Test Method for Colorfastness to Perspiration

1. Purpose and Scope

1.1 This test method is used to determine the fastness of colored textiles to the effects of acid perspiration. It is applicable to dyed, printed or otherwise colored textile fibers, yarns and fabrics of all kinds and to the testing of dyestuffs as applied to textiles.

1.2 Work by Committee RA52 showed this test will correlate with limited field studies. Prior to this there were acid and alkaline tests; however, as a result of these studies the alkaline test was eliminated (see 13.1).

2. Principle

2.1 A specimen of colored textile in contact with other fiber materials (for color transfer) is wet out in simulated acid perspiration solution, subjected to a fixed mechanical pressure and allowed to dry slowly at a slightly elevated temperature. After conditioning, the specimen is evaluated for color change and the other fiber materials are evaluated for color transfer.

3. Terminology

3.1 **colorfastness,** n.—the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage or use of the material.

3.2 **perspiration,** n.—a saline fluid secreted by the sweat glands.

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 Follow good laboratory practices. Wear safety glasses in all laboratory areas.

4.2 All chemicals should be handled with care.

4.3 Observe wringer safety. Normal safe guards on pad should not be removed. Ensure adequate guard at the nip point. A foot operated kick off is recommended for a motorized wringer.

5. Apparatus, Materials and Reagents (see 13.2)

5.1 Perspiration tester (with acrylic plates) (see Figs. 1 and 2).

5.2 Drying oven—convection.

5.3 Balance with a weighing accuracy of ± 0.001 g.

5.4 Cold cut Multifiber test fabric (8 mm [0.33 in.] bands) containing acetate, cotton, nylon, silk, viscose rayon and wool shall be used for specimens containing silk. Multifiber test fabric (8 mm [0.33 in.] bands) containing acetate, cotton, nylon, polyester, acrylic and wool shall be used with specimens with no silk present (see 13.3).

5.5 pH meter accurate to ± 0.01.

5.6 AATCC 9-Step Chromatic Transference Scale (AATCC Evaluation Procedure 8) or Gray Scale for Staining (AATCC Evaluation Procedure 2) (see 13.4).

5.7 Gray Scale for Color Change (AATCC Evaluation Procedure 1 or 7) (see 13.4).

5.8 Wringer.

Fig. 1—Horizontal perspiration tester.

5.9 White AATCC Textile Blotting Paper (see 13.4).

5.10 Acid perspiration solution.

5.11 Petri dish with a depth greater than 1.5 cm and capable of containing a 6 × 6 ± 0.2 cm test specimen

5.12 Un-dyed adjacent fabric

6. Preparation of Reagent

6.1 Prepare the acid perspiration solution by filling a 1 L volumetric flask half full of distilled water. Add the following chemicals and mix to be sure that all chemicals are thoroughly dissolved:

10 ± 0.01 g sodium chloride (NaCl)

1 ± 0.01 g lactic acid, USP 85%

1 ± 0.01 g sodium phosphate, dibasic, anhydrous (Na_2HPO_4)

0.25 ± 0.001 g ℓ-histidine monohydrochloride ($C_6H_9N_3O_2{\cdot}HCl{\cdot}H_2O$)

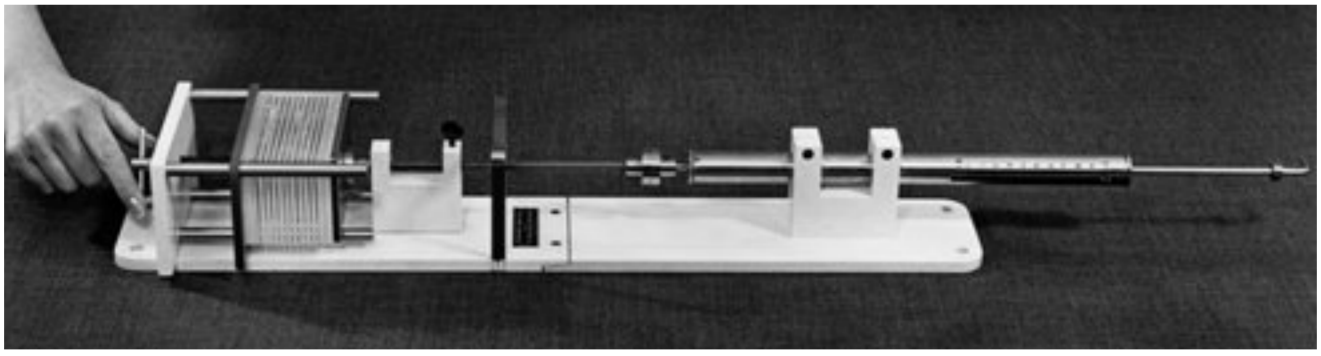

Fig. 2—Vertical perspiration tester.

Fill the volumetric flask with distilled water to the 1 L mark.

6.2 Test the pH of the solution with a pH meter. If it is not 4.3 ± 0.2, discard it and prepare a new one, making sure all ingredients are weighed accurately. The use of pH test paper is not recommended for this purpose because of its lack of accuracy.

6.3 Do not use perspiration solution that is more than three days old (see 13.5).

7. Verification

7.1 Verification checks on the operation of the test and apparatus should be made routinely and the results kept in a log. The following observations and corrective actions are extremely important to avoid incorrect test results.

7.2 Use an in-house perspiration fabric with a mid-range visual grade on the most heavily stained stripe of the multifiber cloth as a calibration specimen and conduct a perspiration test using three specimens. Verification checks should be performed periodically as well as each time a new lot of multifiber or undyed adjacent fabric is used.

7.2.1 Non-uniform color transfer may be due to improper wet-out procedures or may be a result of uneven pressure on the specimens due to warped plates in the tester. Check the wet-out procedures to be sure that the balance is accurate and that the procedure is being carefully followed. Check all plates to be sure they are in good condition and not warped.

8. Test Specimens

8.1 Number and size of specimens.

8.1.1 For fabric testing, one specimen 6 × 6 ± 0.2 cm is needed. Attach a piece of multifiber adjacent fabric measuring 5 × 5 ± 0.2 cm to the face of the specimen by sewing a single seam stitch along one edge of the fabric.

8.1.2 For yarn or loose fiber testing, weigh a 5 × 5 ± 0.2 cm piece of multifiber fabric and a 6 × 6 ± 0.2 cm piece of the un-dyed adjacent fabric together. Then take a mass of the yarn or loose fiber approximately equal to one half of the combined mass of the adjacent fabrics. Place it between the 5 × 5 ± 0.2 cm piece of multifiber fabric and a 6 × 6 ± 0.2 cm piece of the un-dyed adjacent fabric, and sew along all four sides.

8.1.3 Do not use multifiber test fabric that has fused, sealed, or pre-sewn edges because it might have thickness variations at the edges which would cause uneven compression during testing.

9. Procedure

9.1 Weigh each test specimen (as prepared in 8.1) to the nearest 0.1g. Place each test specimen) in a petri dish. Add freshly prepared perspiration solution to a depth of 1.5 cm in the petri dish. Soak the test specimen in the solution for 30 ± 2 min with occasional agitation and squeezing to ensure complete wetting. For fabrics hard to wet out, alternately wet the specimen and pass it through the wringer until it is completely penetrated by the solution.

9.2 After 30 ± 2 min, pass each test specimen assembly through the wringer with the multifiber stripes perpendicular to the length of the wringer rolls (all stripes go through the wringer at the same time). Weigh each test specimen to be sure it weighs 2.25 ± 0.05 times its original weight. Because certain fabrics may not be able to retain this amount of solution when passing through a wringer, such fabrics may be tested after blotting to the required wet pickup with White AATCC Textile Blotting Paper (see 13.4). To obtain consistent results all specimens of a given construction in a test series should have identical pickup, as the degree of staining increases with the amount of retained solution.

9.3 Place each test specimen assembly on an acrylic plate with the multifiber stripes running perpendicular to the long dimension of the plate (see Fig. 3).

9.4 Depending upon equipment available, use the following alternates:

9.4.1 Horizontal Perspiration Tester (see Fig. 1): Place the plates in the perspiration tester with the specimen assemblies evenly distributed between the 21 plates. Place all 21 plates into the unit regardless of the number of specimens. After placing the final plate in position (on top) set the dual plates with compensating springs in position, place the 3.63 kg (8.0 lb) weight on top making a total of 4.54 kg (10.0 lb) under the pressure plate, and lock the pressure plate in position by turning the thumb screws. Remove the weight and place the unit lying on its side in the oven so that the sides of the perspiration tester are parallel to the oven walls (see Fig. 4).

9.4.2 Vertical Perspiration Tester (See Fig. 2): Assemble the plates in the perspiration tester with the specimens evenly distributed between the 21 plates. Place all 21 plates into the unit regardless of the number of specimens. The plates are held in a vertical position between an indicating scale with a fixed metal plate at one end and an adjustable metal plate at the other end. Use the adjusting screw to exert a 4.54 kg (10.0 lb) force against the plates. Lock the specimen unit containing the test specimens with a set screw. Remove the pressure gauge unit from the specimen unit and place the specimen unit in the oven such that the side of the perspiration tester is parallel to the oven walls. Another specimen unit may be added to the pressure gauge unit and the loading procedure repeated.

9.5 Heat the loaded specimen unit in an oven at 38 ± 1°C (100 ± 2°F) for 6 h ± 5 min. Check the oven temperature periodically to be sure it remains at the specified temperature throughout the test.

9.6 Remove the tester from the oven and for each test specimen assembly, separate the multifiber fabric and, if used, the undyed adjacent fabric from the test fabric. Place the multifiber fabric and test fabric specimens separately on a wire screen in a conditioned atmosphere (21 ± 2°C [70 ± 4°F]) and 65 ± 5% relative humidity overnight.

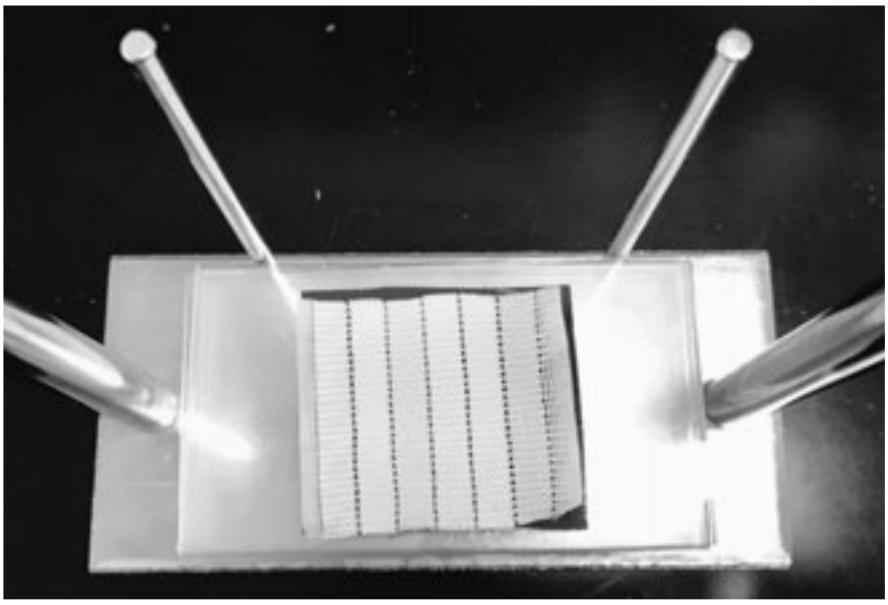

Fig. 3—Specimen in holder.

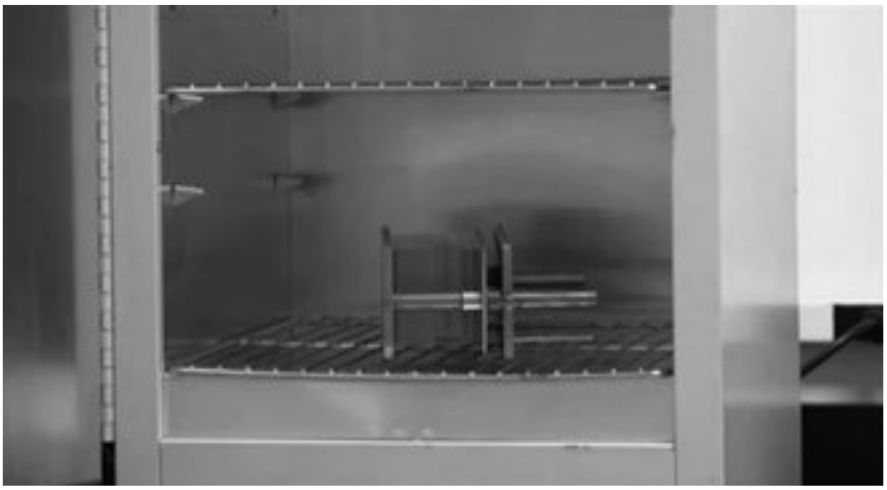

Fig. 4—Horizontal Perspiration tester placement in oven.

10. Evaluation (see 13.7)

10.1 General—Unsatisfactory perspiration fastness may be due to bleeding or migration of color or it may be due to change in color of the dyed material. It should be noted that objectionable change in color may be encountered with no apparent bleeding. On the other hand, there may be bleeding with no apparent change in color, or there may be both bleeding and change in color.

10.2 Rate the effect on the color of the test specimens by comparison with the Gray Scale for Color Change (AATCC Evaluation Procedure 1), or using AATCC Evaluation Procedure 7, Instrumental Assessment of the Change in Color of a Test Specimen, and record the numerical rating that corresponds to the appropriate one on the Gray Scale (see 13.4).

10.3 Rate the staining on each fiber type of the multifiber, and the undyed original fabric if used, by comparison with the Gray Scale for Staining (AATCC Evaluation Procedure 2), the AATCC 9-Step Chromatic Transference Scale (AATCC Evaluation Procedure 8) or Instrumental Assessment of Degree of Staining (AATCC Evaluation Procedure 12), and record the numerical rating that corresponds to the appropriate one on either of them. (see 13.4.)

11. Report

11.1 Report the color change grade and the staining grades for each fiber type in the multifiber test sample and state which scale (AATCC Evaluation Procedure 2, 8, or 12) was used in the staining evaluation (see 13.4).

12. Precision and Bias

12.1 *Precision*. Proficiency data generated by 188 different labs during five different time periods (June 2012, December 2012, June 2013, December 2013 and June 2014) was used to define the precision of stain rating and color change rating values. Each lab used the same fabric materials to obtain the stain rating and color change rating values. Each lab performed three replicate tests for each test material and used three different raters to assign ratings for staining and color change. Each lab also used multi-fiber fabric strips containing acetate, acrylic, cotton, nylon, polyester and wool fibers to assess the staining of individual fibers.

12.1.1 Tables 1-6 give the within lab and between lab precision values for the stain ratings of acetate, acrylic, cotton, nylon, polyester and wool fibers.

12.1.2 Table 7 gives the precision values for color change rating. As mentioned above, the multi-period data generated by 188 different labs was used to compute the precision values.

12.1.3 In addition to providing the precision values, the analysis of the multi-period data revealed the following statistical facts:

- The stain ratings assigned by **different labs** for **acetate** fiber **differed** significantly at 95% confidence level.
- The mean stain ratings of **acetate fiber** corresponding to five different **time periods differed** significantly at 95% confidence level.
- The stain ratings assigned by **different labs** for **acrylic** fiber **differed** significantly at 95% confidence level.
- The mean stain ratings of **acrylic fiber** corresponding to five different **time periods differed** significantly at 95% confidence level.
- The stain ratings assigned by **different labs** for **cotton** fiber **did not differ** significantly at 95% confidence level.
- The mean stain ratings of **cotton** fiber corresponding to five **different time** periods **differed** significantly at 95% confidence level.
- The stain ratings assigned by **different labs** for **nylon** fiber **did not** differ significantly at 95% confidence level.
- The mean stain ratings of **nylon** fiber corresponding to five different **time**

Table 1—Precision Table for Stain Rating of Acetate

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.01173	0.01519
2	0.0083	0.0108
3	0.0068	0.0088
4	0.0059	0.0076
5	0.0052	0.0068
6	0.0048	0.0062

Table 2—Precision Table for Stain Rating of Acrylic

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.02773	0.03646
2	0.0196	0.0258
3	0.0160	0.0210
4	0.0139	0.0182
5	0.0124	0.0163
6	0.0113	0.0149

Table 3—Precision Table for Stain Rating of Cotton

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.09994	0.1315
2	0.0708	0.0931
3	0.0577	0.0759
4	0.0500	0.0658
5	0.0447	0.0588
6	0.0408	0.0537

Table 4—Precision Table for Stain Rating of Nylon

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.040426	0.05312
2	0.0286	0.0376
3	0.0233	0.0307
4	0.0202	0.0266
5	0.0181	0.0238
6	0.0165	0.0217

Table 5—Precision Table for Stain Rating of Polyester

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.019723	0.026041
2	0.0140	0.0184
3	0.0114	0.0150
4	0.0099	0.0130
5	0.0088	0.0116
6	0.0081	0.0106

Table 6—Precision Table for Stain Rating of Wool

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.01951	0.02552
2	0.0138	0.0181
3	0.0113	0.0147
4	0.0098	0.0128
5	0.0087	0.0114
6	0.0080	0.0104

Table 7—Precision Table for Color Change Ratings

No. of Specimens	Within Lab Precision	Between Lab Precision
1	0.02182	0.02552
2	0.0155	0.0181
3	0.0126	0.0147
4	0.0109	0.0128
5	0.0098	0.0114
6	0.0089	0.0104

periods differed significantly at 95% confidence level.

- The stain ratings assigned by **different labs** for **polyester** fiber **differed** significantly at 95% confidence level.
- The mean stain ratings of **polyester** fiber corresponding to five different **time periods differed** significantly at 95% confidence level.
- The stain ratings assigned by **different labs** for **wool** fiber **differed** significantly at 95% confidence level.
- The mean stain ratings of **wool** fiber corresponding to five different **time periods differed** significantly at 95% confidence level.
- The mean **color change ratings** of **different labs differed** significantly at 95% confidence level.
- The mean **color change ratings** of five different **time periods differed** significantly at 95% confidence level.

12.2 *Bias*. The colorfastness to perspiration can be defined only in terms of a test method. There is no independent method for determining the true value. As a means of estimating this property, the method has no known bias.

13. Notes

13.1 Background information on the committee's work and decision to eliminate the alkaline test was published in two articles in *Textile Chemist and Colorist*: "Colorfastness to Perspiration and Chemicals" (October 1974) and "Evaluating Colorfastness to Perspiration: Laboratory Test vs. Wear Test" (November 1974). Although the alkaline test has been eliminated from this method, there may be certain instances in foreign trade or special end-uses that require the alkaline test. In these instances the alkaline test should be run as in AATCC Method 15-1973. For convenient reference the composition of the alkaline solution is as follows: Alkaline Solution–10 g sodium chloride; 4 g ammonium carbonate, USP; 1 g sodium phosphate, dibasic, anhydrous (Na_2HPO_4); 0.25 g ℓ-histidine monohydrochloride. Make up to one liter with distilled water. This solution should give a pH of 8.0.

13.2 For potential equipment information pertaining to this test method, please visit the online *AATCC Buyer's Guide* at http://www.aatcc.org/bg. AATCC provides the possibility of listing equipment and materials sold by its Corporate members, but AATCC does not qualify, or in any way approve, endorse or certify that any of the listed equipment or materials meets the requirements in its test methods.

13.3 The six fiber test fabrics without fused edges should be used in this method.

13.4 The AATCC 9-Step Chromatic Transference Scale, Gray Scale for Staining, Gray Scale for Color Change and White AATCC Textile Blotting Paper are 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.

13.5 Committee RR52 established that fungi begin to grow in the acid perspiration solution and that the pH gradually rises after three days of storage under ambient room temperatures, even when kept in a stoppered solution bottle.

13.6 For very critical visual evaluations and in the case of arbitration, ratings must be based on the Gray Scale for Staining as opposed to the 9 step chromatic transference scale.

13.7 CAUTION: It has been reported that the results for staining obtained by this method on fabrics dyed to dark shades (navy, black, etc.) that contain a combination of polyester and spandex, or their blends, may not show the full staining propensity of such fabrics in consumer use. It is, therefore, recommended that the staining results obtained by this test not be used for the acceptance testing of such fabrics.

14. History

14.1 Editorially revised in 2022 to fix a typo and update conditioning tolerances. Revised in 2021 for clarity and to add History section per the AATCC style guide. Revised 2013; editorially revised 2010; revised in 2009; editorially revised 2008, reaffirmed 2007; editorially revised 2005, 2004; editorially revised and reaffirmed 2002; revised 1997; editorially revised 1995; editorially revised and reaffirmed 1994; reaffirmed 1989; editorially revised 1986; reaffirmed 1985; editorially revised 1983, 1981; reaffirmed 1979; revised 1976, 1975; editorially revised 1974; revised 1973, 1972; reaffirmed 1967; editorially revised 1967; revised 1962; editorially revised 1961; revised 1960, 1957, 1952.

14.2 Developed in 1949 by AATCC Committee RR52; jurisdiction transferred to AATCC Committee RA23 in 2006; related to ISO 105-E04.