

Colorfastness to Water: Chlorinated Pool

Developed in 1984 by Committee RA23. Supersedes AATCC Test Method 105-1975; editorially revised 1985, 1995; editorially revised and reaffirmed 1986, 1997; reaffirmed 1991, 2002. Related to ISO 105-E03.

1. Purpose and Scope

1.1 This test method is intended 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 in a large container 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 6*N* 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 ventilated 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 of January 1, 1989). 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

5.1 SGS U.S. Testing Co. Inc. dry-cleaning and washing machine #6523 (see 11.2).

5.2 Wringer (see 11.3).

5.3 Gray Scale for Color Change (see 11.7).

5.4 Household sodium hypochlorite solution (NaOCl), approximately 5% available chlorine (see 11.4).

5.5 Calcium chloride, anhydrous (CaCl₂) (see 11.5).

5.6 Magnesium chloride, hexahydrate (MgCl₂ · 6H₂O) (see 11.6).

5.7 Test Control Fabric 162 (see 11.7).

5.8 Sulfuric acid (H₂SO₄), 6*N*.

5.9 Potassium iodide, KI, 12%.

5.10 Starch solution, 1%.

5.11 Sodium thiosulfate (Na₂S₂O₃), 0.01*N*, (see 11.8).

5.12 Distilled or deionized water.

5.13 Sodium carbonate (Na₂CO₃).

5.14 Acetic acid (CH₃COOH).

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 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 Purge the drycleaning cylinder. Add approximately 5000 mL deionized water and 0.5 mL Clorox or equivalent (see 11.4). 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.

8.2 Prepare hardness concentrate.

8.2.1 Weigh out 8.24 g calcium chloride, anhydrous.

8.2.2 Weigh out 5.07 g magnesium chloride hexahydrate, MgCl₂ · 6H₂O.

8.2.3 Add 800 mL deionized or distilled water to a 1 L volumetric flask; add calcium chloride and 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.

8.3 Dilute 51 mL hardness concentrate to 5100 mL with deionized or distilled water. Add 0.5 mL Clorox or equivalent which is no more than 60 days old. Determine actual ppm Cl by titration and adjust to 5 ppm (see 11.8).

8.3.1 0.01*N* Sodium thiosulfate can be purchased in this form or can be diluted 10 to 1 volumetrically from 0.1*N* solution.

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

8.5 Place the 5000 mL solution (from 8.3) in the cylinder of the testing machine. Adjust temperature to 21°C (70°F).

8.6 Place colored test specimens including test control fabric in cylinder, close and tumble for 60 min.

8.7 Remove the test specimens and pass through wringer to remove excess solution. 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. 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 (see 11.7 and 11.9).

Grade 5—negligible or no change as shown in Gray Scale Step 5.

Grade 4.5—change in color equivalent to Gray Scale Step 4-5.

Grade 4—change in color equivalent to Gray Scale Step 4.

Grade 3.5—change in color equivalent to Gray Scale Step 3-4.

Grade 3—change in color equivalent to Gray Scale Step 3.

Grade 2.5—change in color equivalent to Gray Scale Step 2-3.

Grade 2—change in color equivalent to Gray Scale Step 2.

Grade 1.5—change in color equivalent to Gray Scale Step 1-2.

Grade 1—change in color equivalent to Gray Scale Step 1.

10. Precision and Bias

10.1 *Interlaboratory Test Data.* Interlaboratory tests were conducted in 1982 and 1983 in which six laboratories each made five replications on six fabrics. Color change was evaluated instrumentally and Gray Scale ratings calculated from the instrumental readings. The components of variance expressed as the

Variance Ratio (F) shows a within laboratory ratio of 1.43, with no laboratory having a statistically significant variation between tests. All tests included a standard test control fabric, and only tests in which the test control fabric rated 2-3 or 3 were considered to be valid. The average standard deviation was 0.18 Gray Scale unit. Between laboratory correlation showed greater variance, with two of the five colors showing statistically significant difference between laboratories. Therefore, before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established (see 11.9).

10.2 *Precision.* Based on the observation described in 10.1, a test is considered to be valid if test control fabric is rated at 2-3 or 3 on the AATCC Gray Scale for Color Change.

10.3 *Bias.* The true value of Colorfastness to Chlorinated Swimming 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: 513/742-2020.

11.2 Drycleaning and washing machine #6523; maximum working capacity 7650 mL, SGS U.S. Testing Co. Inc., Instrument Marketing Div., 291 Fairfield Ave., Fairfield NJ 07004; tel: 973/575-5252 or 800/777-8378.

11.3 The Atlas Motorized Laboratory Wringer is suitable and may be obtained from SDL Atlas L.L.C., 1813A Associate Lane, Charlotte NC 28217; tel: 704/329-0911; fax:

704/329-0914; e-mail: info@sdlatlas.com.

11.4 Clorox is labeled at a strength of 5.25% sodium hypochlorite. 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. Clorox is a registered trademark of The Clorox Co., P.O. Box 24305, Oakland CA 94623; tel: 510/271-7000.

11.5 Calcium chloride, anhydrous, CaCl_2 , J. T. Baker Catalog No. 1308.

11.6 Magnesium chloride hexahydrate, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, J. T. Baker Catalog No. 2444.

11.7 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; fax: 919/549-8933; e-mail: orders@aatcc.org.

11.8 Take a 100 mL (volumetric) sample of test solution. Add 20 mL of 6N 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 0.01N sodium thiosulfate till 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 Clorox 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.)

11.9 Another evaluation method is to determine the Gray Scale grade from instrumental readings. There is a significant difference between grades using the two systems, with instrumental rating being more accurate (see AATCC Evaluation Procedure 7, Instrumental Assessment of the Change in Color of a Test Specimen). If instrumental grades are used, the procedure should be stated in the report.