

Test Method for Retained Chlorine: Tensile Loss

1. Foreword

1.1 This test method is based on AATCC TM92. AATCC TM114 uses an automatic home washing machine to chlorinate multiple specimens while AATCC TM92 uses a beaker for accelerated chlorination of a single specimen.

2. Purpose and Scope

2.1 This test method is a procedure to determine the potential damage that may be caused by chlorine bleaching.

2.2 The method is applicable to woven textile fabrics. The tensile strength test is not recommended for knitted fabrics because of their high stretch.

3. Principle

3.1 Samples are chlorine bleached in a domestic-type laundry machine, rinsed, dried and pressed between hot metal plates. Multiple samples may be bleached together.

3.2 The damaging action of the retained chlorine is calculated from the difference in tensile strength before and after pressing (see 14.1). Results are reported as a percentage of the original tensile strength. A higher percent loss indicates more damage due to retained chlorine.

4. Referenced Documents

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

4.1 AATCC LP1 Laboratory Procedure for Home Laundering: Machine Washing (see 14.2).

4.2 AATCC TM92 Test Method for Chlorine, Retained, Tensile Loss: Single Sample (see 14.2).

4.3 ASTM D5035, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method) (see 14.3).

5. Terminology

5.1 **retained chlorine**, *n.*—in textiles bleached with chlorine-type bleaches, available chlorine that remains in the material after washing and drying.

6. Safety Precautions

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

6.2 It is the user's responsibility to ref-

erence 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 equipment operating instructions and other recommendations. Consult and follow all applicable health and safety regulations (e.g., OSHA standards and rules).

7. Apparatus and Reagents (see 14.4)

7.1 Standard washing machine (see Table I, 14.5).

7.2 Laundering ballast, Type 1 (see Table II).

7.3 Standard tumble dryer (see Table III, 14.5).

7.4 Heating device, providing even heat transfer to the specimen from the top by close contact at a controlled temperature and giving a pressure on the specimen of 9 g/cm².

7.5 Apparatus and conditioning facilities as needed for ASTM D5035. (Refer

to standard for details.)

7.6 Reagents

7.6.1 Sodium hypochlorite solution, approx. 5% available chlorine (see 9.2).

7.7.1 Buffer solution (see 9.1).

7.8.1 Sodium tetraphosphate (Na₆P₄O₁₃).

7.9.1 Sodium carbonate.

7.10.1 Sodium bicarbonate

8. Specimens

8.1 Specimens.

8.1.1 Normally, only the warp strength is determined. Cut two pieces for each sample approximately 35.6 cm (14 in.) in the warp direction and 20.3 cm (8 in.) in the filling direction. (If testing filling specimens, reverse these figures.)

9. Preparation of Reagents

9.1 Buffer Solution: Prepare a solution containing 290 g of sodium tetraphosphate and 93 g of monosodium phosphate (NaH₂PO₄ · H₂O) in sufficient water to make 1000 mL of solution.

Table I—Standard Washing Machine Parameters (see 14.5, 14.7)

Cycle	Normal	
Water Level, L (gal) ¹	45 ± 4 (12 ± 1)	
Agitation Speed (strokes/min.)	86 ± 2	
Stroke Length	Up to 220°	
Washing Time, min. ²	12 ± 1	
Rinse	1	
Final Spin Speed, rpm	660 ± 15	
Final Spin Time, min.	5 ± 1	
Wash Temp, °C (°F) ¹	Hot:	60 ± 3 (140 ± 5)
	Warm:	41 ± 3 (105 ± 5)
	Cold:	27 ± 3 (80 ± 5)

¹ Water Level and Wash Temperature indicated in the table may not correspond with standard machine settings. Verify and adjust as needed to achieve the indicated parameters.

Table II—Laundering Ballast Parameters

Type 1	
Fiber Content	100% Cotton
Greige Fabric Yarns	16/1 ring spun
Greige Fabric Construction	52 × 48 ± 5 yarns/in., plain weave
Finished Fabric Weight	155 ± 10 g/m ²
Edges	All edges hemmed or over-edged
Finished Piece Size	920 × 920 ± 30 mm (36.0 × 36.0 ± 1 in.)
Finished Piece Weight	130 ± 10 g

Table III—Standard Tumble Drying Parameters

Cycle	Normal	Delicate	Permanent Press
Max. Exhaust Temp, °C (°F)	68 ± 6 (155 ± 10)	60 ± 6 (140 ± 10)	68 ± 6 (155 ± 10)
Cool Down Time, min.	≤ 10	≤ 10	≤ 10

9.2 Available Chlorine. Verify the percent available chlorine. Pipette a 1.00-mL portion of nominal 5% sodium hypochlorite solution into an Erlenmeyer flask and dilute to 100 mL with distilled water. Add 6 mL of 12% KI followed by 20 mL of 6N H₂SO₄. Titrate with 0.1N sodium thiosulfate solution and calculate using Eq. 1. Use 1.08 as the value for specific gravity.

Percent available chlorine =

$$\frac{\text{mL Na thiosulfate} \times 0.1N \times 0.0355}{1 \text{ mL} \times \text{sp. grav. Na hypochlorite}} \times 100 \quad (\text{Eq. 1})$$

9.2.1 A 5% available chlorine solution, purchased from a laboratory chemical supplier, may also be used. COA's may be used to ascertain strength. Chlorine does degrade. Once opened, store chemical in refrigerator and use by manufacturer's expiration date.

10. Procedure

10.1 Preparation of Washing Machine. If the washing machine has been used for anything other than chlorine bleaching, run a full wash cycle with warm water, adding 0.15% sodium tetraphosphate at the beginning of the cycle. Determine water volume at low-water level and use in calculating liquor-to-bath ratio.

After the machine is free of impurities, set washing machine controls to obtain the parameters listed in Table I. Select water temperature based on care instructions.

10.2 Chlorination.

10.2.1 Begin selected wash cycle. Allow machine to fill to specified water level (50:1 liquor ratio).

10.2.2 Add sufficient diluted sodium hypochlorite to wash water to obtain a bath liquor concentration of 0.10% by weight of available chlorine.

10.2.3 Stir well. Adjust the pH to 9.5 with sodium carbonate to raise the pH or sodium bicarbonate to lower it.

10.2.4 Add all the test samples and sufficient untreated ballast to make a 50:1 liquor-to-cloth ratio. Run machine through wash portion of cycle.

10.3 Rinsing. After the wash water has drained and the machine has refilled, add 10 mL of the buffer solution for each gallon of water and continue operation through rinse cycle and the final spin cycle.

10.4 Drying and Conditioning. Tumble dry the washed samples with ballast until just dry. Set tumble dryer to obtain the parameters listed in Table III. Select drying temperature based on care instructions. Do not reuse ballast for this test method due to retained chlorine. Transfer at once to a conditioned atmosphere at 65 ± 5% RH and 21 ± 2°C (70 ± 4°F) and

allow to remain through the scorching step and tensile strength testing. The samples should be conditioned not less than 4 nor more than 24 h before scorching, and not less than 16 h before tensile testing.

10.5 Preparation of Specimens for Scorching. Prepare warp specimens by carefully cutting five strips approx. 35.6 × 3.2 cm (14.0 × 1.25 in.). Ravel the 3.2-cm (1.25-in.) strips to exactly 2.54 cm (1 in.) following ASTM D5035. Then trim the 35.6 cm (14 in.) length of each strip to 30.5 cm (12 in.). From this set of five 2.54 × 30.5 cm (1 × 12 in.) strips, make two sets (from the same set of warp threads) of 2.54 × 15.2 cm (1 × 6 in.) raveled strip specimens by cutting the strips in two. Keep these sets separate; one set to be scorched, the other to be used as a control.

10.6 Preparation of Heating Device. Prepare heating device in advance so that the heating plates of the instrument maintain a temperature of 185 ± 1°C (365 ± 2°F). If necessary, to avoid air currents, enclose instrument in a cabinet. Make sure the two heating plates are clean and in good alignment (uniformly in contact at all points) (see 14.6). Scorch each strip of one set separately (one at a time) by placing the 2.54 × 15.2 cm (1 × 6 in.) specimen in the heating device with the long direction of the raveled strip perpendicular to the long direction of the heating plates so that it is scorched across the center of the raveled strip (see Fig. 1). Scorch the strips for 30 s. Check reading of the thermometers frequently during use. Condition the specimens again, this time conditioning at least 16 h before performing tensile strength tests.

10.7 Tensile Strength. Perform tensile strength tests on the unscorched and scorched specimens and record the individual values. From these, calculate the average (mean) tensile strength for each set.

11. Calculations

11.1 Use Eq. 2 (see 14.1):

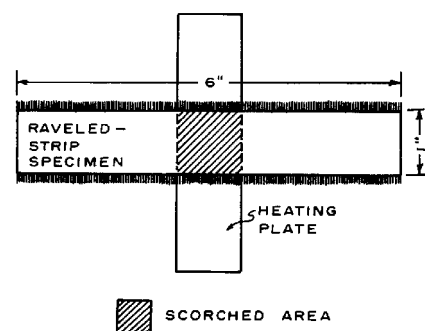


Fig. 2—Specimen on heating plate.

$$(T_c - T_{cs})/T_c \times 100 =$$

% loss in tensile strength due to damage caused by retained chlorine (Eq. 2)

where:

T_c = average tensile strength of chlorinated specimens, unscorched, and

T_{cs} = average tensile strength of chlorinated specimens, scorched.

12. Report

12.1 Describe or identify the samples tested.

12.2 Report that the sample was tested using AATCC TM114-2021.

12.3 Report the testing conditions:

12.3.1 Number of specimens tested.

12.3.2 Laundering conditions.

12.4 Report the test results:

12.4.1 Average percent loss in tensile strength for warp due to damage caused by retained chlorine.

12.4.2 Standard deviation of average

12.4.3 If filling strength loss is determined, report average and standard deviation of percent loss in tensile strength for filling.

12.5 Describe any modification(s) of the published standard.

13. Precision and Bias

13.1 Precision. The standard deviation obtained in developing this method was $s = 5.98$.

The confidence interval based on 5 specimens is C.I. ± 5.2.

13.2 Bias. The tensile strength loss due to retained chlorine 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.

14. Notes

14.1 Where it is suspected that either fabric or finish is susceptible to damage on heating, this susceptibility can be determined by running a distilled-water control, that is, the fabric is run through the entire procedure, but using distilled water in place of the hypochlorite solution. The loss in strength due to heat alone is calculated by Eq 3:

$$(T_w - T_{ws})/T_w \times 100 =$$

Percent tensile strength loss due to scorching alone (Eq. 3)

where:

T_w = average tensile strength of the water-treated specimens, unscorched (handled as above) and

T_c = average tensile strength of the original fabric chlorinated and unscorched.

If this loss is appreciable, there is some question as to whether the chlorine damage test is applicable. It is usually not necessary to