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Standard Test Method for Linear Density and Maturity Index of Cotton Fibers (IIC-Shirley Fineness/Maturity Tester)¹

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INTRODUCTION

The porous plug airflow method provides an indirect measure of fiber specific surface, that is, surface area per unit volume, which depends upon the average fiber perimeter and the average fiber maturity. If the perimeter is known, then the airflow measurement or micronaire reading may be related directly to fiber linear density or mass per unit length, which, for a certain perimeter depends upon the maturity. Conversely, if the maturity is known, then the airflow reading may be related to the perimeter. In American Upland cottons (*Gossypium hirsutum* L.) the average fiber perimeter varies only within a narrow range and so the airflow measurement or micronaire reading can be taken as an indication of wall thickness and hence maturity for all practical purposes. Cottons of other types will not necessarily behave in the same manner. For example, American Pima cottons (*Gossypium barbadense* L.) have a substantially smaller perimeter than the Upland types and therefore would give a lower micronaire reading for the same maturity. Asiatic or cross-bred types would show yet other relationships.

In a dual compression airflow instrument a sample can be measured at two different conditions of density. Linear density and maturity index can be derived from the measurements of airflow at the two densities (1, 2, 3, 4).²

1. Scope

1.1 This test method covers the determination of linear density and maturity index of loose randomized cotton fibers by measuring the resistance to air flow of a plug of cotton fibers under two prescribed conditions.

NOTE 1—For other methods for determining linear density and maturity properties of cotton fibers, see Test Methods D 1442, D 1448, D 1769, D 2480, D 3817, British Standards BS 2016, BS 3085, and ISO 2403.

1.2 *This standard does not purport to address all of the safety problems, 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 Textiles³

D 1441 Practice for Sampling Cotton Fibers for Testing³

D 1442 Test Method for Maturity of Cotton Fibers (Sodium Hydroxide Swelling and Polarized Light Procedures)³

D 1448 Test Method for Micronaire Reading of Cotton Fibers³

D 1769 Test Method for Linear Density of Cotton Fibers (Array Sample)⁴

D 1776 Practice for Conditioning Textiles for Testing³

D 2480 Test Method for Maturity Index and Linear Density of Cotton Fibers by the Causticaire Method³

D 3025 Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards³

D 3817 Test Method for Maturity Index of Cotton Fibers By the Fibrograph Method⁵

2.2 British Standards:⁶

BS 2016 Determination of Weight per Unit Length of Textile Fibers

BS 3085 Cotton Fiber Maturity (Estimation by Classification of Fibers Swollen in Sodium Hydroxide Solution)

2.3 ISO Standards:⁷

ISO 1973 Textile Fibers—Determination of Linear Density (Gravimetric Method)

ISO 2403 Textiles—Cotton Fibers (Determination of Micronaire Value)

3. Definitions

3.1 *calibration cotton standards, n*—cotton samples taken

¹ This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.11 on Cotton Fibers. Current edition approved Oct. 15, 1992. Published January 1993. Originally published as D 3818 – 79. Last previous edition D 3818 – 79 (1984)¹.

² The boldface numbers in parentheses refer to the list of references at the end of this test method.

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

⁴ Discontinued—See 1988 *Annual Book of ASTM Standards*, Vol 07.02.

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

⁶ Available from British Standards Institute, 2 Park Street, London, W1A 2BS UNITED KINGDOM.

⁷ Available from ISO, 1 Rue de Varembe, Geneva CH-1211 20 SWITZERLAND.

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from blended bulk source on which fiber properties have been determined under the International Calibration Cotton Standards Program.

3.2 *maturity, cotton, n*—the degree of fiber wall development.

3.3 *maturity index, n*—a relative indication of cotton fiber maturity.

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

4. Summary of Test Method

4.1 Four grams of cleaned, well-opened, randomized cotton fiber are placed in the specimen holder and compressed to a fixed initial volume. Air at a flow rate of 4.0 L/min is drawn through the plug and the initial pressure drop is measured. The sample is then further compressed to a higher density and the subsequent pressure drop is measured at a flow rate of 1.0 L/min.

4.2 The two measured pressure drops are used to derive estimates of linear density and maturity index. Other equations may be used to derive readings correlating with Causticaire maturity index (see Test Method D 2480).

NOTE 2—The equation for maturity index is based on measures of maturity ratio as directed in BS Method 3085. A secondary equation (5, 6) is used to derive percent mature fiber as determined by Test Method D 1442, Procedure 1. The equation for linear density is based on the test for mass per unit length, (see BS Method 2016).

5. Significance and Use

5.1 This test method provides derived measurements for linear density and maturity. Linear density and maturity affect mill processing performance and the quality of the end products. Linear density determines the number of fibers per cross-section for a prescribed yarn number, thereby affecting drafting characteristics, yarn strength, and yarn evenness. Maturity affects processing because immature fibers break easily during processing, have a tendency to form neps, have a tendency to become entangled around particles of trash and leaf thus making cleaning more difficult and increasing the amount of fiber removed with foreign matter, adversely affect yarn and fabric appearance, and may appear differently after dyeing.

5.2 This test method is not yet considered satisfactory for acceptance testing because neither precision nor bias have been established to a sufficient degree. In some cases the purchaser and seller may have to test a commercial shipment of one or more specific materials by an appropriate method even though the method has not been recommended for acceptance testing of commercial shipments. In such a case, if there is a disagreement arising from differences in values reported by the purchaser and seller in using this test method for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the seller should be determined with comparison based on testing specimens randomly drawn from one sample of material of the type being evaluated.

6. Apparatus and Materials

6.1 *IIC-Shirley Fineness/Maturity Tester*, with accessories.⁸

6.2 *Balance*, having a capacity of at least 4 g and a sensitivity of better than 0.005 g.

6.3 *Suitable Preparation Apparatus*:

6.3.1 *TKI-Essdiel Fibreblender*.⁹

6.3.2 *Shirley Analyzer*.⁹

6.3.3 *TKI Trash Selector*.¹⁰

6.3.4 *Shirley Miniature Card*.⁹

NOTE 3—Other preparation apparatus may be suitable if it produces randomly oriented samples. The apparatus described in Recommended Practice D 1441 has not been found suitable because the web is made up of predominantly parallel fibers.

6.4 *Programmable Calculator* (optional).

6.5 *Calibration Cotton Standards*.¹¹

7. Sampling and Selection of Specimens

7.1 Take a lot sample and a laboratory sample as directed in Practice D 1441.

7.2 Blend, clean, and randomize the subsample by using one of the apparatus listed in 6.3.

8. Conditioning

8.1 Condition the samples under standard atmosphere conditions for 4 h before testing.

9. Procedure

9.1 In the standard atmosphere for testing textiles, set up and adjust the instrument as directed in the manufacturer's instructions.

NOTE 4—It is desirable to check the instrument using cottons of known values of maturity and linear density. The calibration cotton standards, (see 3.1) do not have stated values of maturity and linear density. Users are cautioned against relying on published formulae for converting micronaire reading to linear density.

9.2 From the subsample selected and prepared as described in Section 7, weigh out a test specimen having a mass of 4.000 ± 0.005 g.

9.3 With the controls set to "load" and to low compression (P_L), divide the weighed specimen with the fingers into 4 to 6 portions, tease out each portion randomly until about 5 to 7 cm in diameter, and place each portion into the sample holder until the entire specimen is loaded. Carefully insert the first portion so as to fill out the bottom corners of the sample holder by pushing it well into the bottom of the sample holder and outwards to the corners. Take care to insert all the specimen and not to lose any of the fibers. Insert or activate the sample holder top.

9.4 Set the controls to "test" and read the pressure drop at low compression, P_L . Record this value to the nearest 1 mm.

9.5 Set the controls to high compression, P_H , and read the

⁸ Shirley Developments Limited, P. O. Box 6, 856 Wilmslow Road, Didsbury, Manchester, M20 8SA England represented by Crosrol Inc., Box 6488, Greenville, SC 29606.

⁹ Platt Saco Lowell, Holcombe Road, Helmshore, Rossendale, Lancs., England Platt Saco Lowell Corp. Drawer 2327, Greenville, SC 29602.

¹⁰ Textile Research Institute (TKI), 1475 Budapest 10; P.O. Box 6, Hungary.

¹¹ Available from USDA, AMS, Cotton Division, 4841 Summer Avenue, Memphis, TN 38122.