Designation: D 6720 – 01

Standard Test Method for Evaluation of Recoverable Stretch of Stretch Yarns (Skein Method)[1]

This standard is issued under the fixed designation D 6720; 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 This test method covers the determination of the recoverable stretch of commercial textured yarns, covered elastomeric yarns and other stretch yarns using skeins. This test method is particularly valuable for yarns that develop additional crimp upon exposure to hot, wet conditions. The recoverable stretch is a relative measure of the recovery power the yarn can be expected to provide in a finished fabric.

1.2 This test method is applicable to continuous filament yarns and is suitable for yarns that develop additional stretch potential upon exposure to heat.

1.3 This method is applicable to yarns 500 denier or finer.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only.

1.5 *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[2]

D 1776 Practice for Conditioning and Testing Textiles[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *elastomeric yarn, n*—a nontextured yarn which can be stretched repeatedly at room temperature to at least twice its original length and which after removal of the tensile force will immediately and forcibly return to approximately its original length.

3.1.2 *recoverable stretch, n*—the difference between a length of yarn fully extended under a specified force and its recovery under a lesser specified force.

3.1.2.1 *Discussion*—The recoverable stretch of a yarn is expressed as a percentage of the recovery length.

3.1.3 *stretch yarn, n*—a generic term for filament or spun yarns having a high degree of potential elastic stretch and a rapid recovery.

3.1.3.1 *Discussion*—Stretch yarns are generally produced by an appropriate combination of deforming, heat setting, and developing treatments to attain elastic properties.

4. Summary of Test Method

4.1 A skein of yarn is prepared by winding a prescribed number of turns on a reel in order to obtain a 5000 g skein. The skein is immersed in boiling water for 15 min and air dried to allow the yarn skein to fully develop its stretch (crimp) potential. The skein is exercised under a specified tension and its extended length is recorded. A lessor tension is then applied to the skein and its recovery length is recorded. The recoverable stretch is calculated from the difference between the recorded length measurements and expressed as a percentage of the recovery length.

5. Significance and Use

5.1 This test method is considered satisfactory for acceptance testing of commercial shipments because current estimates of between-laboratory precision are acceptable and the method is used extensively in the trade for acceptance testing.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use samples for such comparative tests that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results for that material must be adjusted in consideration of the known bias.

5.2 This test differs from other crimp contraction test methods in that it measures the recoverable stretch during the

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarns.

Current edition approved Sept. 10, 2001. Published October 2001.

[2] *Annual Book of ASTM Standards,* Vol 07.01.

unload cycle of the yarn.

6. Interferences

6.1 Care should be take to ensure that the skein is not lifted past the point where it is supported by the yarn. If the 30 g weight is lifted beyond this point, a false reading will result since the yarn will be on the next cycle load extension force.

7. Apparatus

7.1 *Reel*—A hand or motor driven reel having a perimeter of 1.37 m (54 in.).

7.2 *Water Bath Tank*, filled with water, minimum dimensions, 50 l capable of maintaining 100° ± 1°C (212° ± 2°F), for boiling off skeins.

7.3 *Rack*, having parallel pegs or bars placed a sufficient distance apart to hold the skeins extended to nearly their full length without stretching, kinking or entangling the yarns.

7.4 *Measuring Scales*, consisting of one meter stick or other scale for each peg position on the rack, having measuring intervals of 1 mm (0.05 in.), mounted vertically with a hook at the top aligned with the scales 0 position.

7.5 *Clock or Stopwatch*, with second intervals.

7.6 *Tension Weights*—A 30 g weight and either a 1000 g or 2 - 500 g weights, having tolerances of 1 %. Metal tongs, to remove skeins from water bath.

8. Sampling, Test Specimens, and Test Units

8.1 *Lot Sample*—As a lot sample for acceptance testing, take a random number of shipping units directed in a applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 2258. Consider shipping cases or other shipping units to be the primary sampling units.

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping units, between packages or ends within a shipping unit, and between specimens from a single package to provide a sampling with a meaningful producer's risk, consumer's risk, acceptable quality level and limiting quality level.

8.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping unit in the lot sample the number of packages as directed in applicable specification or as agreed to between purchaser and supplier.

8.3 *Test Specimens*—Prepare 5000 denier skeins using a winding tension of about 0.1 gf/d. Test one skein from each package in the laboratory sample. In any event, test a minimum of three packages.

9. Conditioning

9.1 No preconditioning is required.

9.2 After exposure in the water bath, condition skein samples as directed in Practice D 1776 for a minimum of 16 hrs. at 21 + 1°C (70 + 2°F) and 65 + 2 % relative humidity.

10. Preparation of Test Equipment and Calibration

10.1 Ensure tension weights are within 1 % of assigned value.

10.2 Ensure that water bath temperature measuring devices are within calibration.

10.3 Bring bath water to 100° ± 1°C (212° ± 2°F).

11. Procedure

11.1 Immerse the test specimen skeins in boiling water 100° ± 1°C (212° ± 2°F) for 15 min to allow development of crimp potential.

11.2 Air dry the skeins on the rack and conditioned as directed in 9.2.

11.3 After drying, hang each skein on the meter stick hooks.

11.4 Gently, apply both the 30 g and 1000 g tension weights to the bottom of the skein.

11.5 After about 10 s, allow the skein to relax by manually supporting the weights by hand, so that it becomes slack.

11.6 After 10 s, allow the skein to gently extend downward under the 1030 g weight.

11.7 After about 10 s, allow the skein to relax by manually supporting the weights by hand, so that it becomes slack.

11.8 After 10 s, reapply the force by letting the skein gently extend under the weight of the 1030 g force.

11.9 After 10 s, record the extended length, L_1, to the nearest 1 mm (0.05 in.) while under the 1030 g tension.

11.10 Place two fingers into the bottom of the skein loop just above the 30 g weight to prevent snap back while holding the relative extended position of the skein and carefully remove the other weight[s] totaling 1000 g.

11.11 Allow the skein to gradually recover under the 30 g tension, without bouncing or lifting beyond its recovery length, guided by the fingers as they leave the loop.

NOTE 2—Care should be taken to ensure that the skein is not lifted past the point where it is supported by the yarn. If the 30 g weight is lifted beyond this point, a false reading will result since the yarn will be on the next cycle load extension force.

11.12 After resting for 30 s, record the unload recovery length to the nearest 1 mm (0.05 in.) while under the 5.4 mgf/dtex (30 g) tension, L_2.

12. Calculation or Interpretation of Results

12.1 Calculate the Recoverable Stretch for each test specimen to the nearest 0.01 percent according to Eq 1:

$$(L_1 - L_2) / L_2 * 100 \quad (1)$$

where:

L_1 = extended length after the third load cycle with 185 mgf/dtex (1030 g) force on the yarn., (from 11.9), and

L_2 = unload recovery length after the third load cycle with 5.4 mgf/dtex (30 g) force on the yarn, (from 11.12).

12.2 Calculate the average recoverable stretch to the nearest 0.01 percent for the lot.

13. Report

13.1 State that the specimens were tested as directed in Test Method 6720. Describe the materials or products sampled.

13.2 Report the following information:

13.2.1 Recoverable Stretch.

14. Precision and Bias

14.1 An interlaboratory study was performed in November 2000 to estimate variability of the test method. The study included two laboratories. Two operators were used in each

laboratory to measure three specimens for five different yarns that develop crimp in hot wet conditions on two different days. ANOVA was used to determine variance components.

14.2 Method repeatability is defined as the "maximum difference" that can "reasonably" be expected between two test results obtained on the same material when the test results are obtained in the same laboratory. Repeatability standard deviation, s_r, is taken to be the square root of the "specimen" variance component, and represents within-operator precision. Method reproducibility is defined as the "maximum difference" that can "reasonably" be expected between two test results obtained on the same material when the test results are obtained from different laboratories.[3] s_R, the total standard deviation, is formed by taking the square root of the sum of intra- and inter-laboratory variance components.

[3] John Mandel and Theodore W. Lashof, 1987. The Nature of Repeatability and Reproducibility. Jour. Quality Technology, 19 (1).

TABLE 1 Recoverable Stretch, Average Percent and Components of Variation expressed as Squares of Standard Deviation

NOTE—Response = Recoverable Stretch, %.

Material	Average	V(lab)	V(operator)	V(date)	V(specimen)
2GT	22.53083	0.00000	1.55343	0.19143	0.38500
4GT	24.20042	3.65089	0.12216	0.11723	0.61726
Nylon 66	17.19917	2.16506	0.00000	0.41629	0.52026
Covered Lycra®	80.21542	0.00000	34.61043	4.93616	4.44413
Inspira®	20.72083	25.78378	0.00000	16.93464	0.96332

TABLE 2 Repeatability and Reproducibility for Recoverable Stretch of Stretch Yarns Expressed as Standard Deviation Percentage Points

NOTE—Response = Recoverable Stretch, %.

Material	s_r	Repeatability	s_R	Reproducibility
2GT	0.62	1.72	1.46	4.05
4GT	0.79	2.18	2.12	5.88
Nylon 66	0.72	2.00	1.76	4.88
Covered Lycra®	2.11	5.84	6.63	18.39
Ispira®	0.98	2.72	6.61	18.32

NOTE 3—Because the interlaboratory test included less than the recommended five laboratories, estimates of precision data in Tables 1 and 2 may be either underestimated or overestimated to a considerable extent and should be used with special caution.

14.3 *Bias*—The procedure of this test method produces a test value that can be defined only in terms of a test method. There is no independent, referee method by which bias may be determined. This test method has no known bias.

15. Keywords

15.1 crimp; elastomeric yarns; recoverable stretch; stretch yarns; textured yarns