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Standard Test Methods for RELAXATION AND CONSOLIDATION DIMENSIONAL CHANGES OF STABILIZED KNIT WOOL FABRICS[1]

This standard is issued under the fixed designation D 1284; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the accelerated determination of the relaxation and the consolidation dimensional change of knit fabrics that include at least 50 % wool, and are designed to be shrink-resistant. The knit fabrics to be tested by these methods include those used in manufacturing underwear, outerwear, and sweaters.

1.2 The methods appear in the following sections:

	Sections
Relaxation Dimensional Change	6 to 13
Consolidation Dimensional Change	14 to 21

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 1905 Test Method for Dimensional Changes in Laundering of Woven or Knitted Textiles[3]

2.2 *Other Documents:*

Fed. Std. No. 751a Stitches, Seams, and Sewing[4]

ISO Method 38/2 N79 Dimensional Changes (Shrinkage), Felting and Relaxation, of Woven of Knitted Wool Textiles[5]

ISO Method 38/2 N100 Dimensional Change in Wetting[5]

3. Definitions

3.1 *consolidation dimensional change, n*—the dimensional change that occurs when a knitted fabric is gently agitated in water to overcome all the frictional constraints in the fabric after it has been immersed in water without agitation to cause the relaxation dimensional change.

3.2 *felting dimensional change, n*—the irreversible dimensional change that occurs in a relaxed fabric when it is subjected to agitation in laundering as specified in Test Method D 1905.

3.3 *frictional constraint, n*—the force imposed by the multitude of fiber to fiber contacts within a fabric.

3.4 *relaxation dimensional change, n*—the dimensional change that occurs when a knitted fabric is immersed in water without agitation and the strains and tensions put into fibers, yarns, or fabrics during previous processing stages such as spinning, knitting, and finishing are relieved.

3.5 For definitions of other textile terms used in these test methods, refer to Terminology D 123.

[1] These test methods are under the jurisdiction of ASTM Committee D-13 on Textiles, and are the direct responsibility of Subcommittee D13.59 on Fabric Test Methods, General.

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[2] *Annual Book of ASTM Standards*, Vols 07.01 and 07.02.

[3] Discontinued, see *1977 Annual Book of ASTM Standards*, Part 32.

[4] Fed. Std. No. 751a, Jan. 25, 1965, superseding Federal Specification DD-S-751. Available from Naval Publications and Forms Center, 5801 Tabor Ave., PA 19120.

[5] Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

4. Summary of Test Methods

4.1 Summaries of the specific test methods used for the different tests are given in the appropriate sections.

5. Uses and Significance

5.1 Dimensional changes in laundering may be objectionable to the ultimate consumer of a garment, but the user is not likely to be interested in any scheme for dividing dimensional change into components according to their origin. However, such an analysis will be invaluable to a producer, since it allows the producer to make appropriate changes in the design and processing of fabrics to reduce their tendency to change dimensionally when washed.

5.2 Knit fabrics that contain at least 50 % wool, can become so distorted by mechanical manipulation and wet finishing at high temperature that they lose all tendency to revert to their original dimensions until free of strains and tensions. As a consequence, it can be expected that garments of these fabrics may show objectionable dimensional change when washed. Therefore, with some fabrics, it may be necessary for the producer to release the strains and tensions by exposing them to water or steam at a higher temperature than was used in setting. The need for removing strains and tensions from a particular fabric is partially indicated by the results from the test for relaxation dimensional change.

5.3 The relaxation of strains by simple soaking as directed in Section 10 is opposed by frictional fiber-fiber contacts within the fabric. Consolidation dimensional change occurs when these frictional constrains are overcome by gentle agitation after the static soak (Note 1). Consequently, to know the full extent of dimensional change caused by strains, it is necessary to test it as directed in Section 18 after first subjecting it to simple soaking.

NOTE 1—For a knit fabric that has not been shrink-resist treated, or shrink-resist treated only to a low degree, felting dimensional change may be caused by the gentle agitation, resulting in a consolidation dimensional change value that includes felting dimensional change.

5.4 These methods for testing knit fabrics that contain at least 50 % wool for relaxation dimensional change and consolidation dimensional change are not recommended for acceptance testing of commercial shipments since between-laboratory precision is poor. In some cases, the purchaser and the supplier might have to test specific commercial shipments by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments. In such a case, there may be a difference in values reported by the purchaser and the supplier. The statistical bias between the results reported by the laboratory of the purchaser and the laboratory of the supplier should be determined by testing specimens randomly drawn from one sample of the fabric being evaluated.

RELAXATION DIMENSIONAL CHANGE

6. Scope

6.1 This test method covers the accelerated determination of the relaxation dimensional change of knit fabrics that include at least 50 % wool, and are designed to be shrink-resistant. The knit fabrics to be tested by this method include those used in manufacturing underwear, outerwear, and sweaters.

6.2 This test method presents only a means of obtaining reproducible results, and does not attempt to set up tolerances or specifications for a fabric used for a specific garment, since all measurements are made with the avoidance of any restorative force.

7. Summary of Test Method

7.1 Fabric specimens are totally immersed in water and dried under specified conditions. The distances between bench marks on the specimen in wale and course directions are measured before immersion and after drying. The changes in dimensions are calculated from these measurements.

8. Apparatus and Materials

8.1 *Hydroextractor*—Centrifugal extractor of the laundry type with a perforated basket approximately 280 mm (11 in.) deep by 432 mm (17 in.) in diameter, with an operating speed of approximately 1500 rpm.[6]

8.2 *Tray*, 762 by 610 by 152 mm (30 by 24 by 6 in.), or a suitable substitute.

[6] Hydroextracting machines of the type described may be obtained from Bock Laundry Machine Co., Toledo, OH 43600 (Model 24BC), and the American Laundry Machinery Co., Cincinnati, OH 45200.

8.3 *Steel Rule,* graduated in 2.5 mm. (0.1 in.).

8.4 *Drying Racks,* made of plastic screening,[7] with 16 openings per inch (630 openings per metre).

8.5 *Sulfated Fatty Alcohols or Wetting Agent.*

9. Number of Specimens

9.1 Take specimens for the determination of relaxation dimensional change only, as directed in 9.1.1. When specimens are being taken for the combined determination of relaxation dimensional change and consolidated dimensional change, the number of specimens shall be determined as directed in 17.1.2, rather than as directed in 9.1.1.

9.1.1 Unless otherwise agreed upon, as when specified in an applicable material specification, take a number of specimens such that the user may expect at the 95 % probability level that the test result is no more than 3.0 percentage points above or below the true average (that is, a theoretical average obtained from an infinite number of observations). Determine the number of specimens as follows:

9.1.2 *Reliable Estimates of s*—When there are reliable estimates of s based upon extensive past records for similar materials tested in the user's laboratory as directed in the method, calculate n using Eq 1:

$$n = \frac{t^2 \times s^2}{E^2} = 0.427\, s^2 \qquad (1)$$

where:

n = number of specimens (rounded upward to a whole number),

s = reliable estimate of the standard deviation of individual observations in the user's laboratory under conditions of single-operator precision,

t = 1.960, the value of Student's t for infinite degrees of freedom, for two-sided limits, and a 95 % probability level ($t^2 = 3.842$),

E = 3.0 percentage points, the value of the allowable variation, and 0.427 = a value calculated from t^2/E^2.

9.1.2 *No Reliable Estimates of s*—When there are no reliable estimates of s for the user's laboratory, Eq 1 should not be used directly. Instead, specify the fixed numbers of two and four specimens, respectively, for changes measured parallel to wales and courses. These numbers of specimens are calculated using $s = 1.73$ and $s = 2.66$, respectively, for changes measured parallel to wales and courses. These values of s are somewhat larger values of s than are usually found in practice. When reliable estimates of s for the user's laboratory become available, Eq 2 (Section 11) will usually require fewer than the above fixed numbers of specimens.

9.1.3 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of fabric and between specimens from a swatch from a roll of fabric to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

9.1.4 *Laboratory Sample*—As a laboratory sample for acceptance testing, take a full width swatch 2 m (2 yd) long from the end of each roll of fabric in the lot sample, after first discarding a minimum of 1 m (1 yd) of fabric from the very outside of the roll.

9.1.5 *Test Specimens*—Cut one test specimen from each swatch in the laboratory sample with each specimen being 305 by 305 ± 2 mm (12 × 12 ± 1/16 in.) in size.

10. Procedure

10.1 *Sewing Edges*—For any fabrics that will ravel, sew both ends, with an over-edge stitch of Stitch Type 505 as specified in Fed. Std. No. 751a.

10.2 *Conditioning*—Bring the specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles, having a relative humidity of 65 ± 2% at 21 ± 1°C (70 ± 2°F) as directed in Practice D 1776.

NOTE 3—It is recognized that in practice, textile materials frequently are not weighed to determine when moisture equilibrium has been reached. Most wool fabrics will be at moisture equilibrium if conditioned at least 8 h, although heavy fabrics may require conditioning up to 16 h and the latter time must be used in cases involved in a dispute.

10.3 *Marking Specimens*—Lay the properly conditioned specimens on a flat surface without tension, wrinkles, or creases. Mark three 254-mm (10-in.) distances on each specimen parallel to both the wale and course directions, and at least 25 mm (1 in.) from all edges. Use indelible

ink and a fine-pointed pen, tubes of textile marking ink, fine threads sewn into the fabric, or similar marking methods.

10.4 *Wetting Out*—Half fill the tray with 0.1 % solution of sulfated fatty alcohols (or other wetting agent) in water at 38 °C (100°F). Submerge the marked specimens in the tray, and allow them to soak for 4 h or overnight. The water temperature may be allowed to come to room temperature during the soaking period.

10.5 *Drying*—With as little distortion as possible, remove the wet specimens from the tray in ball form, and hydroextract them for about 10 s at full speed. Lay the specimens flat without blocking or distortion, on the drying racks to air-dry, or oven-dry them at approximately 60°C (140°F). Do not press the specimens dry.

10.6 *Measuring*—Before measuring, condition the specimens from the dry side in a standard atmosphere as directed in 10.2. Lay out each specimen without tension on a flat surface, and measure the distances that were marked off, to the nearest 1 mm (0.05 in.).

11. Calculation

11.1 Calculate the dimensional change in each direction using Eq 2:

$$R = 100\,(A - B)/B \qquad (2)$$

where:

R = relaxation dimensional change, %,
A = average measurement after change, and
B = average original measurement.

Express a gain in size during immersion in water (when final measurements are larger than original measurements) by a plus (+) sign.

12. Report

12.1 State that the specimens were tested as directed in Sections 6 to 13 of ASTM Test Methods D 1284. Describe the material or product tested and the method of sampling used.

12.2 Report the following information:

12.2.1 Relaxation dimensional change in wale direction, and

12.2.2 Relaxation dimensional change in course direction.

13. Precision and Bias

13.1 *Interlaboratory Test Data*[8]—In an interlaboratory test run in 1973, randomly drawn samples of a 100 % wool-jersey double-knit fabric were tested in seven laboratories as directed in ISO Method 38/2 N 79 and in six laboratories as directed in ISO Method 38/2 N 100. These procedures differ from the relaxation dimensional change procedure in Test Methods D 1284 and each other in the concentration and nature of the wetting solution, the temperature of the wetting solution, and the length of the soaking period. Since published work on relaxation dimensional change indicates that these factors are not critical [9, 10, 11], it is believed that these results can be used to estimate the precision of test results obtained from Test Methods D 1284. Using each of the ISO methods, each laboratory used two operators, each of whom tested three specimens of material. The components of variance expressed as standard deviations are listed in Table 1. The single-operator components of variance for the two methods were combined to obtain the following value:

Single-Operator Components	
Changes parallel to wales	1.24 percentage points
Changes parallel to courses	1.88 percentage points

Estimates of the within-laboratory and between-laboratory components are so inconsistent that it is not recommended that these components be used in calculating critical differences.

13.2 *Precision*—For the single-operator components of variance reported in 13.1, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the following critical differences:

Number of Observations in Each Average	Critical Differences, Points[A]	
	Parallel to wales	Percentage Parallel to Courses
1	3.44	5.21
2	2.43	3.68
4	1.72	2.61
8	1.22	1.64

[A] The critical differences were calculated using $t = 1.960$, which is based on infinite degree of freedom.

NOTE 4—Because of the inconsistent estimates of the within-laboratory and between-laboratory components of variance, caution should be exercised in comparing test results obtained by different operators in a

[7] Saran, or equivalent plastic, has been found satisfactory.

[8] ASTM Research Report No. RR: D-13-1050. A copy is available on loan from ASTM Headquarters, 1916 Race St., Philadelphia, PA 19103.

[9] Nutting, T. S., and Leaf, M. J., *Journal of the Textile Institute*, JTINA, Vol 55, T45, 1964.

[10] Valk, G., and El-Rayyes, N., *Z. ges. Textilind* Vol. 67, 174, 1965.

[11] Baird, K., *Textile Research Journal*, TRJOA, Vol. 31, 1961, p. 624.