AATCC Test Method 197-2013

Vertical Wicking of Textiles

Developed in 2011 by AATCC Committee RA63; editorially revised and reaffirmed 2012; reaffirmed 2013.

Foreword

Historically, the textile industry has utilized many different test procedures for determining the wicking characteristics of textile fabrics, i.e., the movement of water or liquid through fabrics. Within the last decade, the industry has developed new technologies that have changed water movement and absorbency responses of textiles leading to the use of the labeling term "moisture management" to describe these phenomena. Many interested groups (textile manufacturers, chemical suppliers, and retailers, as well as independent testing laboratories) participated in the efforts to standardize test methods to measure the vertical wicking properties of fabrics with moisture management attributes.

Unofficial techniques for determining the absorbency and wicking properties of textile fabrics were published in the 2004 AATCC/ASTM International's *Technical Supplement: A Compilation of Procedures and Guidelines for Textile Products* and the 2008 AATCC/ASTM International's *Moisture Management Technical Supplement: Applicable to Apparel, Linens and Soft Goods* (see 13.1). This test method is based on one of the testing procedures for wicking published in this *Technical Supplement.*

1. Purpose and Scope

1.1 This test method is used to evaluate the ability of vertically aligned fabric specimens to transport liquid along and/or through them, and is applicable to woven, knitted, or nonwoven fabrics.

2. Principle

2.1 The rate (distance per unit of time) liquid travels along and/or through a fabric specimen is visually observed, manually timed and recorded at specified intervals.

3. Terminology

3.1 **fabric,** n.—*in textiles*, a planar structure made from yarns or fibers (ASTM D123 and see 13.4).

3.2 **vertical wicking,** n.—*in a textile held vertically*, the upward movement of liquid from a cut edge.

3.3 **vertical wicking rate,** n.—the speed at which liquid travels along or through a textile.

3.4 **wicking,** n.—*in textiles*, the movement of a liquid, by capillary action, along or through a material.

3.5 **wicking distance,** n.—the linear measurement that the liquid travels along or through a textile from a starting point to a stopping point.

3.6 **wicking time,** n.—the measurable period during which liquid travels along or through a textile.

4. 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.

4.1 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

5. Uses and Limitations

5.1 The movement of liquid through a fabric may be influenced by fiber content, fabric construction, mechanical or chemical processing or a combination of these.

5.2 This test method is used to evaluate the wicking ability of vertically aligned test specimens, exposed to distilled or deionized water, where wicking is influenced by gravity.

5.3 Liquids other than distilled or deionized water (tinted water, dye solutions, etc.) may be used in this test. If a liquid other than water is chosen, its surface tension should be measured and reported as solutions of different surface tensions may yield different results.

5.4 Dark fabric colors or prints and designs may be difficult to test. The use of a soluble ink of a contrasting color may help in making the marks more clearly visible.

5.5 The procedure measures the time and distance water will move up from the cut edge of a specimen, but does not duplicate an end-product's exposure during wear.

5.6. The results obtained by this test are not a measure of comfort which is beyond the scope of this method.

5.7 The relationship between results obtained by vertical and horizontal wicking tests is not known.

6. Apparatus, Reagents, Materials

6. 1 Distilled or deionized water at 21 ± 1°C (70 ± 2°F).

6. 2 Marking pens, with fine point, permanent and soluble ink (see 13.2).

6. 3 Stopwatch or digital timer.

6. 4 Tape or ruler, mm graduations.

6. 5 Surface tensiometer, if using liquid other than water (see 9.1).

6.6 Erlenmeyer flask or elongated pan (see Figs. 2 and 3).

6.7 Pipette and bulb.

6.8 Scissor jack (optional).

6.9 Straight pins or a holder that permits the suspension of a specimen into a flask or other device (see Figs. 2 and 3 and 13.3).

6.10 Small paper clip or clamp (optional).

6.11 Template, 165 (or longer) × 25 mm.

6.12 Disposable gloves, such as latex or nitrile.

6.13 Double-sided tape.

7. Specimens

7.1 Determine whether the fabric has a hydrophobic or hydrophilic side. Upon agreement between interested parties, determine whether both fabric sides are to be tested. If only one fabric side is to be tested, mark the selected side. If testing is to be performed after laundering, use a marking pen with permanent ink to denote the fabric side chosen for testing.

7.2 Minimize handling of the test specimens or use gloves as oils from the skin may affect moisture movement.

7.3 All specimens should be cut at least 100 ± 5 mm from the selvage. If testing garments, take specimens from different garment panels away from seams, pockets, plackets or other assembly features. Take each specimen such that different sets of (fabric) length and width yarns are present.

7.4 Cut three specimens at least 165 ± 3 × 25 ± 3 mm with the long dimension parallel to the fabric direction(s) chosen to be tested. For length direction testing, align the long direction of the template with the warp yarns (wales); for width direction testing, align the long direction of the template along the filling yarns (courses). Cut an extra specimen to determine water level in the flask or beaker before starting the testing (see 9.2.4).

7.5 If testing the durability of finishes or evaluating wicking properties after laundering, take specimens as described in 7.4 from fabric swatches that have been laundered according to conditions chosen from the AATCC Monograph M6, "*Standardization of Home Laundry Test Conditions*," found elsewhere in this TECHNICAL MANUAL.

8. Conditioning

8.1 Prior to testing, condition the specimens as directed in ASTM D1776, Standard Practice for Conditioning and Testing Textiles (see 13.4). Condition specimens for at least 4 h in an atmosphere of 21 ± 1°C (70 ± 2°F), 65 ± 2% RH by laying each test specimen separately on a screen or perforated shelf of a conditioning rack.

8.2 Perform all tests in the standard atmosphere for testing.

9. Procedure

9.1. If necessary, the surface tension of the chosen liquid (including tinted water or dye solution) should be measured as directed in ASTM D1331-89, Standard Test Methods for Surface and Interfacial Tensions of Solutions of Surface-Active Agents (see 13.4) and reported.

9.2 **Option A—Measure time at a given distance.**

9.2.1 Using a marking pen with soluble ink, mark a line across the end of each specimen at a distance of 5 ± 1 mm from the end on the fabric side to be tested. The 5 mm line denotes the level to which a specimen is to be lowered into the water in the flask or beaker which is the test start time.

9.2.2 Using a marking pen with soluble ink, measure from the 5 ± 1 mm line, and mark lines across the width of the specimen at distances of 20 ± 1 and 150 ± 1 mm (see Fig. 1). To facilitate the measurement of wicking distances, intervals of 10 ± 1 mm may be marked along the specimen length between the 20 ± 1 mm and 150 ± 1 mm lines.

9.2.3 Alternative wicking distances may be used depending on the desired end use of the fabric. When comparing results, the same wicking distance benchmarks should be used.

9.2.4 To determine the amount of water for the test, use the extra specimen and position it at the opening of an Erlenmeyer flask (which may be placed on a scissor jack) by the insertion of a straight pin or other device near the end of the specimen (see Fig. 2). Allow the specimen to hang into the flask. Add water up to the level at which the specimen's 5 ± 1 mm line is reached and then mark the required water level on the outside of the flask. Special care should be taken to insure that the lip and the neck of the flask remain dry to prevent premature bleeding of soluble ink marks on the specimen.

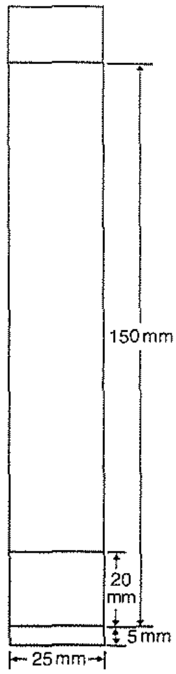

Fig. 1—Vertical wicking specimen and marking.

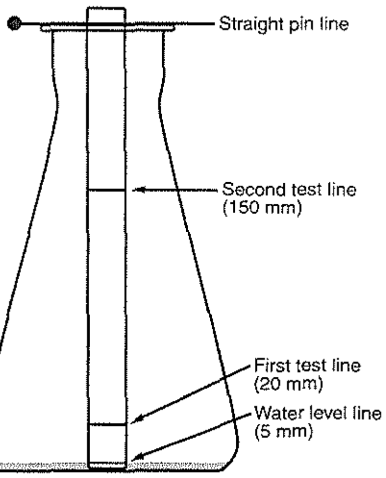

Fig. 2—Vertical alignment test configuration.

9.2.5 Some light weight woven, knitted, or hydrophobic fabrics may float on the water, in which case, a small paper clip or clamp may be attached to the end of the specimen that is to be submerged. If a paper clip or clamp is used, it should be noted in the report (see 11.1.1).

9.2.6 Fill the flask with distilled or deionized water to the line marked as instructed in 9.2.4. Insert the specimen into the flask, or raise the scissor jack to position the specimen so that the water is at the 5 ± 1 mm line.

9.2.7 Alternatively, the approximate amount of water required may be added to a flask as instructed in 9.2.4 for determining and marking a water level fill line on the outside of a flask. After a specimen is suspended in the flask, a pipette can be used to raise the water level to the appropriate height.

9.2.8 Use a clean flask with fresh water for testing subsequent samples.

9.2.9 Start stopwatch or timer as soon as the water reaches the 5 ± 1 mm line and the soluble ink begins to migrate upwards. Monitor the rise of the water. Record the time, to the nearest second, that it takes for the soluble ink at the marked 20 ± 1 mm line to start to migrate. Continue monitoring the rise of the water and record to the nearest second the time and distance that the test was terminated.

9.2.10 The test should be terminated if the water does not wick to either the 20 ± 1 mm line in 5.0 ± 0.1 min or if the total time of the water to wick to the 150 ± 1 mm line exceeds 30.0 ± 0.1 min. In either case, measure the distance the water has migrated and the time that the test was stopped. Record the time and distance and the reason for termination of the test.

9.2.11 Remove the specimen from the flask.

9.2.12 Repeat steps 9.2.2 through 9.2.11 for the remaining specimens.

9.3 **Option B—Measure distance at a given time.**

9.3.1 Place a ruler vertically against the back of the elongated pan (see Fig. 3) inside the box so that the ruler touches the bottom. Fill the elongated pan with distilled or deionized water to a depth of 38 ± 2 mm (1.5 ± 0.1 in.) water.

9.3.2 Remove the ruler from the back of the pan. Secure the ruler with tape on the outside of the pan so that the top of the water surface is at the "0" mm mark on the ruler.

9.3.3 Use double-sided tape to secure a specimen to the top of the box so that the bottom edge just touches the top surface of the water (same as the "0" mm mark on the ruler) and start the stopwatch or

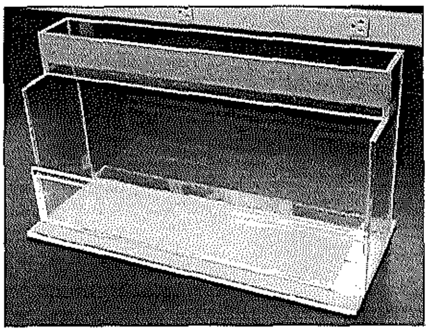

Fig. 3—Multiple specimen elongated pan.

timer immediately.

9.3.4 Some light weight woven, knitted, or hydrophobic fabrics may float on the water, in which case, a small paper clip or clamp may be attached to the end of the specimen that is to be submerged. If a paper clip or clamp is used, it should be noted in the report (see 11.1.1).

9.3.5 Monitor the rise of the water. At 2.0 ± 0.1 min, use a ruler to measure the distance that the water has wicked. Record the distance in millimeters. At 10.0 ± 0.1 min, use a ruler to measure the distance that the water has wicked. Record the distance in millimeters.

9.3.6 Alternative wicking times may be used depending on the desired end use of the fabric. When comparing results, the same wicking time benchmarks should be used.

9.3.7 The test should be terminated if the water does not wick any distance in 10.0 ± 0.1 min or if the total time of the water to wick to the end of the specimen exceeds 30.0 ± 0.1 min. In either case, measure the distance the water has migrated and the time that the test was stopped. Record the time and distance and the reason for termination of the test.

9.3.8 Remove the specimen from the flask.

9.3.9 Repeat steps 9.3.1-9.3.8 for the remaining specimens.

10. Calculation

10.1 Calculate the vertical wicking rates. Two different rates, a short period rate and a long period rate, are obtained for each sample.

10.1.1 Vertical wicking rate is calculated by dividing the wicking distance by the wicking time as shown in formula 1.

$$W = d/t \qquad (1)$$

where:

W = wicking rate, mm/s
d = wicking distance, mm
t = wicking time, s

10.1.2 The short period rate is calculated:

(Option A) from the time it takes to reach the 20 ± 1 mm line or, from the distance the water has wicked in 5.0 ± 0.1 min. or,

(Option B) from the distance the water has wicked in 2.0 ± 0.1 min.

10.1.3 The long period rate is calculated:

(Option A) from the time it takes to reach the 150 ± 1 mm line or, for those specimens that have not reached the 150 mm line from the distance that the water has reached in 30.0 ± 0.1 min. or,

(Option B) from the distance the water has wicked in 10.0 ± 0.1 min.

11. Report and Interpretation

11.1 Report the direction(s) and side(s) of the sample tested.

11.1.1 Report the wicking times, wicking distances, average wicking times, calculated wicking rates, whether short period or long period, and whether a paper clip or clamp was attached to the bottom of the test specimens.

11.1.2 If the test was terminated by reaching the marked distance(s) or the maximum time was exceeded, report the distance wicked and the time the test was terminated.

11.2 Report if a solution other than distilled or deionized water at 21 ± 1°C (70 ± 2°F) was used and its surface tension and temperature.

11.3 Report if testing was performed after laundering, the laundering conditions used and the number of launderings completed.

11.4 The 20 mm mark, or the 5.0 min time, may provide data on initial wicking and the 150 mm mark, or the 30.0 min. time, may provide data on extended wicking. The two levels of vertical wicking ability may be used as indicators to differentiate performance.

12. Precision and Bias

12.1 *Precision.*

12.1.1 *Interlaboratory Study for Option A.* Tests for wicking of textiles using vertical orientation were conducted in 2009, with one laboratory, three operators, and five samples. The five samples used in the study were (a) 100% cotton jersey knit, (b) 100% cotton interlock knit, (c) 100% polyester woven, (d) 100% cotton twill weave, and (e) 50/50 cotton/polyester blend woven.

12.1.2 The analysis of variance technique was applied to the eight different data sets. The analyses are being retained for reference at the AATCC Technical Center. In the analyses of variance, the operators as a source of variation were not found to be significant in all cases except for testing in the width direction, when the measurement was made at the long period, in testing either in the flask or in the elongated pan. The fabrics were found to be a significant source of variation. Table I shows the means and confidence intervals for each fabric in the length direction. Table II shows the means and confidence intervals for each fabric in the width direction.

12.1.3 *Interlaboratory Study for Option B.* Tests for wicking of textiles using vertical orientation were conducted in 2010, with one laboratory, two operators, and four samples. The four samples used in the study were (a) cotton pique, (b) polyester jersey, (c) polyester mesh, and (d) polyester/spandex rib.

12.1.4 The analysis of variance technique was applied to the different data sets (length and width directions). The analyses are being retained for reference at the AATCC Technical Center. In the analyses of variance, the operators as a source of variation were not found to be significant. Table III shows the means and confidence intervals for each fabric in the length direction. Table IV shows the means and confidence intervals for each fabric in the width direction.

12.1.5 *Between-laboratory* precision has not been established for this test method. Until such precision information is available, users of the method should use standard statistical techniques in making any comparison of test results for *between-laboratory* averages.

12.2 *Bias.* The true value of vertical wicking rates of textile fabrics can be defined only in terms of a test method. There is no independent method for determining the true value. In estimating this property, the test method has no known bias.

13. Notes

13.1 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: +1.919.549.8141; fax: +1.919.549.8933; e-mail: orders@aatcc.org; web site: www.aatcc.org.

13.2 A suitable marking pen contains ink that is water soluble, available commercially such as Paper Mate® Flair® Fiber Tip Pen from Sanford Corporation, 2707 Butterfield Rd., Oak Brook IL 60523; tel: +1.630.481.2200; fax: +1. 866.666.8735; web site: www.papermate.com.

13.3 A suitable device that will function as a specimen holder is a ring stand with a horizontal bar. An optional device to automatically lower the specimen into solution is a pneumatic cylinder incorporated into the specimen holder.

13.4 Available from ASTM International, 100 Barr Harbor Dr., W. Conshohocken PA 19428; tel: +1.610. 832.9500; fax: +1.610.832. 9555; web site: www.astm.org.

Table I—Summary of Statistics (OPTION A)—Length Direction (rate in mm/s)

	Jersey	Interlock	Polyester Woven	Cotton Woven	Poly/Cotton Woven
ELONGATED PAN METHOD	**SHORT PERIOD**				
Mean	1.6	0.2	2.6	1.4	0.3
Standard Deviation	0.5	0.1	0.9	0.4	0.1
Count	18	18	18	18	18
Confidence Level (95.0%)	0.3	0.0	0.4	0.2	0.1
FLASK METHOD	**SHORT PERIOD**				
Mean	1.4	0.4	2.6	1.3	0.3
Standard Deviation	0.4	0.1	0.7	0.6	0.0
Count	18	18	18	18	18
Confidence Level (95.0%)	0.2	0.1	0.4	0.3	0.0
ELONGATED PAN METHOD	**LONG PERIOD**				
Mean	0.1	0.0	0.1	0.1	0.1
Standard Deviation	0.0	0.0	0.0	0.0	0.0
Count	18	18	18	18	18
Confidence Level (95.0%)	0.0	0.0	0.0	0.0	0.0
FLASK METHOD	**LONG PERIOD**				
Mean	0.1	0.0	0.1	0.1	0.1
Standard Deviation	0.0	0.0	0.0	0.0	0.0
Count	18	18	18	18	18
Confidence Level (95.0%)	0.0	0.0	0.0	0.0	0.0

Table II—Summary of Statistics (OPTION A)—Width Direction (rate in mm/s)

	Jersey	Interlock	Polyester Woven	Cotton Woven	Poly/Cotton Woven
ELONGATED PAN METHOD	**SHORT PERIOD**				
Mean	1.9	0.9	2.3	1.0	0.3
Standard Deviation	0.7	0.2	0.7	0.3	0.1
Count	18	18	18	18	18
Confidence Level (95.0%)	0.3	0.1	0.4	0.1	0.1
FLASK METHOD	**SHORT PERIOD**				
Mean	1.8	1.0	2.2	1.2	0.2
Standard Deviation	0.6	0.4	0.7	0.7	0.1
Count	18	18	18	18	18
Confidence Level (95.0%)	0.3	0.2	0.4	0.3	0.1
ELONGATED PAN METHOD	**LONG PERIOD**				
Mean	0.1	0.1	0.1	0.1	0.0
Standard Deviation	0.0	0.0	0.0	0.0	0.0
Count	18	18	18	18	18
Confidence Level(95.0%)	0.0	0.0	0.0	0.0	0.0
FLASK METHOD	**LONG PERIOD**				
Mean	0.1	0.1	0.1	0.1	0.0
Standard Deviation	0.0	0.0	0.0	0.0	0.0
Count	18	18	18	18	18
Confidence Level (95.0%)	0.0	0.0	0.0	0.0	0.0

Table III—Summary of Statistics (OPTION B)—Length Direction (rate in mm/s)

	Cotton Pique	Polyester Jersey	Polyester Mesh	Polyester/Spandex Rib
	SHORT PERIOD			
Mean	0.44	0.45	0.61	0.50
Standard Deviation	0.02	0.07	0.03	0.03
Count	20	20	20	20
Confidence Level (95.0%)	0.02	0.07	0.02	0.02
	LONG PERIOD			
Mean	0.14	0.18	0.20	0.18
Standard Deviation	0.003	0.01	0.01	0.01
Count	20	20	20	20
Confidence Level (95.0%)	0.003	0.01	0.01	0.01

Table IV—Summary of Statistics (OPTION B)—Width Direction (rate in mm/s)

	Cotton Pique	Polyester Jersey	Polyester Mesh	Polyester/Spandex Rib
	SHORT PERIOD			
Mean	0.42	0.46	0.58	0.57
Standard Deviation	0.03	0.07	0.03	0.05
Count	20	20	20	20
Confidence Level (95.0%)	0.02	0.07	0.03	0.04
	LONG PERIOD			
Mean	0.13	0.18	0.19	0.20
Standard Deviation	0.01	0.01	0.01	0.01
Count	20	20	20	20
Confidence Level (95.0%)	0.01	0.01	0.01	0.01