

Chlorine, Retained, Tensile Loss: Single Sample Method

Developed in 1958 by AATCC Committee RR35; reaffirmed 1962, 1967, 1971, 1977, 1980, 1989, 1999; editorially revised 1974, 1988, 1992; editorially revised and reaffirmed 1985, 1994, 2004.

1. Purpose and Scope

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

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 which 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. 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 practice should be followed. Wear safety glasses in all laboratory areas.

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

4.3 All chemicals should be handled 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 An eyewash/safety shower should be located nearby and a self-contained breathing apparatus should be readily available for emergency use.

4.5 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 11.7).

5. Apparatus and Reagents

5.1 Beakers, 800 mL.

5.2 pH meter (see 11.2).

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

5.4 Wringer, laboratory or household type.

5.5 Scorch tester (see Fig. 1 and 11.3).

5.6 Tensile-strength tester (see 11.4).

5.7 Sodium hypochlorite stock solution; e.g., Clorox, having an available chlorine content of approximately 5.0%.

5.8 Water, distilled.

6. Preparation of Sample

6.1 Normally, only warpwise specimens are tested. Cut the sample approximately 35.6 cm (14 in.) in the warpwise direction and 20.3 cm (8 in.) in the fill-

ingwise direction (if testing filling specimens, reverse these figures).

7. Preparation of Solutions

7.1 Prewetting and Rinse Solutions. Determine the pH of the distilled water; if outside the range of 6-7, report the actual pH with the final results of test (see 11.5).

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; e.g., Clorox (see 11.6).

7.2.2 Calculate the number of grams (g) of stock solution required to make one liter of a 0.25% available chlorine solution as follows:

$$g = (1000 \times 0.25)/Cl$$

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, concentration and time, significantly influence the amount of damage caused by retained chlorine, it is *important* to fol-

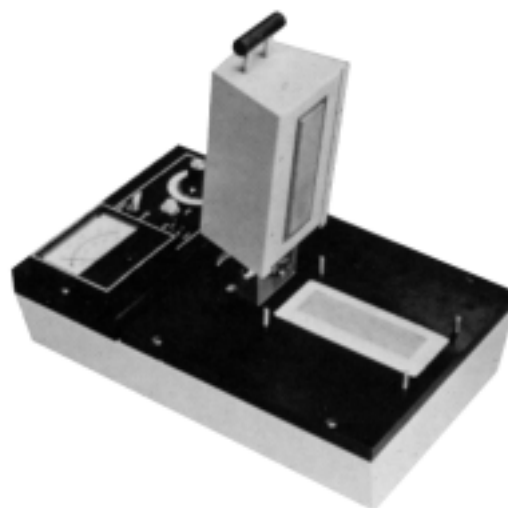


Fig. 1—Scorch tester.

low closely the conditions of the test. Should any deviations be necessary, they should be reported in order that the test results may be evaluated accordingly. As a means of checking the test procedure, it is well 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. Transfer the sample to an 800-mL beaker containing the chlorination solution (equal to 50 times the dry weight of the fabric) which is maintained at a temperature of $25 \pm 1^\circ\text{C}$ ($77 \pm 2^\circ\text{F}$). Agitate the sample frequently and gently with a glass stirring rod during the 15 min chlorination period. At the end of 15 min, remove sample, allow to drain momentarily, and pass through a wringer, to remove as much solution as possible using care to keep the sample 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 sample in a 800-mL beaker containing distilled water (equal to 50 times the weight of the sample) at a temperature of $21\text{--}32^\circ\text{C}$ ($70\text{--}90^\circ\text{F}$) for 2 min, agitating the sample gently and continually. Remove the sample 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 more times, making a total of six rinses. For greater precision, rinse all samples separately, to avoid danger of contamination.

8.2.5 Drying. Samples are to be *air-dried*. Hang on a line or dry flat on a non-corrosive rack, away from heat, until just dry (do *not* press!). Transfer at once to a conditioned atmosphere at $65 \pm 2\%$ RH and $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$) 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 strips approximately 35.6×3.2 cm (14.0×1.25 in.). Ravel the 3.2 cm (1.25 in.) strips to exactly 2.54 cm (1.0 in.) following ASTM D 5035, Test for Breaking Force and Elongation of Textile Fabrics (Strip Test), in preparing specimens. 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 (1.0×12.0 in.) strips, make two sets (from the same set of warp yarns) of 2.54×15.2 cm (1.0

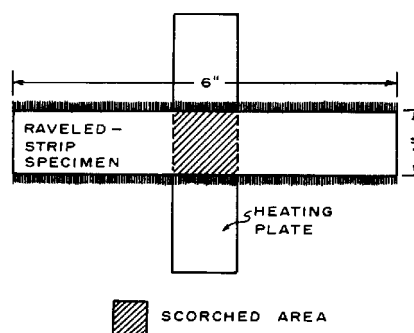


Fig. 2—Specimen on heating plate.

$\times 6.0$ 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 Scorch tester 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 Scorch tester 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_c = average tensile strength of the original fabric chlorinated and unscorched.

11.2 Any standard laboratory pH meter having suitable provision for high pH readings. Colorimetric methods cannot be used with NaOCl.

11.3 A pair of electrically heated hot plates whose temperature is accurately controlled and which can be adjusted to provide a pressure on the specimen of 8.8 g/cm^2 ; e.g., Scorch tester available 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. In order to obtain the specified pressure of 8.8 g/cm^2 the four spring loaded pins must contact the upper housing so that they counterbalance the proper proportion of the weight of the upper housing to provide the specified pressure on the test specimen.