences within samples assignable to known causes.

10. Specimens

10.1 Cut 4 specimens of the test fabric per sample, with a minimum dimension of 200 mm in each direction.

10.1.1 Specimens may be round, rectangular, or a non-standard shape, but must be large enough to cover the ports of the test apparatus and be secured by the specimen rings.

10.1.2 Mark pertinent identification of construction (e.g., warp, course, face, water repellent finish side) on each specimen. Mark which 2 specimens will be tested with simulated precipitation from sprinklers and which 2 specimens will be tested dry.

10.1.3 For multi-layer fabric systems, secure all layers together, leaving an open area (no stitches or other means of attachment) of at least 152.4 mm diameter. Use the open area for testing.

10.2 Use 4 pieces of filter paper. Cut to 163-mm circles.

10.2.1 With indelible ink, mark each piece of filter paper with consecutive numbers or letters for identification purposes.

11. Conditioning

11.1 Bring specimens and filter paper to moisture equilibrium in a standard atmosphere according to ASTM D1776. Use conditions listed for Textiles, General.

12. Preparation of Apparatus

12.1 Secure a cap or other non-porous material over each opening in the test apparatus.

12.2 Fill the sprinkler reservoir. Do not add water above the maximum fill level indicated by the manufacturer.

12.3 Fill the water vaporization plate reservoir to the top with distilled water.

12.4 Set the sprinkler reservoir temperature to 10°C.

12.5 Set the inner chamber air temperature to 35°C.

12.6 Set the inner chamber humidity to 95%.

12.7 Allow the apparatus to reach the prescribed settings.

13. Procedure

13.1 Measure the mass of each conditioned filter paper circle. Record filter paper identification and conditioned mass to the nearest 0.01 g.

13.2 Perform tests in the standard atmosphere for testing textiles.

13.3 When the apparatus inner chamber reaches 35°C and 95% RH, remove the cap from each opening.

13.3.1 If the machine has been idle for more than 30 min., run a full test cycle with the caps or non-porous material in place. Remove caps before mounting fabric specimens.

13.4 Place the specimens over the openings using the mounting and clamping rings. Place the rings with splash guards on the side with sprinkler heads. See Fig. 1. It is important that the specimens are pulled taut such that the material is free from creases or dips that can fill with moisture. First-level saturation of the material will impair transmission and affect the results.

13.5 Begin test within 5 minutes of mounting the test specimen. Start sprinklers and timer. Keep inner chamber settings at 35°C and 95% RH throughout the test.

13.6 After 15 min., stop sprinklers and prepare stopwatch.

13.7 Remove one specimen. If additional tests are to be performed, cover the opening with a cap. Immediately place the specimen on a flat surface, face down.

13.8 After 20 s, place a pre-weighed filter paper circle on the back of the specimen, inside the ring. Place the 2-kg weight on the filter paper for 15 s.

13.9 Remove the weight. Measure the mass of the wet filter paper circle. Record filter paper identification and wet mass to the nearest 0.01 g.

13.10 Repeat 13.7-13.9 for remaining

specimens. After the final specimen, dry all rings and splash covers.

14. Calculation

14.1 For each specimen, calculate the condensation accumulation to the nearest g/m² using Eq. 1.

$$C = (W_a - W_b) / 0.02088 \quad (\text{Eq. 1})$$

where:

C = Condensation accumulated,
W_a = Mass of filter paper after blotting specimen (g),

W_b = Mass of filter paper before blotting specimen (g),

0.02088 = Surface area of 163-mm diameter filter paper (m²),

Round up to the nearest whole number

15. Report

15.1 Describe or identify the sample tested.

15.2 Report that the sample was tested using AATCC TM214-2022.

15.3 Report the testing conditions:

15.3.1 Specimen side tested (face or back).

15.4 Report the test results:

15.4.1 Quantity of water condensation accumulated for each specimen (g/m²), to the nearest whole number. Note which specimens were tested with and without simulated precipitation.

15.4.2 Mean condensation accumulation of the dry specimens.

15.4.3 Standard deviation of condensation accumulation for the dry specimens.

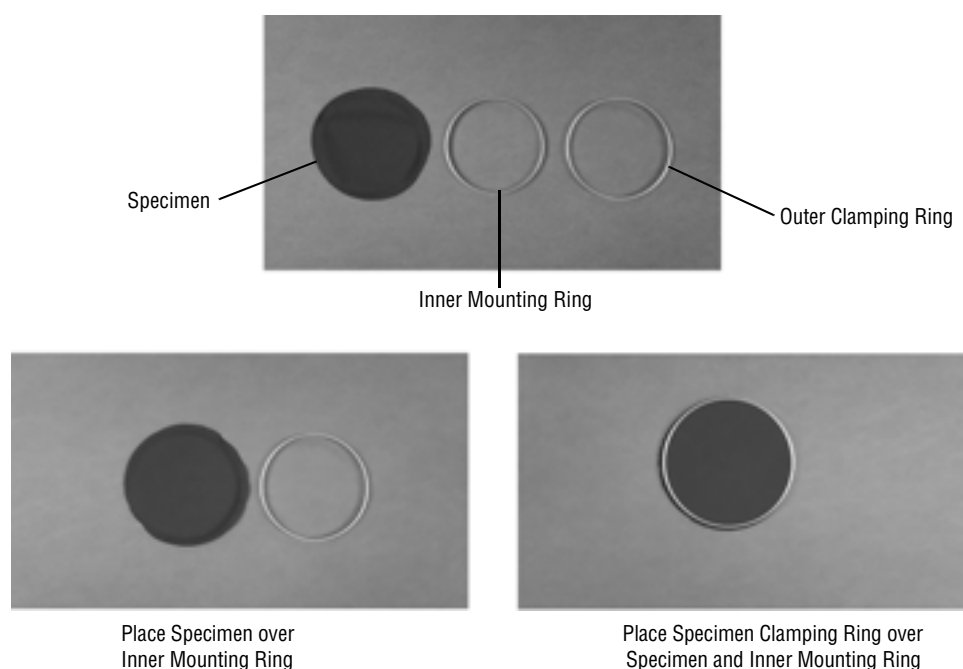


Fig 1a. Mounting procedure for specimens tested dry.