Designation: D 4724 – 989

Standard Test Methods for ~~Degree of~~ Entanglements in Filament ~~Yarn Entanglement~~ Yarns by Needle Insertion ~~Methods~~[1]

This standard is issued under the fixed designation D 4724; 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 The~~i~~se test ~~methods cover three procedures~~ method covers two options for the ~~determination~~ measurement of ~~the degree of~~ entanglements in filament ~~yarn entanglement~~ yarns using needle ~~insertion. The test methods appear in the following order:~~

	~~Sections~~
~~*Test Method 1*—Degree of Filament Entanglement by Average Millimetre Pull~~	~~9-16~~
~~*Test Method 2*—Degree of Filament Entanglement in a Length of Yarn~~	~~17-24~~
~~*Test Method 3*—Degree of Filament Entanglement by Manual Method~~	~~25-32~~

insertion options for instrument (A) and manual (B) techniques.

1.2 The values stated in either SI or inch-pound units (in parentheses) are to be regarded separately as standard. The values st~~a~~nted in each system may not be exact equivalents; therefore, each system must be used independently of the other without combining values 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[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

~~[1] These~~

[1] This test ~~methods are~~ method is under the jurisdiction of ASTM Committee D-13 on Textiles and ~~are~~ is the direct responsibility of Subcommittee D13.58 on General Yarn Test Methods.

Current edition approved ~~April~~ Sept. 10, 1998~~9~~. Published ~~July 1998. Originally published as D 4724 – 87. Last previous edition D 4724 – 87 (1992)$^{\epsilon 1}$~~ . January 2000.

D 2258 Practice for Sampling Yarn for Testing[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *entanglement, n*—~~i~~the extent or degree to which the filaments in a yarn are interlocked and cannot be readily separated.

3.1.1.1 *Discussion*—There are two kinds of entanglements, intermediary (loose) node and hard (tight) node. Intermediary nodes are pulled out easily under tension or separated by a needle. This test method is a measure of the presence of hard nodes in which the interlocking or ~~intermingling of filaments as a substitute for twist to increase interfilament cohesion within~~ interlacing is compact pulling the yarn bundle together.

3.1.2 *filament yarn, n*—a yarn composed of (continuous) filaments assembled with or without twist.

3.2 For definitions of other textile terms used in ~~these~~ this test method~~s~~, refer to Terminology D 123.

4. Summary of Test Methods

4.1 A summary of ~~the directions for the determination of the degree of filament yarn entanglement~~ each option is in the ~~appropriate sections~~ section for ~~the specific method.~~ that option.

5. Significance and Use

~~5.1 Test Methods D 4724~~

5.1 Option 1 of this test method for the determination of the degree of filament yarn entanglement, as measured ~~by needle insertion techniques may be~~ instrumentally, is used for acceptance testing of commercial shipments ~~but~~; however, caution is advised ~~since~~ because information on between-laboratory precision is lacking. Comparative tests, as directed in 5.1.1, may be advisable.

~~5.1.1 In case of a dispute arising from~~

5.1.1 If there are differences of practical significance between the reported test results ~~using Test Methods D 4724~~ for ~~acceptance testing of commercial shipments, the purchaser and the supplier should conduct~~ two or more laboratories, comparative tests should be performed by those laboratories to determine if there is a statistical bias between ~~their laboratories. Competent~~ them, using competent statistical ~~assistance is recommended for the investigation of bias.~~ assistance. As a minimum, ~~the two parties should take a group of~~ samples used for each comparative test ~~specimens which are~~ should be as homogeneous as ~~possible and which are~~ possible, drawn from the same lot of material ~~of~~ as the ~~type~~ samples that results in ~~question. The test specimens should then be~~ disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. Other fabrics with established test values may be used for ~~testing.~~ this purpose. The ~~average~~ test results from the ~~two~~ laboratories involved should be compared ~~using Student's *t*-test for unpaired data~~ appropriate statistical analysis and ~~an acceptable~~ a probability level chosen by the two parties before testing begins, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected or ~~the purchaser and supplier must agree to interpret~~ future test results must be adjusted in ~~the light~~ consideration of the known bias.

~~5.2 These~~

5.2 Option 2 for this test ~~methods are~~ method is intended for use when the ~~determination~~ supply of yarn is limited.

5.3 The instrumental option of this test method is based on the ~~degree~~ total randomization of ~~fil~~ the entanglements in the yarn; therefore, the distan~~gl~~ce measured between the po~~v~~int of insertion of a ~~specified length~~ pin in the middle of the yarn ~~or~~ and the point at which an ~~estimate~~ entanglement is encountered, by movement of the yarn or the pin until it is stopped at a preset level of force, is representative of the distance between ~~entanglements.~~

~~5.3 Filament entanglement may be~~ two entanglements at some location in the yarn.

5.4 Entanglements are used frequently instead of twist to ensure the integrity of filament yarns. ~~Filament entanglement~~ Such entanglements generally give~~s~~ somewhat less protection during weaving or knitting than twist, but with proper care, will perform quite satisfactorily.

6. Sampling and Test Specimens

6.1 ~~*Lot Sample*—Take a lot sample as specified in the applicable material specification, or as agreed upon by the two parties interested in the test results. In the absence~~Primary Sampling Unit—Consider shipping containers of ~~any specification or agreement, take a lot sample as directed in Practice D 2258.~~

6.2 ~~*Laboratory Sample*—As a laboratory sample for acceptance testing, take at random~~ yarn to be the ~~number of packages from each~~ primary sampling ~~unit in the lot sample directed in an applicable material specification or other agreement between the purchaser and the supplier such as an agreement to use Practice D 2258. Sample packages should not be rewound or transferred to another package.~~ unit.

NOTE 1—A realistic specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping containers, packages within a shipping container, and successive lengths from a package to provide a plan ~~which,~~ that, at the specified level for the property of interest, has a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

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

TABLE 1 Values of Student's *t* for One-Sided and Two-Sided Limits and the 95 % Probability[A]

df	One-Sided	Two-Sided	df	One-Sided	Two-Sided	df	One-Sided	Two-Sided
1	6.314	12.706	11	1.796	2.201	22	1.717	2.074
2	2.920	4.303	12	1.782	2.179	24	1.711	2.064
3	2.353	3.182	13	1.771	2.160	26	1.706	2.056
4	2.132	2.776	14	1.761	2.145	28	1.701	2.048
5	2.015	2.571	15	1.753	2.131	30	1.697	2.042
6	1.943	2.447	16	1.746	2.120	40	1.684	2.021
7	1.895	2.365	17	1.740	2.110	50	1.676	2.009
8	1.860	2.306	18	1.734	2.101	60	1.671	2.000
9	1.833	2.262	19	1.729	2.093	120	1.658	1.980
10	1.812	2.228	20	1.725	2.086	—	1.645	1.960

[A] Values in this table were calculated using Hewlett Packard HP 67/97 Users' Library Programs 03848D. "One-Sided and Two-Sided Critical Values of Student's *t*" and 00350D." Improved Normal and Inverse Distribution." For values at other than the 95 % probability level. See published tables of critical values of Student's *t* in any standard statistical test (2), (3), (4), and (5).

6.2 *Laboratory Sample Unit*—For each primary sampling unit, take laboratory sampling units as directed in Practice D 2258. Do not rewind or transfer material from packages taken from shipping containers to another packages.

6.3 *Test Specimen*—Consider each package in the—For acceptance testing, use laboratory sample units as a test specimen. Take the number source of specimens. Make 20 observations per packages as directed in Section 7. on each laboratory sampling unit.

7. Number of Observations per Package

7.1 Unless otherwise agreed upon, as when specified in an applicable material specification, make a number of observations on each package such that the user may expect at the 95 % probability level that the test result is not more than 0.25 % of the average above or below the true average for the observations on each package. Determine the number of observations as follows:

7.1.1 *Reliable Estimate of v*—When there is a reliable estimate of *v* based on extensive past records for similar materials tested in the user's laboratory as directed in this test method, calculate the required number of specimens per package using Eq 1:

$$n = (tv/A)^2 = (tv)^2/0.0625 \quad (1)$$

where:

- v = reliable estimate of the coefficient of the variation of individual observation on similar materials in the user's laboratory under conditions of single operator precision,
- n = number of observations per package (rounded upward to a whole number),
- t = value of student's *t* for two-sided limits, a 95 % probability level, and degrees of freedom associated with the estimate of *v* (Table 1), and
- A = 0.25 % of the average, the value of the allowable variation.

7.1.2 *No Reliable Estimate of v*—Where there is no reliable estimate of *v* for the user's laboratory, Eq 1 should not be used directly. Instead, specify 20 observations per package for Methods 1 and 3. For Method 2, use 10 m of yarn from each package. This may be somewhat larger than usually found in practice. When a reliable estimate of *v* for the user's laboratory becomes available, Eq 1 may require a fewer number of observations per package.

8. Conditioning

87.1 *Preparation of Test Package*—Before preconditioning or conditioning the test package, remove at least 100 m or 110 yds of yarn from the test package to avoid testing nonrepresentative yarn.

87.2 *Preconditioning*—Normally, preconditioning is not necessary unless the test packages are received with higher than the normal moisture level. If preconditioning is necessary, treat the packages as directed in Practice D 1776.

87.3 *Conditioning*—Condition the test packages as directed in Practice D 1776.

TEST METHOD 1—INSTRUMENT METHOD—MEASURE OF THE DEGREE OF ENTANGLEMENT OF FILAMENT

OPTION 1—INSTRUMENTAL MEASUREMENT OF THE DEGREE OF ENTANGLEMENT OF FILAMENT YARN

8. Summary of Option

8.1 A yarn is passed at constant speed and constant pretension through the thread path of the instrument. After a required yarn length has run through, the yarn is pierced by a needle, and advanced automatically until a preset needle tension is attained. Then, the needle is withdrawn, and the yarn length from insertion to this critical point is measured automatically. This cycle of yarn advance, piercing by the needle, and length measurement is repeated for a predetermined number of times. The individual measured pulled yarn lengths and the total of these yarn lengths are automatically recorded.

9. Scope

9.1 This test method covers the determination of the degree of entanglement in man-made filament yarns by estimating the average distance between entanglements.

~~10. Summary of Test Method~~

~~10.1 A yarn strand is passed at constant speed and constant pretension through the thread path of the instrument. After a preset yarn length has run through, the yarn is pierced by a needle, and then advances automatically at reduced speed until a preset needle tension is attained. Then, the yarn stops, the needle is withdrawn, and the yarn length to this critical point is automatically measured and printed. This cycle of yarn advance, piercing by the needle, and length measurement is repeated for a predetermined number of times. The individual measured pulled yarn lengths and the total of the yarn lengths are automatically printed.~~

~~11.~~ **Apparatus**

~~11.1~~

9.1 *Automatic Needle Pull Entanglement Testers*, rapid automatic pin insertion detector (RAPID)[3] ~~—Rothschild Automatic Yarn Entanglement Tester NPT R-2040 using~~and Rothschild ~~Electronic Tensiometer Model R-1192A with 1-N sensing head.~~

~~11.2 *Scissors.*~~

~~11.3~~ automatic yarn entanglement testers NPT.[4,5]

9.2 *Standard Laboratory Weights*, ranging from 1 to 100 g.

~~11.4~~

9.3 *Stopwatch*, with ⅕-s divisions.

~~11.5~~

9.4 *Speed Indicator*, tachometer, 0 to 1000 rpm range.

~~11.6~~

9.5 *Magnetic Whorl Tensioning Device*, optional.

~~12. Number of Observations per Package~~

~~12.1 Make the number of observations per package as directed in Section 7.~~

~~13.~~

10. Procedure

10.1 Test the yarn in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

10.2 Calibrate the entanglement tester and tensiometer as prescribed by the instrument manufacturer.

10.3 Mount the test package on a suitable holder.

~~13.4 Thread the free end of the yarn from the test package through the sensing elements of the tester and through the take-up mechanism (See Fig. 1).~~

~~13.5 Set the entanglement tester as follows:~~

~~13.5.1 *Transport Speed*—400 mm/s.~~

[3] Available from ~~Rothschild Instruments, Zurich, Switzerland or from Lawson-Hemphill Sales,~~ W. Fritz Mezger, Inc., ~~P. O. Drawer 6388,~~ 155 Hall Street, Spartanburg, SC ~~29304. There are no other commercially available units which meet the requirements.~~ 29302–1523; and, Lenzing, Technik Div., Lenzing, Austria.

~~[4] A lamp satisfying this requirement is obtainable~~

[4] Available from ~~J~~ Rothschild Instrument~~s~~, Zurich, Switzerlan~~d~~ or from Lawson-Hemphill Sales, Inc., ~~Tempe, AZ.~~ P.O. Drawer 6388, Spartanburg, SC 29304.

[5] A lamp satisfying this requirement is obtainable from Jenson Tools, Inc., Tempe, AZ.

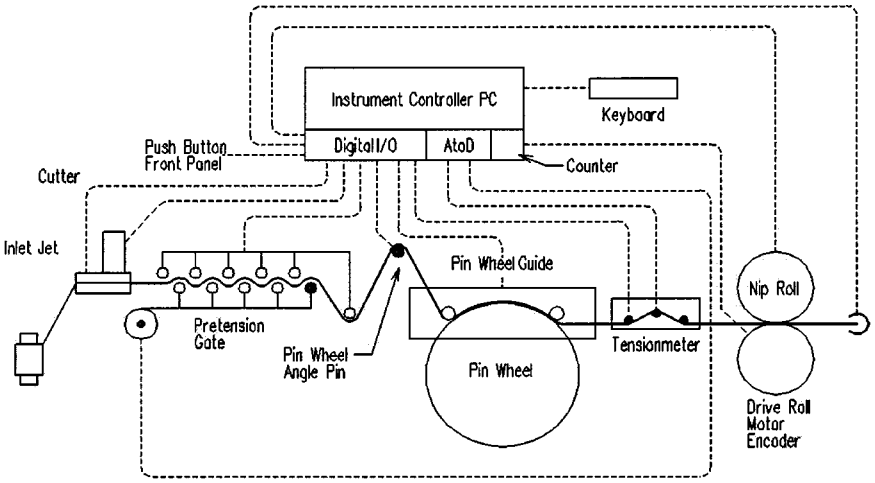

FIG. 1 Yarn String-Up Diagram for Rapid Automatic Pin Insertion Detector (RAPID)

13.5.2 *Measuring Speed*—20 mm/s.
13.5.3 *Forwarding Time*—5 s.
13.5.4

10.4 *Yarn Pretension*—18 mN/tex (0.2 gf/denier).
13.5.5 —Calculate the pretension by using one of the equations below:

$$YP\ (g) = (D\ \wedge\ 0.5)\ 0.75 \quad (1)$$

$$YP\ (cN) = (T\ \wedge\ 0.5) * 0.70 \quad (2)$$

10.5 *Trip Level Tension*—Calculate the trip level tension, *TLT*, by using Eq 2 or Eq 3: one of the equations below:

$$TLT,\ mN/tex = 795(T/F) + 18\ mN/tex \quad (2)$$

$$TLT(g) = (D\ \wedge\ 0.35) * 3.5 \quad (3)$$

$$TLT,\ gf/denier = (D/F) + 0.2\ gf/denier \quad (3)$$

$$TLT\ (cN) = (T\ \wedge\ 0.35) * 3.31 \quad (4)$$

where:
T
YP = linear density, tex,
*D*Yarn pre-tension,
TLT = linear density, denier, and
*F*trip level tension, c/tex (gf/d),
T = filament count.

13.5.6 *Observations per Package (Decade Counter)*—Make the number of observations as directed in Section 7.
13.5.7 *No-Show Length*—At least 500 mm.
13.6 Turn on the Mode Switch to "reel-off", to preclean the test package as directed in 8.1.
13.7 Turn Mode Switch to "automatic" and start the automatic testing sequence.
13.7.1 Make 20 or other specified number of pulls on the test package. The measured length value of each pull will be printed. When a total of the specified number of pulls has been made, the printer tape will advance two blank lines and the cumulative total of the specified number of measured lengths is printed in millimetres.

NOTE 2—If there is no entanglement in the "No-Show" length, the machine will automatically start a new test. The aborted test will not be counted by the printer and will show as a blank space between the print-outs on the printer tape. The entanglement tester can be set to stop and a buzzer will sound if a "No-Show" test is encountered. This option can be set with the "No-Show" automatic toggle switch on the back of the control panel.

13.8 Repeat 13.6-13.7.1 until each of the packages in the laboratory sample has been tested.
13.9 Remove yarn from take-up wheel at frequent intervals to avoid excessive waste build-up. Use care if a sharp blade is used.

14. Calculation

14.1 Calculate the average millimetre pull using Eq 4:

$$AMP = L/N \quad (4)$$

where:
AMP = average millimetre pull to the nearest millimetre,
L = total length of individual pulls, mm, and
N = number of preselected pulls.

14.1.1 *Example*:

$$\text{Total of pulls} = 2494\ \text{mm}$$

$$\text{Number of preselected pulls} = 20$$

$$AMP = \frac{2494\ \text{mm}}{(20)} = 125\ \text{mm}$$

14.2 Report result to nearest average millimetre pull (*AMP*).

15. Report

15.1 State that the test packages were tested as directed in Method 1 of ASTM Test Methods D 4724. Describe the materials or product sampled and the method of sampling used.

15.2 Report the following information:

15.2.1 Type of yarn tested.

15.2.2 Nominal linear density.

15.2.3 Pre-tension level.

15.2.4 Trip level tension.

15.2.5 Measuring speed.

15.2.6 Transport speed.

15.2.7 Transport time.

15.2.8 Number of tests per sample.

15.2.9 No show distance, as specified in 13.5.7.

15.2.10 Number of pulls per package.

15.2.11 Average millimetre pull (*AMP*) per package.

16. Precision and Bias

16.1 *Precision*—The precision for Test Method 1 of Test Methods D 4724 for measuring the degree of filament entanglement by average millimetre pull is being established.

16.2 *Bias*—The procedure in Test Methods D 4724 for measuring the degree of filament entanglement by average millimetre pull has no bias because the value of the property can be defined only in terms of a test method.

TEST METHOD 2—INSTRUMENT METHOD—DEGREE OF FILAMENT ENTANGLEMENT IN A LENGTH OF YARN

17. Scope

17.1 This test method covers the determination of the degree of filament entanglement in man-made filament yarns by estimating the number of entanglements in a given length of yarn.

18. Summary of Test Method

18.1 A yarn strand is passed at constant speed and constant pretension through the thread path of the instrument. A needle is inserted into the threadline while the yarn tension is continuously measured. The yarn is advanced until tension on the needle increases enough to trip a switch, indicating that an entanglement of filaments has been reached. The number of entanglements is recorded for a given length of yarn.

19. Apparatus

19.1 *Continuous Entanglement Tester*[4], Rothschild Entanglement Tester R-2050 using Rothschild Electronic Tensiometer, Model 1192 with 1-N sensing head.

19.2 *Magnetic Whorl Tensioning Device* , optional.

19.3 *Standard Laboratory Weights* , ranging from 1 to 100 g.

19.4 *Stopwatch*, with ⅕-s divisions.

20. Number of Tests (Length of Yarn)

20.1 Select the length of yarn that will give the number of observations per package as directed in Section 7.

21. Procedure

21.1 Test the yarn in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

21.2 Calibrate the entanglement tester and tensiometer as prescribed by the instrument manufacturer.

21.3 Mount the test package on a suitable holder.

21.4 Thread the free end of the yarn from the test package through the sensing elements of the tester and through the take-up mechanism (See Fig. 1).

21.5 Set the entanglement tester as follows:

21.5.1 *Test Length*—10 m.

21.5.2 *Measuring Speed*—20 mm/s.

21.5.3 *Transport Time Setting*—0 (zero).

21.5.4 *Unwinding Time Setting*—0 (zero).

21.5.5 *No-Show Length*—At least 500 mm.

21.5.6 *Tensiometer*—Range 2.5 (250 mN).

21.6 Trip Level Tension Set-up is as follows:

21.6.1 Set range switch at 2.5.
21.6.2 Remove threadline from tension head.
21.6.3 Set the sliding switch on the tensiometer marked" min" to zero.
21.6.4 Set the sliding switch on the tensiometer marked" max" to 10.
21.6.5 Calculate trip level tension, *TLT*, using Eq 5 or Eq 6:

$$TLT, \text{ mN/tex} = 795(T/F) + 18 \text{ mN/tex} \quad (5)$$

$$TLT, \text{ gf/denier} = (D/F) + 0.2 \text{ gf/denier} \quad (6)$$

where:
T = linear density, tex,
D = linear density, denier, and
F = filament count.
21.6.6 Set
10.6 Set the calculated trip level tension from 21.6.5 on RAPID instrument as follows:
10.6.1 *Measuring Speed*—10–20 m/min.
10.6.2 *Observations/Package*—20.
10.6.3 *No-Show Length*—Refer to the tensiometer using manufacturer's manual.
10.6.4 Present the zero adjustment knob.
21.6.7 Slowly slide loose end of the switch marked "max" on yarn to the tensiometer downward until inlet gun (see Fig. 1). The instrument will string up, automatically strip some yarn, start the red indicator lamp comes on. Trip level tension measurement cycle, and discard the tested yarn to waste.
10.6.4.1 If there is now set.
21.6.8 Set no entanglement in the "No-Show" length, the instrument will do the following:
(1) If the "Pin Miss Ignored Limit" has not been exceeded, rotate the pinwheel, reinsert the needle back to zero with in the zero knob.
21.6.9 Thread yarn, and continue testing. The test is aborted and a "No-Show" recorded.
(2) If the "Pin Miss Ignored Limit" has been exceeded, enter a "Freeze" state and request confirmation of pin insertion. The operator will restart the test if the pin did not pierce the yarn through (increasing the tension head, making sure that "Pin Miss Count" by 1, or the center operator will acknowledge pin is deflected in piercing by pressing the "Confirm" button designating this a true no entanglement section of, which adds the arrow.
21.7 Run Tension set-up is length to the results.
10.7 Set the Rothschild instrument as follows:
10.7.1 *Measuring Speed*—10–20 m/min.
10.7.2 *Forwarding Time*—5 s.
10.7.3 *Observations/Package (decade counter)*—20.
10.7.4 *No-Show Length*—500 mm or as specified by user. This is an optional setting and the range switch length should be established based on the tensiometer at 2.5.
21.7.2 Tie in a product or end-use of the product.
10.7.5 Feed the yarn from the package through the pretension device. The yarn then is threaded across the needle piercing section and press through the start button. As directed in 8.1, reel off 100 m of measuring head. Then, yarn goes to ensure a clean specimen.
21.7.3 Adjust the pre-tension, as yarn speed roll and is being reeled off, taken up to 18 mN/tex (0.2 gf/denier) using the built-in tension control "Take-up" wheel (see Fig. 2) or an optimal magnetic tension device.
21.7.4 Press can bypass the start button again if more time is needed to make this adjustment.
21.7.5 Check "Take-up" wheel and readjust pre-tension as necessary.
21.8 *Threadline Measurement*:
21.8.1 Set go into the sample test length for 10 m.
21.8.2 Tie in aspirator after the yarn package speed roll, to be tested.
21.8.3 Press start button. At prevent buildup on the end of the test take-up wheel. The software initializes a specified length (10 m), yarn travel will stop, for stripping and starts the total number of entanglements test.
10.7.5.1 If there is no entanglement in the "No-Show" length, the instrument will be printed on a tape (entanglements per metre).
21.8.4 Repeat 21.8.3 until do the predetermined number of entanglements have been encountered on following:
(1) Stop the yarn package.

NOTE 3—If no entanglements are detected, and withdraw the needle.

(2) Record a series of zeroes will be printed "No-Show" in the software (and on the tape. This will also occur if printout).
(3) Reinsert the needle misses into the yarn. If yarn and wind until a suspect low-value node (entanglement) is printed, retest detected.

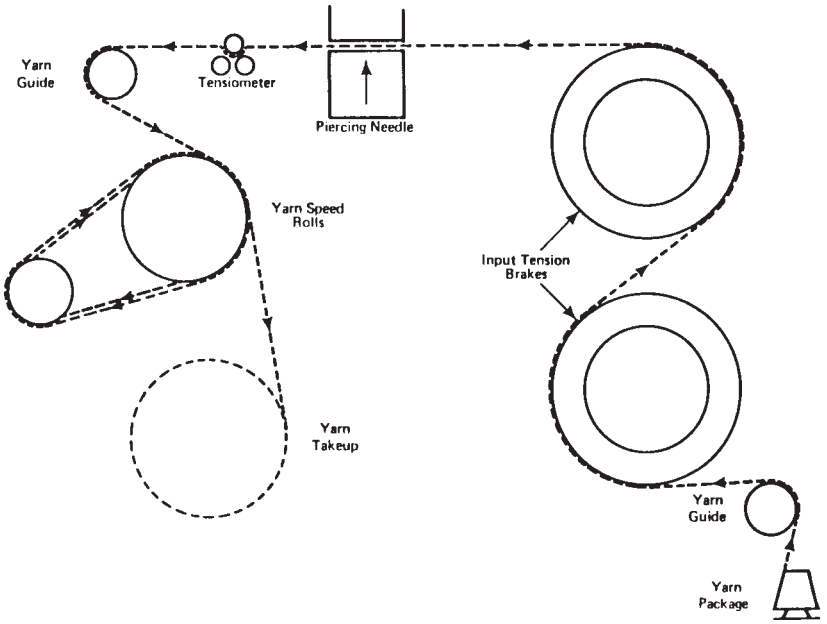

FIG. 2 Yarn String-Up Diagram for Rothschild Needle Insertion Entanglement Apparatus

(4) The first entanglement after a "No-Show" is ignored.

(5) The needle is withdrawn, and the yarn is amdvanced the specified length of the entanglement and check is reinserted into the needle position to be sure yarn and the test result continues. This is valid.

22. Calculation

22.1 Calculate to ensure that an accurate reference between entanglement is established.

10.7.6 Remove the yarn from the take-up wheel frequently to avoid excessive waste build-up. Use care if a sharp blade is used. To avoid any build-up, the yarn may be placed in the aspirator after the last wrap on the "Yarn speed roll."

11. Calculations

11.1 The tester computer will calculate the average number of entanglements per metre using Eq 7: 5:

EPM = C/L (5)

EPM = C/L (5)

where:

EPM = average number of entanglements per metre,

C

entanglements/m,

C = count of entanglements, assigned nodes/m (aim) for RAPID or preset for 20 for the Rothschild testers, and

L = lengthsum of the distances between entanglements in the yarn tested, m.

11.2 Calculate the average entanglements/m for the lot.

123. Report

123.1 State that the test packages were tested as directed in Method 2 Option 1 of ASTM Test Methods D 4724. Describe the materials or products sampled and the method of sampling used.

123.2 RThe report shall include the following information:

23.2.1 Type of yarn tested.

23.2.2 Nominal

12.2.1 Nominal linear density.

123.2.2 Pretension level used.

12.2.3 Trip lestvel tengthsion used.

123.2.4 Measuring speed.

23.2.5 Individual

12.2.5 Transport time.

12.2.6 The distances between entanglements per metre.

23.2.6 Average entanglements per metre.

24. Precision for each specimen.

12.2.7 No show distance and Bias

24.1 *Precision*—The precision any no shows encountered for Test Method 2 of Test Methods D 4724 each specimen.

12.2.8 The EMC for estimating each package and the number of entanglements in a given length of yarn is being established.

24.2 *Bias*—The procedure in Test Methods D 4724 average for measuring the degree of filament entanglement by lot.

12.2.9 The instrument used.

12.2.10 Any modifications to the number of entanglements in a given length of yarn has no bias because the value of this property can be defined only in terms of a test method.

TEST METHOD 3—DEGREE OF FILAMENT ENTANGLEMENT BY MANUAL METHOD

25. Scope

25.1 This test method covers the determination of the degree of filament entanglement in man-made filament yarns by a manual procedure (noninstrumental) of needle insertion.

26. test.

OPTION 2—MANUAL MEASUREMENT OF DEGREE OF FILAMENT ENTANGLEMENT

13. Summary of Test Method

26.1 A Option

13.1 A stationary needle is inserted into a single strand of continuous filament yarn. In in the same opening of the yarn, a yarn. A hook is placed beside in the same opening made by the needle. The hook is attached to one end of a flexible cord and a calibrated tensioning weight to the other end of the cord. The weight is allowed to drop vertically and gradually until the hook is stopped by an entanglement in the yarn. The needle is then moved in the opposite direction along the length of the specimen until it encounters another entanglement. The distance between the hook and needle is recorded as the distance between entanglements. See Fig. 3

2714. Apparatus

27.1

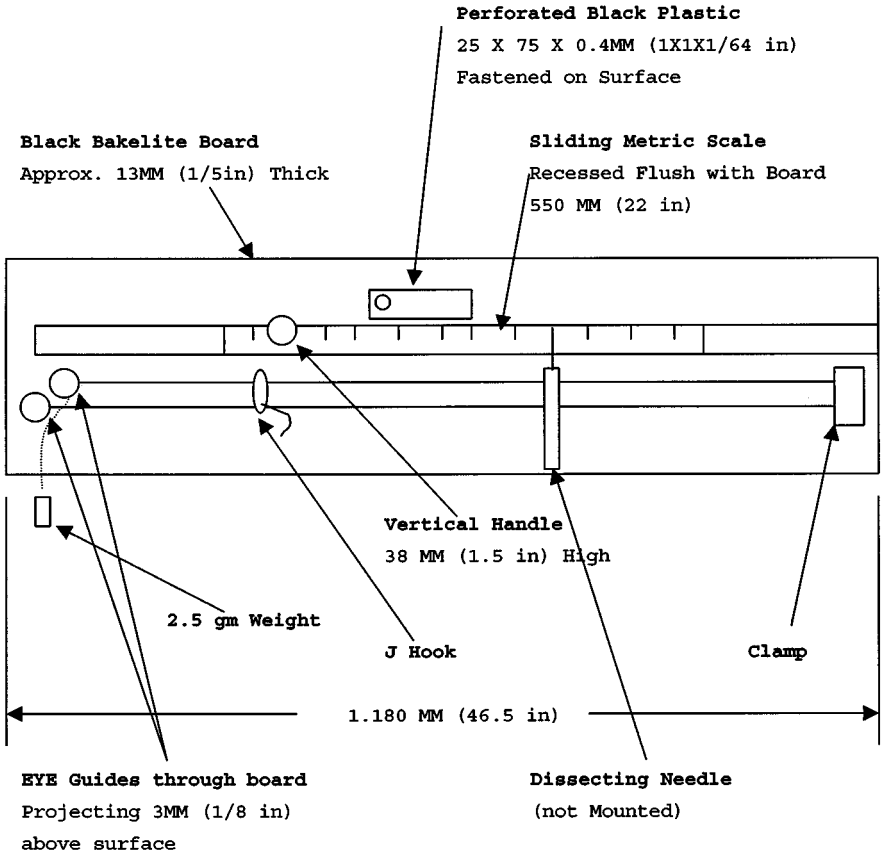

FIG. 3 Entanglement Tester (Manual Method)

14.1 *Weight*, 2.5 ± 0.01 g.

27.14.2 *J-sShaped Hook*, approximately 25 mm long.

27.3 *Flexible Cord*

14.3 *Cord, or thread*, flexible, No. 50 cotton.

27.4

14.4 *Illuminated Magnifier*[4], with a lens capable of 3× 3x to 10×x magnifications.

27.14.5 *Horizontal Test Board*, equipped with a sliding metric scale, movable black plastic perforated card 25 by 75 by 1.6 mm (1.0 by 3.0 by 1/16 in.), and yarn clamp (See Fig. 2).

27.6 clamp.

14.6 *Air Jet* suction.

27.7 Suction.

14.7 *Pick Needle*.

27.8

14.8 *Tensiometer*.

28. Number of Observations per Package

28.1 Make the number of observations per package as directed in Section 7.

29.

15. Procedure

29.15.1 Test the yarn in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

29.15.2 Place the yarn package to be tested on a suitable stand under the table supporting the test apparatus.

29.3 Open

15.3 Feed the yarn through the test apparatus.

15.4 Open the main air valve completely for the air- jet suction device.

29.4 Thread yarn through test apparatus as shown in Fig. 2.

29.5 Waste-off approximately 100 m device and strip off the outside layer of yarn using yarn.

15.5 Attach the air jet, as directed in 8.1.

29.6 Attach the J-hook to one end of the flexible cord cord, or thread, and string feed the other end through the guide at the left side of the test board. Cut cord off so the end is cord to a length that allows it to hang at least 750 mm from above the floor. Hang Attach the 2.5 g weight from to the free end of the cord.

29.7 Set the

15.6 Adjust tension on the yarn at the air jet.

29.7.1 Adjust tension to 1.0 mN 0.1 cN (0.01 gf/d) using a valve at the air jet. This is done Do this while the air jet is pulling against the yarn that is held stationary by a clamp on the right side of the test board.

29.8 Place

15.7 Place the illuminated magnifier over the control test area.

29.9 Slide

15.8 Slide the plastic card under the strand of yarn.

29.10 Push

15.9 Push the pick needle through the center of the yarn strand making the and make an opening wide enough for the J-hook. Extend the pick needle into a hole in the card.

29.15.110 Insert the hook into the opening next to the pick needle and let the hook move gently to the left until it catches on an entanglement.

29.12 Release the hook entanglement (hard node) and let its mass holds it in the yarn.

29.13 Gently move

15.11 With the pick needle, still in the yarn, pull it from the card and gently move it to the right until resistance due to another entanglement (hard node) is encountered.

29.14 Move

15.12 Move the plastic card out of the way and way, measure the distance between the hook, and needle.

29.15 Record pick needle (two entanglements) to the distance between entanglements in millimetres.

29.16 Remove nearest mm.

15.13 Remove the hook and pick needle, open the clamp and allow yarn to pass through the air jet for approximately 10 s.

29.17 Repeat 29.6-29.15

15.14 Repeat 15.5-15.13 until 20 observations are have been made on each test package or until as many observations as directed in 28.1 are made.

30. package.

16. Calculation

3016.1 Calculate the average distance between entanglements for each package to the nearest millimetre.

16.2 Calculate the entanglements/m for each package to the nearest 0.1 unit using Eq 8: 6:

~~EPM = 1000/L~~ (6)

$$EPM = 1000/L \quad (6)$$

where:

EPM = ~~entanglement per metre,~~ entanglements/m,
1000 = number of ~~millimetres per metre,~~ mm/m, and
L = average distance between entanglements in ~~millimetres.~~ mm.

16.3 Calculate the average entanglements/m for all the packages.

17. Report

317.1 State that the test packages were tested as directed in ~~Method 3~~ Option 2 of ~~ASTM~~ Test Methods D 4724. Describe the materials or products sampled and the method of sampling used.

317.2 ~~R~~The report shall include the following ~~information:~~

~~31.2.1 Type of yarn tested.~~

~~31.2.2 Normal~~ information for the laboratory sampling unit and for the lot as applicable to a material specifications or contract order:

17.2.1 Normal linear density.

317.2.32 Yarn tension.

317.2.43 Number of ~~pulls.~~

~~31.2.5 Average entanglement~~ observations, if more than 20.

17.2.4 Entanglement value for each package~~r~~ and the~~s~~ average for all the packages.

3218. Precision and Bias

~~32.1 *Precision*—The precision for Method 3~~

18.1 *Summary*—In comparing two rates of entanglements/m, the entanglements measured over the same length of opportunity should be compared using the critical different in Table 2. If the rates of entanglements include bias due to systematic sampling or testing errors, the critical differences in Table 2 will be overly optimistic. When the two counts being compared are measured over difference lengths, Table 2 is no longer valid and help should be sought from a competent statistician.

18.2 *Interlaboratory Test ~~Methods D 4724 for measuring~~ Data*—A interlaboratory test was run in 1997 in which randomly drawn samples of five materials were tested in each of four laboratories. Each laboratory used two operators, each of whom tested two specimens of each material. Since the data reggresents counts, components of ~~filament entanglement~~ variance were not calculated. Instead, the data was analyzed by nonparametric statistical methods to determine bias and interactions among laboratories and operators.

NOTE 2—Because the interlaboratory tests included only four laboratories, estimates of between laboratory precision may be underestimated to a considerable extent and should be used with special caution.

18.3 *Critical Differences*—Two rates of entanglements measured over the same test length should be considered significantly difference at the 95 % probability level, if the smallest rates is ~~being established.~~

~~32.2~~ less then or equal to the tabulated value of *b* in Table 2.

18.4 *Bias*—The procedure ~~in Test Methods D 4724 for measuring the degree~~ of ~~filament entanglement by manual~~ this test method ~~has no bias because the~~ produces a test value ~~of this property can~~ that cannot 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 know bias.

3319. Keywords

3319.1 entanglement; yarn

TABLE 2 Values of *b* for Critical Differences in Entanglement Counts, *a* and *b*, for Two-Sides Tests at a the 95 % Probability Level

r=a+b	*b*	*r=a+b*	*b*	*r=a+b*	*b*	*r=a+b*	*b*
8	0	24	6	39	12	53	18
11	1	27	7	41	13	55	19
14	2	29	8	43	14	57	20
16	3	32	9	46	15	60	21
19	4	34	10	48	16	62	22
22	5	36	11	50	17	64	23