

# Test Method for Colorfastness to Water: Chlorinated Pool

Developed in 1984 by Committee RA23. Supersedes AATCC TM105-1975; editorially revised 1985, 1995, 2008, 2010, 2012, 2019; editorially revised and reaffirmed 1986, 1997; reaffirmed 1991, 2002, 2009; revised 2011. Related to ISO 105-E03.

## 1. Purpose and Scope

1.1 This test method is used for evaluating the resistance to chlorinated pool water of dyed, printed or otherwise colored textile yarns and fabrics of all kinds.

## 2. Principle

2.1 Yarn or fabric specimens are agitated at a fixed rate in diluted chlorine solution under specified conditions of temperature, time, pH and hardness. The dried specimens are evaluated for change in color.

## 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 **pool water, n.**—water to which various chemicals are added to maintain purity and clarity, normally used for swimming.

## 4. 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.

4.2 All chemicals should be handled with care.

4.3 When using 6N sulfuric acid and acetic acid, use chemical goggles or face shield, impervious gloves and an impervious apron. Concentrated acids should be handled only in an adequately venti-

lated laboratory hood. CAUTION: Always add acid to water.

4.4 An eyewash/safety shower should be located nearby and a high efficiency particulate respirator with a full face-piece should be readily available for emergency use.

4.5 Manufacturer's safety recommendations should be followed when operating laboratory testing equipment.

4.6 Observe padder safety. Ensure adequate guard at the nip point. Normal safeguards on pad should not be removed. A foot-operated kickoff is recommended.

4.7 Exposure to chemicals used in this procedure must be controlled at or below levels set by governmental authorities (e.g., Occupational Safety and Health Administration's [OSHA] permissible exposure limits [PEL] as found in 29 CFR 1910.1000; see web site: [www.osha.gov](http://www.osha.gov) for latest version). In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) comprised of time weighted averages (TLV-TWA), short term exposure limits (TLV-STEL) and ceiling limits (TLV-C) are recommended as a general guide for air contaminant exposure which should be met (see 11.1).

## 5. Apparatus and Materials (see 11.2)

### 5.1 Equipment:

5.1.1 Option 1-Accelerated laundering machine (see 7.1 and 11.3).

5.1.2 Stainless steel lever lock canisters Type 2, 1200 mL, 90 × 200 mL (3.5 × 8.0 in.).

5.2 Option 2-Drycleaning Cylinder (see 7.2 and 11.4).

### 5.3 Wringer.

5.4 Gray Scale for Color Change (AATCC EP1) (see 11.6).

5.5 Test Control Fabric 162 (see 11.6).

### 5.6 Reagents:

5.6.1 Household sodium hypochlorite solution (NaOCl), approximately 5% available chlorine (see 11.5).

5.6.2 Calcium chloride, anhydrous (CaCl<sub>2</sub>).

5.6.3 Magnesium chloride, hexahydrate (MgCl<sub>2</sub> · 6H<sub>2</sub>O).

5.6.4 Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), 6N.

5.6.5 Potassium iodide, KI, 12%.

5.6.6 Starch solution, 1%.

5.6.7 Sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>), 0.01N, (see 11.7).

5.6.8 Distilled or deionized water.

5.6.9 Sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>).

5.6.10 Acetic acid (CH<sub>3</sub>COOH).

## 6. Preparation of Reagents

6.1 Deionized or distilled water to which 5 ppm chlorine and 100 ppm salts (hardness concentrate) are added; adjusted to 21°C (70°F) and pH 7.0 with sodium carbonate or acetic acid.

## 7. Test Specimens

7.1 Option 1-Accelerated Laundering Machine.

7.1.1 Specimen size 5 × 5 cm; control fabric size 5 × 5 cm. Total weight of specimen and control fabric 1.0 ± 0.05 g. Multiple specimens of the same sample can be used to achieve a 1.0 g load.

7.2 Option 2-Drycleaning Cylinder Equipment.

7.2.1 Colored specimens, approximately 6 × 6 cm. Total weight of test specimens should be 5.0 ± 0.25 g. If specimens to be tested do not weigh 5.0 g, add multiple specimens to make 5.0 g. Include the Test Control Fabric in the 5.0 g weight. Different colored specimens can be mixed when making up the 5.0 g load.

## 8. Procedure

### 8.1 Solution Preparation.

8.1.1 Add 800 mL deionized or distilled water to a 1 L volumetric flask and add 8.24 g calcium chloride and 5.07 g magnesium chloride while stirring to dissolve. Bring volume up to 1 L with water. This is a "hardness concentrate" which can be retained and used for 30 days.

8.1.2 Dilute 51 mL hardness concentrate to 5100 mL with deionized or distilled water. Add 0.5 mL household sodium hypochlorite solution which is no more than 60 days old. Determine actual ppm Cl by titration and adjust to 5 ppm (see 11.7).

8.1.3 0.01N Sodium thiosulfate can be purchased in this form or can be diluted 10 to 1 volumetrically from 0.1N solution.

8.1.4 Adjust solution to pH 7.0 with sodium carbonate or acetic acid as necessary.

8.2 Option 1-Accelerated Laundering Tester:

8.2.1 Place 1000 mL of solution (from 8.1) in the canister of the testing machine. Adjust temperature to 21°C (70°F).

8.2.2 Place specimen and control fabric in canister with solution. Specimen size 5 × 5 cm; control fabric size 5 × 5 cm. Total weight of specimen and control fabric 1.0 ± 0.05 g. Multiple specimens from the same sample can be used to achieve a

1.0 g load. Place lid with gasket on top of canister and lock in place. Invert canister and check for leakage.

8.2.3 The closed canister is placed in the testing machine with the test specimens and the control fabric at 21°C. Run each fabric and control fabric separately for this test. Tumble the specimen with solution for 60 min. Note: Steel balls are not added to this solution.

8.3 Option 2-Drycleaning Cylinder Tester:

8.3.1 Purge the drycleaning cylinder. Add approximately 5000 mL deionized water and 0.5 mL household sodium hypochlorite solution (see 11.5). Close cylinder and run for 10 min (purging is necessary only if cylinder has been used for testing other than chlorinated pool water, or has not been used for a period of two weeks). Discard this solution.

8.3.2 Place the 5000 mL solution (from 8.1) in the cylinder of the testing machine. Adjust temperature to 21°C (70°F).

8.3.3 Place colored test specimens including test control, close and tumble for 60 min.

8.4 For both options, remove the test specimens and pass through wringer to remove excess solutions. Rinse thoroughly with deionized or distilled water. Wring again and allow to dry on absorbent, bleached paper toweling at room temperature.

## 9. Evaluation Method for Color Change

9.1 Classify the change in color of the Test Control Fabric 162 with the Gray Scale for Color Change (AATCC EP1) or AATCC EP7, Instrumental Assessment of the Change in Color of a Test Specimen. If the classification is not equivalent to a 2-3 or 3, the test is considered to be invalid. If classification is equivalent to a 2-3 or 3, proceed with 9.2.

9.2 Rate the change in color of test specimens with the Gray Scale for Color Change (AATCC EP1), or using AATCC EP7, and record the numerical rating that corresponds to the appropriate one on the Gray Scale (see 11.6 and 11.8).

## 10. Precision and Bias (see 11.8)

10.1 An interlaboratory study involving five different laboratories, eight different colored fabric samples, eight control fabrics, two test methods (drycleaning cylinder and accelerated laundering machine) and two colorfastness rating procedures (manual and photometer) was conducted to define the various statistical parameters for this test method. All five laboratories ran the colorfastness test on the group of eight fabrics using both test methods and both rating procedures. The main observations of the study are stated in Table I.

10.1.1 The drycleaning cylinder method showed a mean fastness rating of 3.483 and the accelerated laundering method showed a mean fastness rating of 3.3213. The difference between the mean values was not statistically significant at 95% confidence level.

10.1.2 Manual rating procedure gave a mean fastness rating of 3.24 while spectrophotometer rating gave a mean fastness rating of 3.23. The difference between the mean values was not statistically significant at 95% confidence level.

10.1.3 Among the five laboratories, three laboratories showed very close mean rating values of 3.249, 3.229 and 3.261. The two outliers showed mean rating values of 3.415 and 3.055

10.2 *Bias*. The true value of Colorfastness to Chlorinated Pool Water can only be defined in terms of a test method. Within this limitation, this test method has no known bias.

## 11. Notes

11.1 Available from Publications Office, ACGIH, Kemper Woods Center, 1330 Kemper Meadow Dr., Cincinnati OH 45240; tel: +1.

**Table I—Computed Values of Precision for Colorfastness Rating**

| No. of Specimens | Within Lab | Between Lab |
|------------------|------------|-------------|
| 3                | 0.207      | 0.397       |
| 2                | 0.256      | 0.487       |
| 1                | 0.357      | 0.689       |

513.742.2020; web site: [www.acgih.org](http://www.acgih.org).

11.2 For potential equipment information pertaining to this test method, please visit the online *AATCC Buyer's Guide* at [www.aatcc.org/bg](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.

11.3 Option 1-Accelerated laundering machine for rotating closed canisters in a thermostatically controlled water bath at 40 ± 2 rpm.

11.4 Option 2-Drycleaning Cylinder; stainless steel cylinder of approximately 33 cm (13 in.) high and about 22 cm (8.75 in.) in diameter. The cylinder is mounted in a vertical position on an axis inclined 50° and is rotated at a speed of 45-50 rpm.

11.5 Household sodium hypochlorite solution. When purchased, the strength will be 5.25% or slightly higher. All sodium hypochlorite solutions lose strength in time. Strength loss is accelerated by exposure to light and heat. Do not use after 60 days from purchase.

11.6 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: +1.919.549.8141; fax: +1.919.549.8933; e-mail: [ordering@aatcc.org](mailto:ordering@aatcc.org); web site: [www.aatcc.org](http://www.aatcc.org).

11.7 Use a 100 mL sample of test solution. Add 20 mL of 6*N* sulfuric acid, 6 mL of 12% potassium iodide and 3 drops of 1% starch solution. Mix thoroughly; the solution should be brownish blue color. Back titrate with 0.01*N* sodium thiosulfate until the first disappearance of the blue starch indicator color. Calculate the available chlorine as follows:

% available chlorine =

$$\frac{\text{mL Na thiosulfate} \times 0.01N \times 0.0355}{100 \text{ mL} \times \text{sp. gr. Na hypochlorite}} \times 100$$

(Specific gravity of household sodium hypochlorite solution is 1.08. Using the above equation, the use of 1.6 mL of sodium thiosulfate in back titration would yield a result of 0.0005% or 5.0 ppm.)

11.8 The precision of this test method is dependent on the combined variability of the material being tested, the test method itself and the evaluation procedure utilized.

11.8.1 The precision statement shown in Section 10 was developed from results obtained by visual and instrumental evaluations (AATCC EP1 and AATCC EP7).