

Test Method for Chlorine, Retained, Tensile Loss: Single Sample

1. Purpose and Scope

1.1 This is an accelerated test method to determine the potential damage caused by retained chlorine.

1.2 It has been designed for use on cotton and rayon fabrics, but may be used on any fabric or finish that is not damaged by heat alone (see 11.1). Fabrics must be appropriate for tensile strength testing (typically woven fabrics).

2. Principle

2.1 The fabrics are treated in sodium hypochlorite solution, rinsed, dried and pressed between hot metal plates. The damaging action of the retained chlorine is calculated from the difference in tensile strength before and after pressing.

3. Terminology

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

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. Users MUST consult manufacturers for specific details such as safety data sheets and other recommendations. Consult and follow all applicable OSHA standards and rules.

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

4.2 Follow manufacturer's safety recommendations when operating laboratory testing equipment.

4.3 Handle all chemicals with care. Use chemical goggles or face shield, impervious gloves and an impervious apron when handling sodium carbonate and sodium hypochlorite bleach solutions; these are corrosive chemicals.

4.4 Ensure an eyewash/safety shower is located nearby and a self-contained breathing apparatus is readily available for emergency use.

4.5 Control exposure to chemicals used in this procedure at or below levels set by governmental authorities (e.g., Occupa-

tional Safety and Health Administration's [OSHA] permissible exposure limits [PEL] as found in 29 CFR 1910.1000; see web site: 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 11.2).

5. Apparatus and Reagents (see 11.3)

5.1 Beakers, 800 mL.

5.2 pH meter (see 11.4).

5.3 Constant temperature bath (or suitable alternative means of controlling temperatures).

5.4 Wringer, laboratory or household type.

5.5 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 8.8 g/cm² (see Fig. 1 and 11.5).

5.6 Tensile-strength tester.

5.7 Sodium hypochlorite stock solution having an available chlorine content of approximately 5.0%.

5.8 Water, distilled.

6. Preparation of Specimens

6.1 Normally, only warp-wise specimens are tested. Cut a swatch approximately 35.6 cm (14 in.) in the warp-wise

direction and 20.3 cm (8 in.) in the filling-wise direction (if testing filling specimens, reverse these dimensions). Specimens will be cut from this swatch after chlorination.

7. Preparation of Reagents

7.1 Prewetting and Rinse Solutions. Determine the pH of the distilled water; if outside the range of 6-7, report the actual pH (see 11.6).

7.2 Chlorination Solution. Prepare a chlorination solution containing 0.25% available chlorine at a pH of 9.5 ± 0.1 as follows:

7.2.1 Determine the percent available chlorine (Cl) of the sodium hypochlorite stock solution (see 11.7).

7.2.2 Calculate the number of grams (g) of stock solution required to make one liter of a 0.25% available chlorine solution using Eq. 1:

$$g = (1000 \times 0.25) / Cl \quad \text{Eq. 1}$$

where:

g = grams of stock solution required.

Cl = % available chlorine determined.

7.2.3 To 900 mL of distilled water add the calculated grams (g) of stock solution required. Adjust the pH to 9.5 ± 0.1 by the addition of either sodium bicarbonate to lower the pH or sodium carbonate to raise it. Finally, add distilled water to make 1 L and recheck the pH.

8. Procedure

8.1 Because many factors, such as pH,



Fig. 1—Heating device.

concentration and time, significantly influence the amount of damage caused by retained chlorine, it is *important* to follow closely the conditions of the test. Should any deviations be necessary, include details in the test. As a means of checking the test procedure, it is good practice to run, at the same time, a cotton fabric whose chlorine-retentive properties have been determined previously.

8.2 Chlorination Step.

8.2.1 Prewetting Bath. Measure into an 800-mL beaker a volume of distilled water equal to 50 times the dry weight of the fabric sample. Immerse the sample for 3 min at $71 \pm 3^\circ\text{C}$ ($160 \pm 5^\circ\text{F}$), stirring frequently. Remove sample from bath, allow to drain and cool at room temperature.

8.2.2 Chlorination Bath. Place the swatch in an 800-mL beaker containing the chlorination solution (equal to 50 times the dry weight of the fabric) that is maintained at a temperature of $25 \pm 1^\circ\text{C}$ ($77 \pm 2^\circ\text{F}$). Agitate the swatch frequently and gently with a glass stirring rod during the 15-min chlorination period. At the end of 15 min, remove swatch, allow to drain momentarily, and pass through a wringer to remove as much solution as possible using care to keep the swatch flat and free from wrinkles. Rinse equipment free of chlorination solution with distilled water to avoid contamination of specimens during the subsequent rinsing procedure.

8.2.3 Rinsing. Immerse the swatch in an 800-mL beaker containing distilled water (equal to 50 times the weight of the swatch) at a temperature of $21\text{--}32^\circ\text{C}$ ($70\text{--}90^\circ\text{F}$) for 2 min, agitating the swatch gently and continually. Remove the swatch from the bath, allow to drain momentarily, and then pass through a wringer, as before, taking all precautions mentioned previously.

8.2.4 Repeat this rinsing procedure five (5) more times, making a total of six (6) rinses. For greater precision, rinse *all swatches separately*, to avoid danger of contamination.

8.2.5 Drying. *Air-dry* swatches. Hang on a line or dry flat on a noncorrosive rack, away from heat, until just dry (do *not* press!) Transfer at once to a conditioned atmosphere at $65 \pm 5\%$ RH and $21 \pm 2^\circ\text{C}$ ($70 \pm 4^\circ\text{F}$) and allow to remain through the scorching step and tensile strength testing.

8.3 Scorching Step.

8.3.1 Prepare warp specimens by carefully cutting five (5) strips approximately 35.6×3.2 cm (14.0×1.25 in.). Ravel the strips to exactly 2.54 cm (1.0 in.) wide following ASTM D5035, Test for Breaking Force and Elongation of Textile Fabrics (Strip Test). Then trim the 35.6 cm (14.0 in.) length to 30.5 cm (12.0 in.). From this set of five 2.54×30.5 cm (1.0

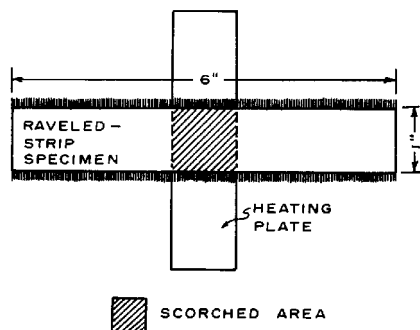


Fig. 2—Specimen on heating plate.

$\times 12.0$ in.) strips, make two sets (from the same set of warp yarns) of 2.54×15.2 cm (1.0×6.0 in.) raveled strip specimens by cutting the strips in two. These sets should be kept separate; one set is to be scorched, the other used as a control. The total conditioning time should be not less than 4 nor more than 24 h.

8.3.2 Prepare heating device in advance so that the heating plates of the instrument maintain a temperature of $185 \pm 1^\circ\text{C}$ ($365 \pm 2^\circ\text{F}$). If necessary, to avoid air currents, enclose instrument in a cabinet. Make sure the two heating plates are clean and in good adjustment (uniformly in contact at all points). Scorch each strip of one set separately (one at a time) by placing the 2.54×15.2 cm (1.0×6.0 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 Figs. 1 and 2). 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 making tensile strength measurements.

8.4 Tensile Strength.

8.4.1 Make tensile strength tests on the unscorched and scorched specimens and record the individual values. From those, calculate the average tensile strength for each set.

9. Calculation of Damage Caused by Retained Chlorine

9.1 Use the formula as follows:

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

% loss in tensile strength due to damage caused by retained chlorine.

where:

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

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

10. Precision and Bias

10.1 Precision. Precision for this test method has not been established. Until a precision statement is generated for this test method, use standard statistical techniques in making any comparisons of test results for either *within-laboratory* or *between-laboratory* averages.

10.2 Bias. The retained chlorine as determined by tensile loss-single sample method 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.

11. Notes

11.1 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 the equation:

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

% tensile strength loss due to scorching alone.

where:

T_w = average tensile strength of the water-treated specimens, unscorched, and

T_{ws} = average tensile strength of the water-treated specimens, scorched.

If this loss is appreciable, there is some question as to whether the chlorine damage test is applicable.

It is usually not necessary to determine the effect of wet chlorination on the fabric, as this factor is canceled out in the calculation for chlorine damage. However, where it is desirable to determine the effect of the wet chlorination step, this may be calculated as follows:

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

% tensile strength loss due to wet chlorination.

where:

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

T_{wc} = average tensile strength of the original fabric chlorinated and unscorched.

11.2 Available from Publications Office, ACGIH, Kemper Woods Center, 1330 Kemper Meadow Dr., Cincinnati OH 45240, USA; +1. 513.742.2020; www.acgih.org.

11.3 For potential equipment information pertaining to this test method, please visit the online *AATCC Buyer's Guide* at 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.