This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D6774 – 22

Standard Test Method for Crimp and Shrinkage Properties for Textured Yarns Using a Dynamic Textured Yarn Tester[1]

This standard is issued under the fixed designation D6774; 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 crimp contraction, residual fiber shrinkage and their variability of all types of filament yarns (partially oriented yarn (POY), fully oriented yarn (FOY), flat yarns, textured and bulked continuous filament (BCF) carpet yarns) using an automated tester.

NOTE 1—For another method of testing crimp in textured yarns, refer to Test Method D4031.

1.1.1 This method may also be used for non-textured yarns.

1.2 This test method is limited to crimped, multi-filament yarns ranging from 22.0 dtex to 890 dtex (15 denier to 800 denier) and for BCF yarns from 890 dtex to 4200 dtex (800 denier to 3800 denier).

1.3 The values stated in SI units are to be regarded as standard. Inch-pound units in parentheses after SI units are provided for information only and are not considered standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D2258 Practice for Sampling Yarn for Testing

D4031 Test Method for Bulk Properties of Textured Yarns

D4849 Terminology Related to Yarns and Fibers

3. Terminology

3.1 For definitions of textile terms in this test method, refer to Terminology D4849. For other textile terms used in this test method, refer to Terminology D123.

4. Summary of Test Method

4.1 The specimen passes through a pretension device to remove crimp. The specimen then passes, at a constant speed, around an input roller, to a calibrated sensor which maintains a specific tension.

4.1.1 Subsequently, the specimen passes through a heating element, at a low tension, where the specimen shrinks and again is crimped.

4.1.2 The crimped specimen then goes to an intermediate roll, at a low tension.

4.1.3 The specimen then travels to a second sensor, which maintains a tension equal to the pretension applied, to remove developed crimp.

4.2 Residual fiber shrinkage, crimp developed, and maximum total contraction are calculated by the computer software using speeds of the input, intermediate and output rolls.

5. Significance and Use

5.1 Test Method D6774, for determining maximum total contraction, crimp, and residual fiber shrinkage in textured filament yarns is suitable for acceptance testing of commercial shipments.

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 the samples for such a 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, a probability level chosen prior to the testing

[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 and Fibers.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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series. If a 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 The properties and their variability as measured by this method relate to bulk appearance, stretch and recovery of fabrics and dyeability of yarns.

5.3 For some yarns, elapsed time between processing and testing has a marked effect on the results, of this test, especially during the first 72 h. The effect is caused by stress decay which is known to be minimal beyond the seventh day and after which time the yarn remains relatively stable. Therefore, specimens should only be compared if tested after the same elapsed time. Samples can be tested at-line, thus having little to no elapsed time between processing and testing.

6. Apparatus

6.1 *Textured Yarn Tester*[3], equipped with the following:

6.1.1 *Non-contact Heater Tube,* with a temperature range from 100 °C to 205 °C (with an accuracy of ±1 °C), for filament yarns 22.0 dtex to 890 dtex (15 denier to 800 denier): or

6.1.1.1 *Non-contact Heater Tube,* with a temperature range from 185 °C to 250 °C (with an accuracy of ±1 °C), for textile and BCF yarns 890 dtex to 4200 dtex (800 denier to 3800 denier).

6.1.2 *Pretension Device*

6.1.2.1 For filament yarns 22.0 dtex to 890 dtex (15 denier to 800 denier), to control the tension within a range of 5 g to 25 g, with an accuracy of ±3 %: or

6.1.2.2 For textile and BCF yarns 890 dtex to 4200 dtex (800 denier to 3800 denier), to controls the tension within a range of 10 g to 250 g, with an accuracy of ±3 %.

6.1.3 *Sensor Assemblies,* for Zones 1 and 2 (see Fig. 1).

6.1.3.1 *Fine Yarn Sensors,* 22.0 dtex to 890 dtex (15 denier to 800 denier).

6.1.3.2 *Heavy Yarn Sensors,* 890 dtex to 4200 dtex (800 denier to 3800 denier).

6.1.4 *Computer, Software and Printer.*

6.2 *Static Eliminator,* optional if necessary.

NOTE 2—A static eliminator is used when the static level in the yarn is great enough to cause the filaments to flare out and cause snagging of the filaments on components of the tester.

6.3 *Automatic Package Changer,* for high volume production testing, optional.

6.4 *Tensiometer.*

7. Sampling

7.1 *Lot Sample*—For acceptance testing, take a lot sample of shipping containers as directed in an applicable specification, or as agreed upon between the purchaser and supplier. In the absence of an applicable specification or agreement, take a lot sample as directed in Practice D2258.

NOTE 3—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 plan with a meaningful producer's risk, consumer's risk, acceptable quality level and limiting quality level.

[3] The sole source of supply of the Textured Yarn Apparatus known to the committee is Lawson-Hemphill, Inc., 1658 G.A.R. Highway, Suite 5, Swansea, MA 02777, USA. If you are aware of alternative suppliers, please provide information to ASTM headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

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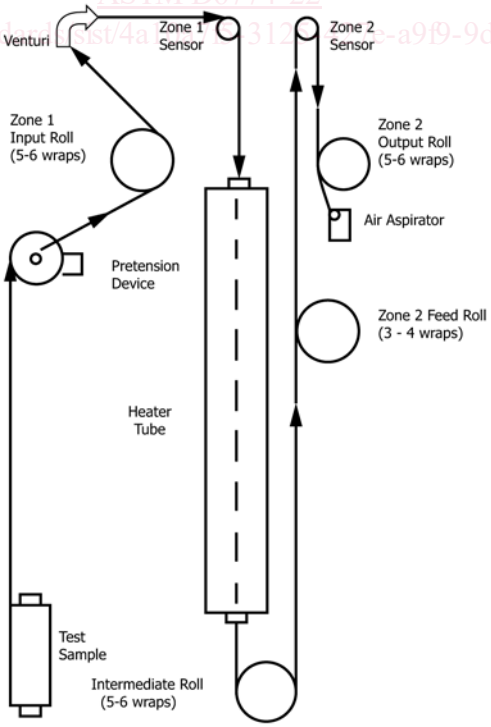

FIG. 1 Diagram of the Yarn Thread Path through the Textured Yarn Tester

7.2 *Laboratory Sample*—For acceptance testing, take at random from each shipping container in the lot sample the number of laboratory sampling units as directed in an applicable material specification or other agreement between purchaser and supplier such as an agreement to use Practice D2258. Preferably, take the same number of laboratory units from each shipping container in the lot sample.

7.3 *Number of Specimens*—Test ten, 2 m length, specimens from each package in the laboratory sample.

NOTE 4—Current software for the test apparatus is designed to measure only in meters. When available, tests can be run in 2 yd increments.

8. Conditioning

8.1 Conditioning and preconditioning are not required. Testing may be performed in the production area (at-line).

9. Preparation and Calibration of Apparatus

9.1 For yarn types and deniers not previously tested, and for which initial set-up conditions have not been established, follow the directions in Annex A1 before proceeding to 9.2.

9.2 For previously tested yarn types and deniers for which set-up procedures have been established, prepare and calibrate the tester using the established set-up procedure for that yarn, manufacturer's manual, A1.1 – A1.10 and the following information.

9.2.1 Turn on the motor and check the speed on the computer monitor.

9.2.2 Check that both appropriate sensor assemblies (zone 1 and zone 2) for freedom of movement.

9.2.3 Set the zero adjustment for the sensing arms and calibrate the tester.

9.2.4 Set sensing arm tension and pretension as prescribed in A1.4 – A1.6 or refer to manufacturer's operational manual.

9.2.5 Stop the tester motor.

10. Procedure

10.1 Operate the test apparatus as directed in the manufacturer's operating manual.

10.2 When performing routine testing and the parameters have previously been set as directed in Section 9, follow the procedure below.

10.2.1 Thread the yarn in the tester and let the tester run about a minute. Check to ensure that the yarn moves freely through the tester in the center of the heating tube.

10.2.2 Stop the tester.

10.2.3 Set the pretension as required for the yarn under test.

10.2.4 Set the test length to 2 m and the number of tests to ten.

10.2.5 Enter the yarn identification information into the computer and start the test.

10.2.6 When testing multiple packages, with different linear densities, it may be necessary to reset the tensions in the sensing zones and pretension, with the change in linear density.

10.2.7 Remove specimen from the tester when testing is complete.

11. Calculation of Results

11.1 All calculations shown below, including averages, standard deviation and coefficient of variation for the laboratory sampling units and for the lot, are determined using the computer software. Equations used for determining the property values are given in the following sections (see Fig. 2).

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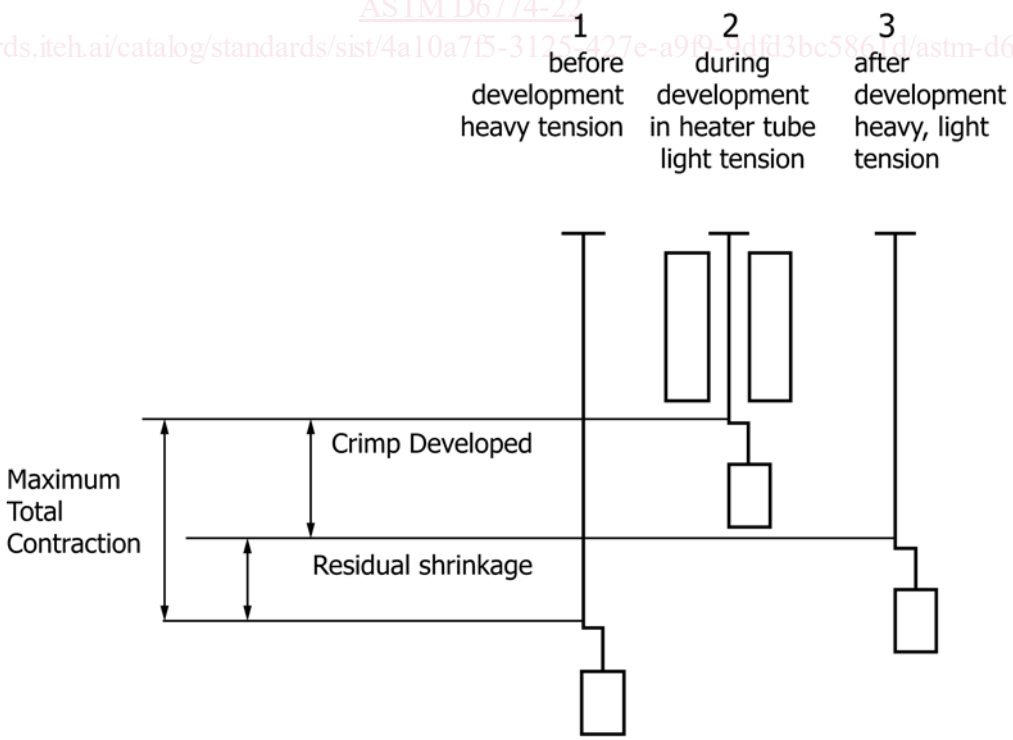

FIG. 2 Diagram Relating the Terminology of Textured Yarn Tester

11.2 *Total Contraction*—Calculate the total contraction to the nearest 0.1 % using Eq 1.

$$T = 100\,\frac{(R1 - R2)}{R1} \tag{1}$$

where:

T = total contraction, %,
$R1$ = input roller speed, m/min (yd/min), and
$R2$ = intermediate roller speed, m/min (yd/min).

11.3 *Crimp*—Calculate the crimp developed to the nearest 0.1 % using Eq 2.

$$C = 100\,\frac{(R3 - R2)}{R3} \tag{2}$$

where:

C = crimp, %, and
$R3$ = output roller speed, m/min (yd/min).

11.4 *Residual Fiber Shrinkage*—Calculate the residual fiber shrinkage to the nearest 0.1 % using Eq 3.

$$S = 100\,\frac{(R1 - R3)}{R1} \tag{3}$$

where:

S = residual fiber shrinkage, %.

12. Report

12.1 State that the specimens were tested as directed in Test Method D6774. Describe the material or product sampled and the method of sampling used.

12.2 Report the following properties for each specimen and averages for each laboratory sampling unit and lot sample for the following parameters:

12.2.1 Maximum total contraction.
12.2.2 Crimp.
12.2.3 Residual fiber shrinkage.
12.2.4 Standard deviation and coefficient of variation.
12.2.5 Mean values for maximum total contraction and residual fiber shrinkage, and the standard deviation and coefficient of variation for the lot sample.

12.3 Report the following test conditions used for the test:

12.3.1 Test speed used.
12.3.2 Test temperature used.
12.3.3 Specify heater type.
12.3.4 Pretension used.
12.3.5 If static eliminator was used during testing.
12.3.6 Elapsed time.

13. Precision and Bias

13.1 *Precision*—An interlaboratory study was performed to estimate variability of the test method. The study included 12 laboratories. Four operators were used to measure three specimens for five different yarns, which develop crimp in hot wet conditions on two different days. ANOVA was used to determine variance components:

TABLE 1 Response = Total Contraction (%)

Material	Average	V(Instrument)	V(Operator)	V(Package)	V(Specimen)
75	16.61146	0.03422	0.00000	1.73951	0.02205
150	15.69156	0.01678	0.00000	0.42009	0.03236
165	15.32594	0.11261	0.00000	0.27580	0.02625
190	18.34844	0.35085	0.00000	2.88366	0.07342

TABLE 2 Response = Shrinkage (%)

Material	Average	V(Instrument)	V(Operator)	V(Package)	V(Specimen)
75	3.28594	0.03306	0.00000	0.08752	0.00689
150	1.74146	0.02272	0.00000	0.00268	0.01810
165	4.55219	0.00082	0.00000	0.68329	0.03363
190	2.67563	0.09634	0.00000	0.19280	0.01388

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, sr, 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.[4] s_R, the total standard deviation, is formed by taking the square root of the sum of intra- and inter-laboratory variance components.

TABLE 3 Response = Total Contraction (%)

Material	s_r	Repeatability	s_R	Reproducibility
75	0.14849	0.41160	1.34006	3.71447
150	0.17989	0.49864	0.68501	1.89875
165	0.16203	0.44912	0.64395	1.78493
190	0.27096	0.75108	1.81877	5.04137

TABLE 4 Response = Shrinkage (%)

Material	s_r	Repeatability	s_R	Reproducibility
75	0.08303	0.23016	0.35703	0.98964
150	0.13455	0.37296	0.20857	0.57812
165	0.18338	0.50830	0.84720	2.34831
190	0.11782	0.32658	0.55047	1.52583

13.2 *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.

14. Keywords

14.1 crimp; residual fiber shrinkage; textured yarn; total contraction

[4] Mandel, John and Lashof, Theodore W., "The Nature of Repeatability and Reproducibility," *Journal of Quality Technology*, 19, 1, 1987.

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