



## Standard Test Method for Shrinkage of Yarns<sup>1</sup>

This standard is issued under the fixed designation D 2259; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method is used to determine the shrinkage of yarns in skein form when treated in boiling water, dry heat, saturated steam, or solvents. This test method is applicable to yarns made from any fiber or combination of fibers where the tex of the yarn is known or can be determined. This is not recommended for elastomeric yarns and those yarns that stretch more than 5 % under the tension loadings prescribed, although it has been used for the latter.

NOTE 1—Procedures for determining yarn shrinkage and bulk properties of textured yarns are covered in Test Method D 4031.

1.2 This test method shows the values in both SI and inch-pound units. “SI” units is the technically correct name for the system of metric units known as the International System of Units. “Inch-pound” units is the technically correct name for the customary units used in the United States. The values stated in either SI units or in other units shall be regarded as standard. The values expressed in each system may not be exact equivalents; therefore each system must be used independently of the other without combining in any way.

1.3 *This standard does not purport to address all of the safety concerns, if any, 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<sup>2</sup>
- D 1059 Test Method for Yarn Number Based on Short-Length Specimens<sup>2</sup>
- D 1776 Practice for Conditioning Textiles for Testing<sup>2</sup>
- D 1907 Test Method for Yarn Number by the Skein Method<sup>2</sup>
- D 2258 Practice for Sampling Yarn for Testing<sup>2</sup>
- D 2259 Test Method for Shrinkage of Yarns<sup>2</sup>
- D 4031 Test Method for Bulk Properties of Textured Yarns<sup>3</sup>

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<sup>2</sup> Annual Book of ASTM Standards, Vol 07.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 07.02.

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens<sup>4</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *extension, n*—the change in length of a material due to stretching.

3.1.1.1 *Discussion*—In yarn shrinkage testing, extension is usually expressed as a percentage of the length prior to exposure. For yarns in skein form, this change is an increase in loop length. Extension is sometimes referred to as “negative” shrinkage or growth.

3.1.2 *shrinkage, n*—a decrease in one or more dimensions of an object or material.

3.1.2.1 *Discussion*—Shrinkage is usually expressed as a percentage of the length prior to exposure. For yarns in skein form this decrease is in loop length.

3.1.3 *skein loop-length, n*—the inside length of a coil of yarn mounted vertically as measured under a specified tension.

3.1.4 For definitions of other textile terms used in this test method, refer to Terminology D 123.

### 4. Summary of Test Method

4.1 The loop length of a conditioned skein of yarn is measured under a specific tension, which is sufficient to straighten but not stretch the skein. The tension-free skein is then immersed in boiling water or exposed to dry heat or saturated steam or in the solvent reconditioned, and remeasured. The shrinkage (or in some cases, growth) is calculated as the change in length expressed as a percentage of the length before immersion or exposure.

### 5. Significance and Use

5.1 Test Method D 2259 for testing yarn for shrinkage in boiling water, saturated steam, dry heat, or solvents is considered satisfactory for acceptance testing of commercial shipments of yarn because the test method has been used extensively in the trade for that purpose.

5.1.1 In case of a dispute arising from differences in reported test results when using Test Method D 2259 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent

<sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis and an acceptable probability level chosen by the two parties before the testing began. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.

5.2 Results obtained by this test method can be used for the following purposes:

5.2.1 As an aid in predicting the dimensional stability of fabrics to wet processing,

5.2.2 As an aid in predicting the dimensional stability of fabrics during processing at elevated temperatures, and

5.2.3 As a control measure in the manufacture of some types of fibers.

5.3 The shrinkage medium to be used in the test depends on the requirements of the parties involved.

5.4 The procedure for shrinkage in boiling water is described in Section 12, for shrinkage in dry heat in Section 13, for shrinkage in saturated steam in Section 14, and for shrinkage in solvents in Section 15. A 30-min exposure time is prescribed for boiling water. In exposure to dry heat, saturated steam, or solvents, the extent of change in the length of yarn is dependent upon the fiber type and upon the time and temperature of the exposure. Fiber types differ in their reaction to elevated temperature as well as the nature of the specific solvent, and prior fiber history can have a great influence upon the heat and solvent shrinkage of a yarn. Therefore, the time and temperature conditions to be used to determine dry heat or saturated steam shrinkage must be agreed upon for the particular product involved. In addition, time and temperature conditions, and solvent to be used must be agreed upon for solvent shrinkage determination for the particular product involved.

## 6. Apparatus and Reagents

6.1 *Reel*—A hand or motor-driven reel having a nominal perimeter of 1 m, 1.5 yd, or 1.125 m (Note 2). The reel should have a traversing mechanism that will minimize bunching of ends on the reel, a yarn-tensioning device capable of maintaining tension below 1 cN/tex or 1.0 gf/den, and a yarn length or revolution indicator. A warning bell that will ring just prior to the specified number of reel revolutions is recommended. A collapsible arm is advisable for convenience in skein removal.

NOTE 2—By agreement, reels of other perimeters, between 1 and 2 m (1 and 2 yd) may be used.

6.2 *Measuring Scale*—A tape or scale accurate to 1 part in 1000 is recommended. Any scale length exceeding the reel diameter by 250 mm or 10 in. allowing for the extension of the skein is satisfactory. The scale should be mounted vertically. A top hook holds the skein and is mounted with support surface in line with the zero index of the scale.

6.3 *Metal Hook*—A hook designed to hang from the skein, shaped to receive the tensioning weights, and with a mass

known to 1 part in 1000. The hook may have a pointer located and attached for ease in reading the measuring scale at a point level with the inside bottom of the skein.

6.4 *Tensioning Masses*—Accurate to 1 part in 1000.

6.5 *For Boiling Water:*

6.5.1 *Container*, of sufficient size for 40:1 mass ratio water bath.

6.5.2 *Roller Wringer or Centrifugal Extractor*.

6.5.3 *Heat Source*, for water bath.

6.5.4 *Distilled or Demineralized Water*.

6.5.5 *Nonionic Wetting Agent*.

6.6 *For Dry Heat:*

6.6.1 *Heating Oven*—A forced-draft oven capable of meeting the required temperature and that meets the temperature uniformity requirements for a Type IIB oven as described in Specification E 145, Table 1. There must be a means of suspending the skeins in the oven. This may be accomplished with a rod with cup hooks from which to suspend skeins. The rod may be mounted on a stand for placement in the oven; skeins should not be allowed to touch the sides of the oven.

6.7 *For Saturated Steam:*

6.7.1 *Autoclave*—A pressure vessel capable of sustaining the temperatures and pressures required, and of such a size that the test skeins of yarn can be suspended without touching sides or bottom of the autoclave.

6.8 *For Solvents:*

6.8.1 *Hot Plate or Heated Block*—A temperature controlled hot plate or heated block which can maintain the temperature of the solvent in a container to  $\pm 2^\circ\text{C}$  or  $4^\circ\text{F}$  of the specified value.

6.8.2 *Container*, of sufficient size for a 40:1 mass ratio solvent bath.

6.9 *For Drying Wet Skeins:*

6.9.1 *Drying Oven*—A ventilated drying oven maintained at a temperature of  $65 \pm 3^\circ\text{C}$  or  $149 \pm 5^\circ\text{F}$ , in which the yarn specimens are not exposed to direct radiation from the heating elements.

## 7. Hazards

7.1 Avoid physical contact with hot water and hot metal and especially saturated steam (Sections 12, 13, and 14).

7.2 Refer to manufacturer's safety data sheets (MSDS) on the operation of the autoclave. Care should be exercised in

**TABLE 1 Components of Variance as Standard Deviations, Percentage Points**

Properties	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
Shrinkage, boiling water:			
Nylon spun yarn	0.32	0.60	0.61
Nylon filament yarn	0.20	0.76	0.79
Polyester spun yarn	0.32	0.31	0.26
Polyester filament yarn	0.11	0.32	0.25
Acrylic filament yarn	0.22	0.42	0.30
Cotton yarn	0.16	0.21	0.19
Rayon spun yarn	0.16	0.25	0.21
Shrinkage, dry heat:			
Nylon spun yarn at 150°C	0.24	0.23	0.17
Nylon filament yarn at 150°C	0.20	0.55	0.51
Polyester spun yarn at 190°C	0.39	0.38	0.26
Polyester filament yarn at 190°C	0.15	0.65	0.65