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Standard Test Methods for Measurement of Physical Properties of Cotton Fibers by High Volume Instruments[1]

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1. Scope

1.1 These test methods cover the color, trash content, micronaire, length, length uniformity, strength and elongation of cotton fibers using the Spinlab System HVI 900 SA[2] or the Motion Control, Inc. Systems HVI 3500 and HVI 4000[2] that are a series of instruments connected to single dedicated programmed computers.

1.2 These test methods are applicable to loose fibers taken from raw or partially processed cotton and some types of cotton waste.

1.3 These test methods contain the following sections:

1.4 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are 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[3]

D 1441 Practice for Sampling Cotton Fibers for Testing[3]

D 1445 Test Method for Breaking Strength and Elongation of Cotton Fibers (Flat Bundle Method)[3]

D 1447 Test Method for Length and Length Uniformity of Cotton Fibers by Fibrograph Measurement[3]

D 1448 Test Method for Micronaire Reading of Cotton Fibers[3]

D 1776 Practice for Conditioning Textiles for Testing[3]

D 2253 Test Method for Color of Raw Cotton Using the Nickerson-Hunter Cotton Colorimeter[4]

D 2812 Test Method for Non-Lint Content of Cotton[3]

D 3025 Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards[3]

D 4848 Terminology of Force, Deformation and Related Properties of Textiles[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *breaking tenacity*, *n*—the tenacity at the breaking force.

3.1.1.1 *Discussion*—Cotton breaking tenacity is expressed as grams-force per tex or grams-force per denier. Standard SI units in newtons can be calculated by multiplying grams-force per tex by 0.0098.

3.1.2 *elongation at break*, *n*—the elongation corresponding to breaking force.

3.1.2.1 *Discussion*—Cotton elongation is the elongation at the maximum force and expressed as a percentage of a ⅛-in. (3.2-mm) gage length.

3.1.3 *mean length*, *n*—in testing cotton, the average length by number of all of the fibers in the test specimen.

3.1.4 *micronaire reading*, *n*—in testing cotton, a measure of specific surface area that is influenced by fiber perimeter and fiber wall thickness determined by the resistance to air flow through a known mass of cotton fiber compressed to a fixed volume.

3.1.4.1 *Discussion*—During growth of the cotton fiber, the fiber wall thickens as layers of cellulose are deposited daily on the inner surface. When wall thickening ultimately ceases, there remains a center void called the lumen. Both the wall thickness, or volume of cellulose, and the fiber perimeter, or fiber surface area, are important in textiles because they significantly affect yarn strength and dyeing behavior. In early development of an instrument to measure cotton fineness, the instrument scale was calibrated using measuredμ g/in. linear densities of a group of test cottons. Later experiences with the instrument on a broader range of cotton samples showed that

[1] These test methods are under the jurisdiction of ASTM Committee D-13 on Textiles and are the direct responsibility of Subcommittee D13.11 on Cotton Fibers.
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[2] Equipment is available from Zellweger Uster, Inc., 456 Troy Circle, P.O. Box 51270, Knoxville, TN 37950-1270.

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

[4] Discontinued; see *1994 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 07.02.

its scale did not represent gravimetric fineness. However, use of the tester became so widespread that the early scale was retained and named micronaire reading.

3.1.5 *particle count*, *n*—in testing cotton with the trash meter, a value that correlates to the total number of pieces of trash on the surface of a sample of cotton over the viewing window.

3.1.6 *percent area*, *n—in testing cotton with the trash meter*, the ratio of total area of trash on the surface of a sample of cotton to that of the area of the viewing window, expressed in percent of the area of the viewing window.

3.1.7 *span length*, *n—in testing cotton*, the distance a specified percent of fibers in a test beard extend from a clamp in which they are caught at random along their lengths.

3.1.8 *Rd and +b*, *n—for the purpose of these test methods for cotton color*, the daylight color of opaque cotton specimens as described by Hunter in terms of three color scales: reflectance, Rd, and the chromaticity coordinates for redness or greenness, ± a, and yellowness or blueness, ± b.

3.1.8.1 *Discussion*—Graphically, there are three mutually perpendicular unit vectors in which Rd is represented vertically, and the chromaticity coordinates *a* and *b* represented on a horizontal plane at right angles to each other. In the range of Rd for colors observed in cotton, the scales of the cotton colorimeter show a reasonably close relationship to the uniform perceptual spacing of the scales represented in the Munsell color space.

3.1.9 *strength*, *n*—the property that resists deformation induced by external forces.

3.1.10 *test beard*, *n—in length testing of cotton*, the portion of the test specimen that has been combed and brushed into a "beard" that protrudes from the outside of the comb(s) or the clamp(s).

3.1.11 *uniformity index*, *n—in fiber length testing of cotton*, the ratio between the mean length and the upper-half-mean length expressed as a percentage of the upper-half-mean length.

3.1.12 *uniformity ratio*, *n—in fiber length testing of cotton*, the ratio between two span lengths expressed as a percentage of the longer span length.

3.1.13 *upper-half-mean length*, *n—in length testing of cotton*, the mean length by number of the longer one-half of fibers by weight.

3.1.14 For definitions of other textile terms in these test methods, refer to Terminology D 123 and Terminology D 4848.

4. Significance and Use—General

4.1 These test methods are used in the trade and are considered satisfactory for acceptance testing of commercial shipments when the level of tests, of any one or several or all of the individual physical properties, in the laboratory of the purchaser and the laboratory of the supplier are controlled by the use of the same laboratory control samples.

4.1.1 In case of dispute arising from differences in reported test results when using these test methods 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 statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that 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 average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before testing is begun. 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 in the light with consideration to the known bias.

4.2 Being able to measure color, particle count of trash, micronaire, length, strength, and elongation using an integrated and dedicated system has the following benefits:

4.2.1 The HVI measuring system[2] can rapidly and objectively determine the color of cotton that is an important factor in determining the end use of cotton.

4.2.2 The HVI system[2] provides a particle count of the cotton trash that is directly related to textile processing waste.

4.2.3 The HVI system[2] determines micronaire, a factor that is correlated with cleaning efficiency, neppiness, the strength and uniformity of yarn, and dyeing of fibers, yarns, and fabrics.

4.2.4 The HVI system[2] provides a reproducible and economical procedure to measure length and length uniformity of fibers.

4.2.5 The HVI system[2] can determine various stress-strain parameters that are useful for research and for relating fiber characteristics to processing performance and quality of end products.

5. Sampling

5.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 1441 for bales of fiber or containers of sliver. Consider shipping containers or bales to be the primary sample units.

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between sampling units, between laboratory samples within a sampling unit, and between test specimens within a laboratory sample to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

5.2 *Laboratory Sample*—For acceptance testing, randomly take material from each lot sampling unit, or original material, such as: loose fibers from one or more bolls, plants, or rows in a field; bales, mixes, or blends of cotton; or any consignment, shipment, or lot of cotton; of any size or mass to yield the required test specimen(s).

5.3 *Test Specimens*—Take test specimens as directed in the description of individual test methods.

6. Conditioning

6.1 Bring the laboratory samples to moisture equilibrium for testing in these test methods atmosphere for testing textiles. See Practice D 1776.

NOTE 2—Cotton is normally received in the laboratory in a relative dry condition, making special preconditioning procedures unnecessary. Samples that are obviously damp should be preconditioned before being brought into the laboratory for conditioning.

NOTE 3—If tests are not made for moisture equilibrium, it is recommended that the samples be conditioned for at least 12 h prior to testing.

COLOR OF RAW COTTON

7. Scope

7.1 This test method covers the comparison of the color of raw cotton with the official standards of the United States Department of Agriculture for Color Grade of cotton by means of a cotton colorimeter of the Nickerson-Hunter type. It can be used to measure the color of any type of raw cotton but is particularly applicable to Upland and American Pima cotton, for which official grade Standards have been established.

7.2 The instrument employs the use of a programmable microprocessor with memory for controlling internal operations and performing required calibration, calculation, and data presentation.

NOTE 4—For another method describing the measurement of the color of raw cotton, refer to Test Method D 2253.

8. Summary of Test Method

8.1 A smooth representative surface of a cotton sample is placed over the colorimeter sample window and pressed flat. The instrument colorimeter is energized, and color values are displayed on the instrument's visual monitor in one or more of the following terms: the grayness and yellowness scale developed for cotton, the Rd and +b values, and the United States Department of Agriculture color grade code number.

9. Significance and Use

9.1 Color is the primary factor of the color grade of cotton. Since cotton is graded by visual judgment, an instrument that measures color in terms that are highly correlated with visual judgement is a decided asset. Color measurements are even more important for use as an aid in reproducing copies of the official standards for color grade of cotton.

9.2 Color is an element of cotton quality, and raw stock color measurements are useful in controlling the color of manufactured greige, bleached, or dyed yarns and fabrics.

10. Apparatus and Materials

10.1 *Cotton Colorimeter*, HVI Model,[2] with accessories.

10.2 *Calibration Tile Standards*[2]—A set of five working calibration tile standards of designated Rd and + b values.

10.3 *Cotton Color Check Standards*[2].

11. Preparation of Apparatus

11.1 Allow the instrument to warm up for at least 4 h or until it becomes electronically stable.

11.2 By keyboard entry, select the appropriate routine for calibration from the menu displayed on the monitor.

11.3 Follow the displayed instructions requiring keyboard entry of the Rd and +b values of each calibration tile. As each tile is presented to the instrument, the programmed microprocessor will cause electronic circuitry to be automatically adjusted for agreement of displayed values with the designated values of the tiles.

11.4 Perform measurements of the color check standards of cotton to verify calibration.

11.5 If unacceptable results are obtained from the measurement of the color check standards of cotton, repeat the calibration tile procedure (see 11.3) until acceptable results are obtained.

12. Test Specimens

12.1 Test two specimens, one from each side of the laboratory sample.

12.2 Select a smooth surface of the laboratory sample that is judged to be representative for color as the test specimen. The surface of the sample should be large enough to completely cover the instrument's viewing window and thick enough to be opaque (no light transmitted through the sample). From experience, a thickness of 50 cm (2 in.) or more has been found acceptable.

NOTE 5—Laboratory samples usually consist of samples cut from sides of bales or taken by an automatic sampling device. Such samples come in layers, and different surfaces can be observed easily by opening the samples in a manner similar to turning pages in a book. The surface selected should be fairly smooth and free of lumps or folds which many cause dark shadows and produce erroneous results.

13. Procedure

13.1 By keyboard entry, select the appropriate routine for testing cotton from the menu displayed on the monitor.

NOTE 6—The test routines are governed by software programs tailored for individual requirements, such as necessary for sample identification number and other identifier entries, number of tests per sample, choice of units of measure (such as millimetres or inches), selection of test parameters, necessary for statistical summary, need for hard copy printout, forwarding data to compatible external data handling systems and computers, and other parameters.

13.2 Place the surface of the specimen to be measured over the sample window and energize the instrument by pressing the appropriate switch that will cause a plate to apply pressure to the specimen.

13.3 Hold the specimen until the instrument, by display at the visual monitor, advises that the measurement is complete.

13.4 Make one observation on each side of the specimen unless it is obviously nonuniform in color.

13.4.1 If the specimen is nonuniform in color, make additional observations on it at different places in the specimen to obtain a measure of the full range of color.

14. Calculation

14.1 All calculations are performed by the instrument's internal programmed microprocessor.

15. Report

15.1 State that the samples were tested for color as directed in these test methods. Describe the material and the method of sampling used.

15.2 Report the following information:

15.2.1 The number of specimens tested for each sample.

15.2.2 The average Rd value and the average +b value to the nearest 0.1 unit.

15.2.3 The color code of the United States Department of Agriculture cotton color grade diagrams that shows the various color grades of cotton in relationship to the scale of Rd on the vertical axis and the +b on the horizontal axis.

TRASH CONTENT

16. Scope

16.1 This test method describes the measurement of the amount of trash as seen by a video camera focused on the surface of a test specimen of cotton pressed against a glass window.

NOTE 7—For another method describing the measurement of trash or non-lint content of cotton, refer to Test Method D 2812.

16.2 The instrument may be incorporated within the space occupied by and adjacent to the apparatus to measure color of raw cotton (see Sections 7-15), thus permitting simultaneous measurement of color and trash on the same test specimen.

17. Summary of Test Method

17.1 A smooth representative surface of a test specimen of cotton is placed over the colorimeter/trashmeter sample window, the specimen is pressed flat. The trash meter is energized, and test values are read directly from instrument's visual monitor trashmeter.

18. Significance and Use

18.1 Trash content is an element in determining the quality or use value of raw cotton. Trash is the primary factor of the leaf grade of cotton. Since cotton is usually graded by visual judgement, an instrument that measures trash in terms that are highly correlated with visual judgement is a decided asset.

18.2 Trash content is useful for: estimating the net amount of manufactured textile product obtainable from raw cotton, predicting the quality of cotton textile products, particularly their aesthetic properties, assembling and blending values in a mix on a trash content basis, adjusting ginning and textile processing machinery for maximum efficiency in removing trash from cotton, and relating trash content of cotton to processing efficiency and end-product quality.

19. Apparatus and Materials

19.1 *Trashmeter*, HVI model.[2]

19.2 *Calibration Tile Standards*[2]—A set of working calibration tile standards of designated value for use in instrument calibration.

20. Preparation of Apparatus

20.1 Allow the instrument to warm up for at least 1 h or until it becomes electronically stable.

20.2 By keyboard entry, select the appropriate routine for calibration from the menu displayed on the monitor.

20.3 Follow the displayed instructions requiring keyboard entry of the calibration tile values for number of pieces of trash and percent area. The programmed microprocessor will cause electronic circuitry to be automatically adjusted in order that displayed values will agree with designated values of the tiles.

20.4 Perform measurements of the tiles to verify calibration.

21. Test Specimens

21.1 The test specimen is the surface of the laboratory sample that is placed over the sample window.

22. Procedure

22.1 By keyboard entry, select the appropriate routine for testing cotton from the menu display on monitor (see Note 6).

22.2 Place the surface of the specimen to be measured over the sample window and energize the instrument by pressing the appropriate switch that will cause a plate to apply pressure to the specimen.

22.3 Hold the specimen until the instrument, by display at the visual monitor, advises that the measurement is completed.

22.4 Present to the sample window at least four different surface areas of the sample since trash within cotton is not uniformly distributed.

23. Calculation

23.1 Perform all calculations by the instrument's internal programmed microprocessor.

24. Report

24.1 State that the samples were tested for trash as directed in these test methods. Describe the material and the method of sampling used.

24.2 Report the following information:

24.2.1 The number of specimens tested for each sample, and

24.2.2 The average percent area to the nearest 0.1 unit place and the average number of pieces of trash.

MICRONAIRE READING

25. Scope

25.1 This test method describes the determination of the micronaire of loose cotton by measuring the resistance of a plug of cotton to air flow under prescribed conditions. The instrument employs a programmed microprocessor with memory for controlling internal operation and performing required calibration, adjustments, calculations, and data presentation.

NOTE 8—For another method describing the determination of micronaire, refer to Test Method D 1448.

26. Summary of Test Method

26.1 A predetermined mass of loose cotton is placed in the specimen holder and compressed to a fixed volume. The resistance to air flow, using constant pressure compressed air, is measured and the pressure drop across the plug of cotton is expressed as micronaire. The pressure drops associated with micronaire are determined by performing tests on a wide range of cottons having previously established micronaire values.

27. Significance and Use

27.1 The micronaire of cotton fibers is a function of both fineness and maturity and is related to environmental conditions during the growth of cotton, variety of cotton, yarn