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Standard Test Method for ~~Unevenness~~Evenness of Textile Strands Using Capacitance Testing Equipment[1]

This standard is issued under the fixed designation D1425/D1425M; 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.

~~ε[1] NOTE—Footnotes A and B were added to Table 1 in April 2012.~~

1. Scope

1.1 This test method covers the indirect measurement of evenness (mass variation) of non-conductive textile strands, including top, comber lap, sliver, roving, and yarn produced from staple fibers and continuous filament yarns, by means of capacitance testing equipment.

1.2 Strands made from fiber blends can be tested using this test method only if the different fibers are uniformly distributed throughout the strand.

1.3 The test method provides numeric values for the measurement and evaluation of short-, mid-, and long-term mass variations of the tested strand in terms of frequently occurring faults classified as thin places, thick places, and neps and graphical representations of evenness values in the form of diagram charts, spectrograms, length variation curves, and histograms.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:*[2]

D123 Terminology Relating to Textiles

D1776 Practice for Conditioning and Testing Textiles

D2258 Practice for Sampling Yarn for Testing

D4849 Terminology Related to Yarns and Fibers

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*

~~3.1.1 *electric constant, n—in textile capacitance testing*, the change in the electrical field as measured by the sensors (capacitors) of an evenness instrument when a non-conductive textile strand travels between capacitor plates.~~

[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.

~~3.1.1.1 *Discussion*—~~

~~The dielectric change is measured as the ratio of the amount of stored energy between the capacitors without a strand and during the movement of a strand through the sensor zone and is in direct proportion to the mass variation that is output to a diagram chart.~~

3.1.1 The following terms are relevant to this standard: electric constant; evenness; imperfections; length between, L_b; length capacitance zone, L_c; mass variation; mean deviation of evenness, U%; sample length L_s; strand; strand irregularity; and total imperfections.

~~3.1.2 *evenness, CV% (or U%), n— in textiles*, the coefficient of mass variation derived from the standard deviation of the mass variation of a specified strand length (L_s) over the mass variation (formerly known as unevenness).~~

~~3.1.2.1 *Discussion—*~~

~~For strands with normal mass variation distribution, the relationship between CV% and U% is U% is multiplied by 1.25. Although both CV% and U% are used as values of evenness, CV% is considered more accurate CV% is gradually replacing U% as the only calculated measurement of evenness.~~

~~3.1.3 *imperfections, n—in textile evenness testing*, the individual number of thick places, thin places, and neps of a sample strand length measured by a capacitive evenness tester at selected sensitivity settings.~~

~~3.1.4 *length between, L_b,, n—in textile evenness testing*, the length of strand segments weighed to determine evenness for the direct method (cut & weigh) of measuring evenness.~~

~~3.1.5 *length capacitance zone, L_c, n—*, the width of the measurement field of the capacitive sensor.~~

~~3.1.5.1 *Discussion—*~~

~~The capacitive sensor measurement field determines the length between the indirect method of evenness testing. The Lc is the length of strand being measured between the sensing elements at any moment. L_c is analogous to L_b of the direct method.~~

~~3.1.6 *mass variation, n—in textile evenness testing*, the changes of the cross sectional mass along the length of a continuous strand or of a portion of a strand.~~

~~3.1.7 *mean deviation of evenness U%, n—in textiles*, the average of the absolute values of the deviations of the linear densities of the integrated lengths between which evenness is measured and expressed as a percentage of the average mass variation for the total sample length over which evenness is measured.~~

~~3.1.8 *sample length, L_s, n—in textile evenness testing*, the length determined by multiplying the test instrument's speed and the time of the test run.~~

~~3.1.8.1 *Discussion—*~~

~~The total length of the strand from which the segments are weighed determines sample length by the direct method, e.g. the variation in segments weight. For the indirect method for measuring evenness, the sample length L, is the variation of the segment with respect to the average mass.~~

~~3.1.9 *strand, n—*(1) monofilament or multifilament yarns; (2) an ordered assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit, including sliver, roving, single yarns, plied yarns, cords, braids, and ropes.~~

~~3.1.10 *strand irregularity, n—in textiles*, the variation in a property along a strand.~~

~~3.1.11 *total imperfections, n—in textile evenness testing*, an evenness value that is the cumulative number thicks, thins, and neps from a tested strand, strands from a sample, or lot sample.~~

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

4. Basic Principles of Test Method

4.1 Properties of strand irregularity measured along its length are measured in terms of mass variation.

4.2 The direct method of evenness testing utilizes the technique of cutting and weighing strand segments of length L_b and is the reference method of determining evenness (mass variation). Utilization of the capacitance measurement technique is an indirect testing method. The accuracy of an indirect method of testing can be judged by a comparison of evenness values between it and the direct method (cutting and weighing).

4.3 In capacitance testing, a high frequency electric field is generated in the space between a pair of capacitor plates (measuring slots). If the mass of a strand moving between the plates changes, the electrical field between the plates changes accordingly, and results in electrical signal output variation proportional to the mass variation of the strand.

4.4 Evenness is always expressed as variation between successive lengths L and over a total length Ls. When the L_c evenness is measured, it corresponds to the length capacitance zone width, i.e., 8 mm ~~(0.3 in)~~[0.3 in.] for yarns, 12 mm ~~(0.5 in)~~[0.5 in.] for rovings and fine slivers, and 20 mm ~~(0.8 in)~~[0.8 in.] for slivers that are referred to as short-term evenness. Longer-term evenness may also be evaluated by electronically increasing the L_c.

5. Summary of Test Method

5.1 A textile strand is passed through a length capacitance zone of an evenness tester at a constant speed. The mass variation of successive L_c interval lengths is measured and from which other values of evenness are derived: coefficient of variation, short-, mid- and long-term variations, and imperfections.

6. Significance and Use

6.1 This test method for the determination of evenness of textile strands is used extensively for acceptance testing of commercial shipments of filament or spun staple yarn, comber laps, roving, sliver, or tops. ~~6.2 6.3 6.4 6.5 Evenness values obtained on different instruments will be comparable for strands from the same sample provided the following parameters are the same in all cases: (1) the measure of evenness used; (2) the capacitive length zone L (see 3.1.5 and 3.1.5.1); (3) the sample length, Ls (see 3.1.8); (4) instrument test speed, (5) laboratory temperature and humidity conditions (see 12.1 and 12.1.1); and (6) test specimen variation. When different models of an instrument are used, and one or more of the six parameters are not identical, test results may differ.~~

6.2 Values of strand evenness are also used in quality control, process optimization, and together with yarn strength measurements, ~~is~~as the first appraisal of a strand's quality. A low evenness value is, in general, preferred. Higher evenness values generally indicate ~~difficult spinning,~~ poor yarn manufacturing practices, lower yarn strength, and poorer fabric appearance. Experience has shown that the relationship of evenness to the prediction of yarn performance and to fabric appearance is not a simple one. An evenness value must, therefore, be used cautiously and be supplemented by additional evenness information, such as mid-term and long-term mass variations, thin, thick, and nep imperfection counts, diagram chart spectrogram chart, length variation curve, and histogram analyses.

6.3 Continuous filament yarns should be tested for mass variation on ~~instruments~~ evenness testers that are specifically designed to ~~them.;~~ test this yarn type; failure to do so will result in inaccurate test results. Further, low-twist, continuous filament yarns tend to flatten to a ribbon configuration while passing through the ~~condenser~~sensor of a capacitance instrument. ~~These specific instruments are designed to insert false twist in the condenser~~ This flattening effect will cause false mass variation measurements by the capacitive sensor (commonly referred to as shape effect). Evenness testers that are specifically designed to test continuous filament yarns insert a false twist to the yarn strand during testing to overcome the flattening effect and ~~may result in false variation readings.~~thus ensure accurate mass variation measurements.

6.4 Strands made from fiber blends should be tested only if the different fibers are uniformly distributed throughout the strand. Non-uniform blending may cause a higher reading of mass variation than the true value if the component fibers differ in dielectric ~~constant (see 3.1.1 and 3.1.1.1).~~constant.

6.5 Evenness values obtained on different instruments will be comparable for strands from the same sample provided the following parameters are the same in all cases: (1) the measure of evenness ~~used;~~ used (CV% or U%); (2) the capacitive length zone L_c ~~(see 3.1.5 and 3.1.5.1);~~ ; (3) the sample length, *Ls* ~~(see 3.1.8);~~ ; (4) instrument test speed, (5) laboratory temperature and humidity conditions (see 10.1~~12.1~~); and ~~12.1.1); and~~ (6) test specimen preparation, and (7) test specimen variation. When different models of an instrument are used, and one or more of the ~~six~~seven parameters are not identical, test results may differ.

6.6 If there are any differences of practical significance between reported test results for two (or more) laboratories, comparative ~~test~~tests should be performed using ~~competent statistical assistance and~~ an agreed upon number of samples that are homogeneous and randomly ~~assigned,~~ assigned. Competent statistical assistance should be used to determine if there is a statistically significant difference between ~~them.~~ the laboratories. If a bias is found, either its cause must be found and corrected, or future testing for that material must be adjusted in consideration of the statistically significant differences found.

7. Apparatus

7.1 *Capacitance-Type ~~Unevenness~~Evenness Testing Instruments*—A textile strand evenness tester that utilizes the electronic capacitance measuring principle.

7.1.1 Differences between older and newer capacitance testers for calibration, recording devices, test settings, and data output can be found in the manufacturer's instruction manual for specific models.

7.2 *Package holders, guides, tension devices, unwinding, and take-up mechanisms*——Devices and attachments to evenness testing instruments that aid in the uniform delivery of the strand at specified speed, without undue acceleration or deceleration, at a reasonably constant tension. These devices are especially critical for loose textile strands such as sliver, roving, and comber laps

7.3 *Recording device*—Printer or computer-generated files from which numeric and graphic test data can be produced.

7.4 *Twist insertion device*—A mechanism ~~in the condenser zone of an evenness testing instrument that inserts false twist into continuous filament yarns~~that inserts false twist into continuous filament yarns. This mechanism is used only on evenness testers that are designed to test continuous filament yarns.

8. Sampling

8.1 Unless otherwise agreed upon, as when specified in an applicable material specification, take a lot sample and laboratory sample as directed in Practice D2258.

8.2 Typical spun yarn sample lots are ten or twenty ~~packages. Unless otherwise agreed upon, as when specified in an applicable material specification, take a lot sample and laboratory sample as directed in.~~packages, unless otherwise agreed upon.

9. Number of Specimens

9.1 Conduct a test on ~~one strand from~~ each yarn package or bobbin in the sample lot. Refer to 11.1, Table 1 for the recommended test length. If required, multiple tests on successive test lengths can be performed on each package or bobbin.

9.2 ~~Test three strands from silver, roving, comber laps or tops or the recommended number of equipment manufacturer.~~ Conduct a test on each sample of sliver, roving, comber lap, top or the number of test recommended by the equipment manufacturer. Refer to 11.1, Table 1 for the recommended test length. If required, multiple tests on successive test lengths can be performed on each sample.

10. Conditioning

10.1 Condition strands according to Practice D1776. Preconditioning is not required unless in the case of dispute.

10.2 For yarn, the time required for conditioning depends on the fiber, the size of the package and the compactness of the yarn wound on the package. Further, a shorter conditioning time may be sufficient if only the outside layer of a yarn package is to be tested than if the whole package is to be tested. As a general guide, condition ~~tightly wound~~ bobbins for 24 h and yarn packages for 48 h. Other strands such as sliver, roving, and laps ~~may~~do not require conditioning and can be tested as soon as they are brought into the laboratory.

10.3 If the standard atmosphere described in Practice D1776 is not available, condition the strand in a stable atmosphere in which the test is to be performed until it has reached equilibrium. Record the conditions under which the test was performed.

10.4 Test results may not be comparable if conditioned and tested in different atmospheres.

11. Selection of Testing Parameters

11.1 *Measure of ~~Unevenness~~—Evenness—*Recommended evaluation test times and strand speeds are listed in Table 1.

11.1.1 The selection of test speeds is important to avoid stretching strands during the test length and is specific to the type of strand and the model of capacitance tester used. Yarns can normally be tested at higher speeds than yarn intermediates such as sliver or roving. In general, the testing speed setting for sliver and tops is 25 m/min ~~(25 yd/min).~~[25 yd/min]. Higher rates can be used if the test instrument is equipped with a powered unwinding device or if the material does not exhibit any additional mass variation caused by stretching at the selected speed. The testing speed rate setting for roving is 50 m/min ~~(50 yd/min) and for yarns~~

TABLE 1 Recommended Strand Speeds and Evaluating Times

Material	Strand Speed	Evaluating Time
~~Top or sliver~~	~~4 m/min (4 yd/min)~~	~~5 or 10 min~~
~~Sliver or roving~~	~~8 m/min (8 yd/min)~~	~~5 or 10 min~~
~~Sliver or roving~~	~~25 m/min (25 yd/min)~~	~~5 or 10 min~~
~~Sliver~~	~~50, 100 m/min (50, 100yd/min)~~[A]	~~1 or 2.5 min~~
~~Roving~~	~~50, 100, 200 m/min (50, 100, 200yd/min)~~	~~2.5 or 5 min~~
~~Yarn~~	~~400, 800~~[B] ~~m/min (400, 800 yd/min)~~	~~0.5 ,1.0, 1.25 or 2.5 min~~
~~Filament Yarns~~	~~400 or 800 m/min (400 or 800 yd/min)~~	~~2.5 min~~

TABLE 1 Recommended Strand Speeds and Evaluating Times

Material	Strand Speed	Evaluating Time
Top or sliver	4 m/min [4 yd/min]	5 or 10 min
Sliver or roving	8 m/min [8 yd/min]	5 or 10 min
Sliver or roving	25 m/min [25 yd/min]	5 or 10 min
Sliver	50, 100 m/min [50, 100yd/min][A]	1 or 2.5 min
Roving	50, 100, 200 m/min [50, 100, 200yd/min]	2.5 or 5 min
Yarn	400, 800[B] m/min [400, 800 yd/min]	0.5 ,1.0, 1.25 or 2.5 min
Filament Yarns	100, 200, 400 or 800 m/min [100, 200, 400 or 800 yd/min]	2.5 min

[A] This speed may be used if the sliver specimen is not stretched or if a powered unwinding apparatus is used.
[B] The 800 m/min or yd/min testing speed is not available on all instruments.