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Standard Test Method for Yarn Number and Yarn Number Variability Using Automated Tester[1]

This standard is issued under the fixed designation D6612; 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 covers the measurement of yarn number up to 4000 dtex (3600 denier) and related variability properties of filament and spun yarns using an automated tester with capability for measuring mass variability characteristics.

1.2 Yarn number variability properties include percent density spread (%DS), coefficient of variation (%CV), density frequency variation.

NOTE 1—For determination of yarn number by use of reel and balance, refer to Test Method D1907. For another method of measuring variability (unevenness) in yarn, refer to Test Method D1425.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the inch-pound units are in parentheses. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in inaccuracies of results.

1.4 *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

D1425 Test Method for Unevenness of Textile Strands Using Capacitance Testing Equipment

D1776 Practice for Conditioning and Testing Textiles

D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method

D2258 Practice for Sampling Yarn for Testing

D4849 Terminology Related to Yarns and Fibers

3. Terminology

3.1 For all terminology relating to D13.58, Yarns and Fibers, refer to Terminology D4849.

3.1.1 The following terms are relevant to this standard: cotton count, coefficient of variation, denier, linear density, tex, yarn number, yarn numbering system, bad/good test, density frequency variability, density spread.

3.2 For all other textile terms used in this test method, see Terminology D123.

4. Summary of Test Method

4.1 A specified length of yarn (specimen) is stripped automatically directly from the package, cut, and weighed. The yarn number is calculated by interfaced computer, displayed on a monitor, and may be printed. The yarn number can be reported in tex, denier, or cotton count units.

4.2 Simultaneously, by means of a capacitance cell, the mass of the specimen is measured in subsections and frequency of mass value crossovers are counted for calculation of variability properties: %DS, %CV, %BGT and %DFV.

5. Significance and Use

5.1 Test Method D6612 for yarn number and yarn number variability is satisfactory for acceptance of commercial shipments and is used in the trade.

5.1.1 If there are differences of practical significance between the 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, samples used for each comparative tests should be as homogeneous as possible, drawn from the same lot of material as the samples that results in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. Other fabrics with established tests values are used for this purpose. The test results from the laboratories involved should be compared appropriate statistical analysis and 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

[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.

found, either its cause must be found and corrected, or future test results adjusted in consideration of the known bias.

5.1.2 The average results from the two laboratories should be compared using appropriate statistical analysis and a probability level chosen by the two parties before the 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 with consideration to the known bias.

5.2 Test Method D6612 also is used for the quality control of filament yarns.

5.3 *Indices of Variability:*

5.3.1 *Coefficient of Variation*—%CV is a standard statistical calculation and is the most common index of yarn unevenness. For most textile applications in the 80–330 dtex (70–300 denier) range, a 1.0–1.3 %CV is adequate. %CV of yarns coarser than 666 dtex (600 denier) is not routine and usually not meaningful. %CV is less discriminating that %DS.

5.3.2 *Bad/Good Test*—%BGT, which will normally be up to 20 % greater than %DS value, emphasizes the greatest spread in the entire length tested, (%DS is an average). If the value is greater than 50 % of the %DS, it suggests that there is a process that needs to be investigated.

5.3.3 *Density Spread*—%DS is equivalent to the Uster % unevenness (Test Method D1425) and is an indication of short-term variability. Yarns with extreme values are more likely to cause trouble in subsequent yarn processes, which makes this perhaps the most useful index. The minimum achievable and maximum tolerance spread for a yarn product will depend on the yarn manufacturing process and end use. A spread of 3–4 % generally is, for most textile applications, in the range of 160–550 dtex (150 to 500 deniers). More critical applications, such as those using finer yarns, may require lower values.

5.3.4 *Density Frequency Variability*—DFV is an index of spacing variability, whereas the others are indices of magnitude or unevenness. Frequency variability can induce resonance in high-speed processing and is a common source of barre, dye streaks, or patterned unevenness in fabrics.

6. Apparatus

6.1 *Automatic Yarn Numbering Instrument (ACW),* (automatic-cut-and-weigh) ACW with interfaced computer (see Fig. 1)

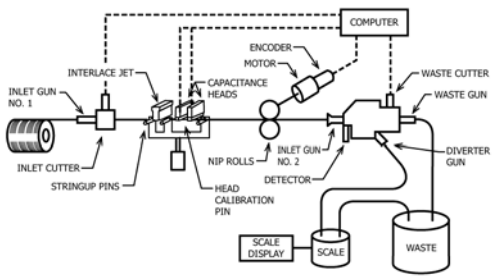

FIG. 1 ACW/DVA (Automatic-Cut-and Weigh with Density Variability Accessory) Tester

6.2 *Density Variability Accessory (DVA),*[3] with yarn number ranges:

6.2.1 *Low (9.7-mm slit),* up to 30 dtex (up to 27 denier).

6.2.2 *Medium (1.2-mm slit),* 31–239 dtex (25–215 denier).

6.2.3 *High (2.2-mm slit),* 240–1333 dtex (216–1200 denier).

6.2.4 *Ultra-High (3.2-mm slit),* 1334–4000 dtex (1201–3600 denier).

6.3 *Calibration Weights,* 2-g and others as needed to cover the tex (denier) ranges of interest.

7. Sampling

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping units directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D2258. Consider shipping cases or other shipping units to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping units, between packages or ends within a shipping unit, and between specimens from a single package to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping unit in the lot sample the number of packages directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D2258. Preferably, the same number of packages should be taken from each shipping unit in the lot sample. If differing numbers of packages are to be taken from shipping units in the lot sample, determine at random, which shipping units are to have each number of packages drawn.

7.3 *Test Specimen*—Test one specimen from each package of filament yarn and five specimens from each package of spun yarns. A 240-m specimen is needed for variability parameters. see Table X1.1 for the lengths of yarn for yarn number specimen lengths.

8. Conditioning

8.1 Condition the packages in the standard atmosphere for testing textiles, which is 21 ± 1° (70 ± 2°F) and 65 ± 2 % relative humidity, for not less than 4 h, see Practice D1776.

9. Preparation and Calibration of Apparatus

9.1 Set up the tester as prescribed in Appendix X1.

10. Procedure

10.1 Check each package for cleanliness, overthrown ends and any package formation, which might interfere with the free running of the yarn from the package.

10.2 String up the yarn, input sample and specimen information, and test the specimen as directed in the manufacturer's manual. The tester is automatically controlled. See the appendix for default operation condition values.

10.3 The computer software calculates the yarn number and compares this value to the capacitance head estimate of the

yarn number. If the two agree within specified limits, the system proceeds, otherwise the test is aborted.

11. Calculation

11.1 *Yarn Number:*

11.1.1 The calculation for the yarn number as dtex or denier is based on Eq 1.

$$N = K \times M/L \quad (1)$$

where:

N = yarn number in direct system, dtex (denier),
K = constant depending on numbering system, 10 000 (9000),
M = mass of specimen, g, and
L = length of specimen, m.

11.1.2 The calculation for cotton count N is based on Eq 2, Eq 3, or Eq 4:

$$N = K \times L/M \quad (2)$$

$$N = 5905.41/T \quad (3)$$

$$N = 5314.87/D \quad (4)$$

where:

N = cotton count,
K = constant for cotton 0.590541,
L = length of specimen, m,
M = mass of specimen, g,
T = linear density, dtex, and
D = linear density, denier.

NOTE 3—The tester computer automatically averages the five tests from a package of spun yarn and only reports this average for the package.

11.1.3 Calculate the average yarn number for each laboratory-sampling. unit and for the lot.

11.2 *Density Spread (%DS):*

11.2.1 The calculation for %DS for each specimen is based on Eq 5.

$$DS = (\mathrm{H} - \mathrm{L})/8\mathrm{A} \quad (5)$$

where:

DS = Density spread, *%DS*,
H = Highest value for yarn number for the 30-m segment,
L = Lowest value for yarn number for the 30-m segment, and
A = reference yarn number obtained by the DVA.

11.2.2 Calculate the *%DS* value for the lot.

11.3 *Coefficient of Variation (TCV):*

11.3.1 The %CV for each specimen is calculated by the computer for all the variability observations taken.

11.3.2 Calculate the %CV for the lot.

11.4 *Bad/Good Test (%BGT):*

11.4.1 The BGT is calculated by the computer as the difference between the maximum and minimum readings for the total specimen divided by the average yarn number for the specimen and expressed as a percent.

11.4.2 Calculate the %BGT for the lot.

11.5 *Density Frequency Variation:*

11.5.1 The DFV is determined by the computer as the average number of crossovers of the analog signal not using the first 50 m.

11.5.2 Calculate the DFV for the lot.

12. Report

12.1 State the yarn was tested as directed in Test Method D6612. Describe the material or product sampled and the method of sampling.

12.2 Report the following information:

12.2.1 The yarn number for each specimen and for the lot,

12.2.2 The %BGT, %CV, %DS, and DFV for each specimen, and

12.2.3 Any modification in the test method.

13. Precision and Bias

13.1 *Precision*—An interlaboratory test is in process; analysis for a precision and bias statement will be provided as soon as possible.

13.2 *Bias*—The values for yarn number and yarn number variability properties can be defined only in terms of a test method. Within this limitation, Test Method D6612 has no known bias.

14. Keywords

14.1 linear density; variability, yarn; yarn; yarn number

APPENDIX

(Nonmandatory Information)

X1. ACW AUTOMATED TESTER WITH DVA

X1.1 *Preparation and Calibration of Apparatus*:

X1.1.1 Turn on the motor and allow the ACW/DVA tester to warm up for at least 30 min before calibrating the scale.

X1.1.2 Enter the computer command <F2> to automatically calibrate both the DVA unit and the scale, and zero the scale.

X1.1.3 To eliminate errors due to long-term drift, set the tester to automatically tare the balance after each set of 20 tests.

X1.1.4 Make other periodic checks and inspections of the tester as noted in the manufacturer's manual.

X1.1.5 Set the tester for operation in Mode 2 with the Model ACW, T, and DVA.

X1.1.6 Computer commands and prompts, error messages, diagnostic test commands, and trouble shooting information are given in the manufacturer's manual.

X1.2 Default specimen lengths for the different yarn number ranges are shown in Table X1.1.

X1.3 Default operation parameters for the DVA are shown in Table X1.2.

X1.4 *Values Obtained by the Computer During the Test for Use in Calculations*:

TABLE X1.1 Specimen Lengths

Yarn Number Range		Yarn Number *N*	Specimen Length
dtex	denier		m
< 22	< 20	. . .	240
22–564	20–510	≥10.4	90
565–1333		511–1200	10.4 9

TABLE X1.2 DVA Default Parameters

Parameter	Values
Specimen length for observations	Every 0.5 m for the four variables
Segment length for observations	30 m
Number of segments	8

X1.4.1 For %BGT, the tester determines the highest and lowest mass among the 480 measurements made.

X1.4.2 For %CV, the tester makes 480 measurements of mass, one every 0.5 m.

X1.4.3 For DFV, after measuring the mean mass of the first 50 m as a reference, the tester counts the number of times the measured mass crosses over the average mass line from higher-to-lower and lower-to-higher in the next 190 m.

X1.4.4 For %DS, the specimen is mathematically divided into eight subsections of 30 m each and the maximum and minimum mass values within each subsection determined.