Standard Test Method for Assessing Clean Flax Fiber Fineness[1]

This standard is issued under the fixed designation D 7025; 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 provides two options that cover the determination of the fineness of clean loose flax fibers by: Option 1, measuring the specific surface area by the resistance of a plug of flax fibers to air flow under prescribed conditions, or Option 2, estimating the mass per unit length.

1.2 The values, stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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:* [2]

D 123 Terminology Relating to Textiles
D 1059 Test Method for Yarn Number Based on Short-Length Specimens
D 1282 Test Method for Resistance to Airflow as an Indication of Average Fiber Diameter of Wool Top, Card Sliver, and Scoured Wool
D 1441 Practice for Sampling Cotton Fibers for Testing
D 1444 Test Method for Cross-Sectional Characteristics of Cotton Fibers
D 1448 Test Method for Micronaire Reading of Cotton Fibers
D 1449 Test Method for Specific Area and Immunity Ratio of Cotton Fibers (Arealometer Method)
D 1577 Test Method for Linear Density of Textile Fibers
D 1769 Test Method for Linear Density of Cotton Fibers (Array Sample)
D 1776 Practice for Conditioning and Testing Textiles
D 2130 Test Method for Diameter of Wool and Other Animal Fibers by Microprojection
D 2480 Method of Test for Maturity Index and Linear Density of Cotton Fibers by the Causticaire Method
D 3510 Test Method for Diameter of Wool and Other Animal Fibers by Image Analyser
D 6798 Terminology Relating to Flax and Linen

3. Terminology

3.1 *Definitions:*

3.1.1 *fineness index*, *n*—the use of a cellulosic fiber to measure air permeability having a specific gravity of 1.5 and a nominal linear density of 1.1 denier, 1.5 denier, or 3.0 denier.

3.1.1.1 *Discussion*—Viscose rayon fiber samples are less variable than natural fibers and manufactured to exacting properties by many fiber distributors. These fibers are derived from regenerated cellulose to contain a chemically induced crimp (4 to 6 crimps/cm) and a staple length of approximately 5 cm. Linear density of these fibers can be verified using the bundle weighing Option A of Test Method D 1577 to be approximately 0.11, 0.17, and 0.33 mg/m. As detailed in Test Method D 1577, fibers were cut with a mechanical cutting device under sufficient tension to remove fiber crimp. These cellulosic fibers have the same specific gravity as flax and can be used to determine the specific surface area.

3.1.2 *specific surface index*, *n*—relative fineness obtained by measuring the specific surface area by the resistance of airflow through a known mass of fiber compressed to a fixed volume.

3.1.2.1 *Discussion*—The specific surface index is influenced by various types of flax whose fiber perimeter, fiber bundles, cross-sectional shape, density, and trash differ between samples.

3.2 For definitions of textile terms used in this test method, refer to Terminology D 6798.

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

4. Summary of Test Method

4.1 Using Option 1, a predetermined mass of clean loose flax fibers generated by using a mechanical blender is placed in the specimen holder and compressed to a fixed volume.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.17 on Flax and Linen 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.

4.1.1 The resistance to airflow is measured using a cotton fiber instrument that provides a reading. This reading is converted to a specific surface index which is derived from the linear density of flax.

4.2 Using Option 2, the average linear density of single fibers in a bundle is calculated from mass and length measurements on the bundle and the number of single fibers in the bundle.

NOTE 1—There may be no overall correlation between the results obtained with Options 1 and 2. Consequently, these two options cannot be used interchangeably. In case of controversy, Option 1 shall prevail.

5. Significance and Use

5.1 This test method for determining fineness of cleaned flax fibers is considered satisfactory for acceptance testing of commercial shipments when the levels are controlled by use of a range of calibration standards.

5.1.1 If there are differences of practical significance between reported test results for two or more laboratories, comparative tests should be performed by those laboratories to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use test samples that are as homogenous as possible, are drawn from the material from which the disparate test results were obtained, and are randomly assigned in equal numbers to each laboratory for testing. These test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing 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 resistance that a plug of flax fibers offers to the flow of air is measured as an approximate indication of the average relative fineness of the fibers.

5.2.1 The total surface area of finer fibers has a larger per unit mass and increased resistance to airflow than do coarser fibers.

5.3 Instruments are available to indicate the resistance to air flow using either compressed air or a vacuum; and are constructed *(1)* to measure airflow under constant pressure drop across the plug, *(2)* to measure pressure drop when a constant flow of air is maintained, or *(3)* to indicate resistance to air flow from both a balanced and unbalanced Wheatstone bridge.

5.4 The reliability of the results of any test method depends primarily upon how well the specimens tested represent the original source material. Flax fibers are different from many textile fibers, such as cotton or synthetic ones, in that they are not individual filaments but bundles of fibrous material that may or may not be completely separated into individual filaments and therefore have a high degree of variability. While cleaning and processing can produce separation and changes in length, there is no certainty of fibrillation of the fibrous material.

NOTE 2—A modification of this test method can be used in commercial trading to select bales that will conform to contract guarantees for specified specific surface index. For this purpose, the usual practice to test only one specimen per sample.

5.4.1 This specific surface index reading is related to the average linear density of single fibers in a bundle calculated from mass and length measurements on the bundle and the number of single fibers in the bundle.

5.5 The specific surface index of flax fibers may be a function of fineness, degree of retting, cleanliness, variety, bundle separation, and plant maturity harvest date. This fineness of flax fibers affects their mill processing and spinning performance as well as contributes significantly to the appearance and strength of the yarns produced.

5.6 The accuracy of weighing can be controlled by the number of fibers composing the bundle. However, with short fiber of low linear density the number of fibers to be counted becomes prohibitive unless the bundle mass is kept low.

6. Apparatus and Materials

6.1 *Air-Flow Instrument,*[3] a device calibrated in micronaire readings or yielding numerical readings from which specific surface index readings can be computed.

6.2 *Balances*, with one having a capacity suitable for mass of the specific surface index specimen to be used and sensitivity of at least 0.2 % of the mass and another for linear density having a capacity of 15 mg and sensitivity of at least 0.005 mg.

6.3 *Air Supply*, to furnish the required pressure or vacuum to operate the instrument in accordance with the manufacturer's instructions.

6.4 *Fineness Calibration Standards*, viscose rayon fibers reduced to 5 cm with a nominal linear density of 1.1, 1.5, or 3.0 denier and a nominal specific surface fineness index value of 2.55, 2.9, or 4.0.

6.5 *Mechanical Cutting Device, Template, Stelometer Clamps, or Die*, having a precision of 0.1 % designed to permit cutting fibers of a specified length.

6.6 *Stationary Coarse Comb*, approximately 63 mm in width and having needles approximately 12.5 mm in length and spaced 19 needles to the centimeter.

6.7 *Mechanical Blender*, to open and blend the flax fibers.

7. Sampling and Selection of Specimens

7.1 Take the test specimen by random sampling from the laboratory sample prepared as recommended in Practice D 1441.

7.1.1 Pass the test specimen through a mechanical blender to open and blend fibers as directed in 6.1 of recommended Practice D 1441.

8. Conditioning

8.1 Bring the laboratory sample from the prevailing atmosphere to moisture equilibrium for testing which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 relative humidity and check the equilibrium as directed in Practice D 1776. No preconditioning is required.

[3] Apparatus and accessories are commercially available.

OPTION 1: SPECIFIC SURFACE INDEX FINENESS

9. Scope

9.1 This option covers the fineness measurement by resistance to airflow which is converted to the specific surface index to help characterize fibers by approximating the fineness. (See Note 1.)

10. Procedure

10.1 Test the conditioned specimens in the atmosphere for testing textiles.

10.1.1 Set up and adjust the instrument as directed in the manufacturer's instructions.

10.1.2 Adjust the instrument if necessary to secure values, which correspond to the values assigned to the Calibration Reference Standards at the beginning of each testing period.

10.2 Use a mechanical blender twice to open and blend each standard viscose rayon fiber.

10.3 Using 5 g specimens, make two tests with each standard viscose rayon fiber.

10.3.1 When the average of the two results is not within 0.1 unit of the established specific surface index reading, recheck the instrument and the technique used by the operator.

10.3.2 Check the instrument against the standards again at the end of each testing period.

10.3.3 When incorrect readings on the standards are obtained at the end of a testing period, discard the results, recheck the instrument, and repeat the tests.[4]

10.4 Test the conditioned specimens in the atmosphere for testing textiles.

10.5 Use a mechanical blender twice to open and blend flax fibers. Using forceps, remove obvious, large pieces of shive and other foreign materials.

10.5.1 Weigh out a 5 g test specimen for the instrument.

10.5.2 Place the weighed specimen in the fiber compression cylinder, fluffing it with the fingers as it is packed into the cylinder to eliminate knotty balls and being careful to place all the fibers inside the cylinder. Insert or activate the fiber compression plunger. Turn on or activate the air and read the value to the nearest 0.1 unit reading.

10.6 Test three specimens for each laboratory sampling unit.

11. Calculations

11.1 If the instrument readings are not in resistance to airflow readings, compute resistance to airflow readings from instrument readings in accordance with manufacturer's instructions.

11.2 Convert resistance to airflow readings into specific surface index fineness values, using Eq 1:

$$SSI = (J_1 \times R) - J_2 \quad (1)$$

where:

SSI = specific surface index,
R = resistance to airflow reading,
J_1 = 0.899, and
J_2 = 2.023.

Factors determined by linear regression between resistance to airflow readings and linear density values using 9 International Flax Grades.

11.3 Calculate the average for the three specimens test to the nearest 0.1 specific surface index reading for each laboratory sampling unit and for the lot.

OPTION 2: LINEAR DENSITY FINENESS

12. Scope

12.1 This option measures the fineness by determining the linear density of flax fiber which is cut and weighed. Average linear density of single fibers in a bundle is calculated from mass and length measurements on the bundle and the number of single fibers in the bundle. (See Note 1.)

13. Test Specimens

13.1 From each laboratory-sampling unit in a container, take three specimens at random.

13.2 Select tufts or bundles of fibers containing a sufficient number of fibers to weigh between 0.5 and 7.5 mg when cut to a specified length.

14. Preparation of Specimens

14.1 The specimens chosen from staple fiber may require combing to align the fibers and remove short ends and obvious large pieces of nonfibrous materials.

14.1.1 Grip the specimen at one end in suitable clamp or tweezers. Ease the specimen onto the stationary coarse comb needles 3 to 5 mm on the clamp side of the center of the tuft. Draw the specimen gently toward the center.

14.1.2 Lift the specimen off the comb. Replace the specimen on the needles 3 to 5 mm closer to the clamp than the last position. Draw the specimen gently to the center as before.

14.1.3 Continue to comb the specimen until the clamp is reached and all unclamped fibers are drawn to the center.

14.1.4 Reverse the specimen. Clamp in the combed segment approximately 3 to 5 mm from the uncombed segment near the center. Comb the other end of the specimen, progressing from tip to center in 3 to 5 mm increments. Discard the combings.

14.1.5 Arrange fibers in parallel alignment.

15. Procedure

15.1 Test the specimens in the standard atmosphere for testing textiles.

15.2 Place the combed bundle of fibers in a cutting device with fibers in parallel alignment and cut to known length.

15.3 Count 500 fibers in the combed bundle of fibers.[5]

NOTE 3—Counting of fibers is facilitated by using some magnification and shuffling the specimen on a short pile surface of contrasting color to separate fibers. Small fiber bundles still attached are counted as a single fiber.

[4] Built-in calibration devices and calibration plugs alone give only approximate results.

[5] It is complicated to obtain the linear density of a group or individual flax fibers because of fiber bundles being partially divided. Consequently, extra flax fibers must be counted, which results in fiber bundles that are still joined together being counted as a single fiber.

15.4 Weigh the 500 fibers from the specimen to the nearest 0.005 mg.

15.5 Test three specimens for each laboratory sampling unit.

16. Calculations

16.1 Calculate the average fiber linear density for each specimen to the nearest 0.1 mg/m.

16.2 Calculate the average for the three specimens test to the nearest 0.1 mg/m fiber linear density reading, using Eq 2:

$$LD = W/(L \times N) \tag{2}$$

where:

LD = average fiber linear density (mg/m),
W = mass of bundle specimen (mg),
L = length of bundle specimen (m), and
N = number of fibers and attached fibers in the bundle specimen (500 fibers).

16.3 Calculate the mean of the average linear density for each laboratory sampling unit and for the lot sample.

16.4 If requested, calculate the standard deviation, coefficient of variation or both.

17. Report

17.1 State that the test was carried out as directed using either Option 1 (Specific Surface Index Fineness by air flow) or Option 2 (Linear Density Fineness by fiber bundle weighing) as directed by ASTM Test Method D XXXX. (See Note 1.)

17.2 Report the following information:

17.2.1 Type, variety, and extent of retting for flax material according to Terminology D 6798.

17.2.2 Identification of flax processing and/or cottonizing system.

17.2.3 Identification of the samples by shipment, mark, lot numbers or bale numbers, which ever is applicable.

17.3 Method of fiber sampling.

17.4 For Option 1 report the average specific surface index reading and make, type, and model of the micronaire instrument used.

17.5 For Option 2 report the average linear density of each standard flax specimen.

18. Precision and Bias

18.1 *Precision*—The mean, standard deviation, and 95 % repeatability limit (2.8× sample standard deviation) of within-laboratory samples tested with the same method, equipment, laboratory, and operator for various samples of flax fiber are shown below in Table 1.

TABLE 1 Mean, Standard Deviation, and Within-laboratory Repeatability Limit[A]

Sample Type[B]	Statistic	Resistance to Airflow Reading	Linear Density
International Flax Grades			
International Flax Grade B	Mean	4.06	1.19
	Standard deviation	0.13	0.087
	Repeatability Limit	0.38	0.24
International Flax Grade C	Mean	4.36	1.36
	Standard deviation	0.12	0.11
	Repeatability Limit	0.32	0.31
International Flax Grade D	Mean	4.91	1.46
	Standard deviation	0.13	0.15
	Repeatability Limit	0.36	0.42
International Flax Grade E	Mean	5.08	1.70
	Standard deviation	0.14	0.20
	Repeatability Limit	0.39	0.55
International Flax Grade F	Mean	5.39	2.25
	Standard deviation	0.074	0.23
	Repeatability Limit	0.21	0.63
International Flax Grade G	Mean	5.94	2.46
	Standard deviation	0.052	0.23
	Repeatability Limit	0.144	0.64
International Flax Grade H	Mean	5.76	2.95
	Standard deviation	0.12	0.24
	Repeatability Limit	0.33	0.67
International Flax Grade I	Mean	7.00	2.89
	Standard deviation	0.11	0.21
	Repeatability Limit	0.30	0.59
International Flax Grade J	Mean	7.49	3.90
	Standard deviation	0.074	0.21
	Repeatability Limit	0.21	0.60
Generated Test Samples			
Cottonized flax fiber tow	Mean	3.70	1.62
	Standard deviation	0.054	0.043
	Repeatability Limit	0.15	0.12
Kingstree flax fiber	Mean	6.60	2.68
	Standard deviation	0.084	0.048
	Repeatability Limit	0.23	0.14
Temafa flax fiber	Mean	4.20	2.00
	Standard deviation	0.055	0.23
	Repeatability Limit	0.15	0.63

[A] The average and standard deviation (SD) are from 3 samples as described in 10.6 and 15.5 The 95 % repeatability limit (RL) is derived by multiplying 2.8× the sample SD in accordance with Form and Style of ASTM Standards, section A21.2.5.

[B] Samples are as follows: International Flax Grades B–J were purchased from the Institut Textile de France, Lille, France, Cottonized flax fiber tow (Grade 23), Kingstree flax fiber (grown and cottonized in Kingstree, SC, by the Unified Line), Temafa flax fiber (grown and cottonized in Germany by the Temafa Lin Line).

18.2 *Bias*—With the limitation imposed by within-laboratory evaluation, this test method has no known bias.

19. Keywords

19.1 fineness; flax fiber; linear density; micronaire reading

APPENDIX

(Nonmandatory Information)

X1.

X1.1 *Other Sources of Fineness Measurement*—ISO 27370 Textiles—Determination of Fineness of Flax Fibres—Permeametric Methods