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Standard Test Method for Thickness of Nonwoven Fabrics[1]

This standard is issued under the fixed designation D 5729; 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—Section 6.1.2 was corrected editorially in September 2006.

1. Scope

1.1 This test method covers the measurement of the thickness of most nonwoven fabrics.

1.2 This test method applies to most nonwoven fabrics that are treated or untreated, including those heavily sized, coated or resin-treated.

1.3 This test method may not be useful for highloft nonwoven fabrics. For thickness of highloft nonwoven fabric see Test Method D 5736.

1.4 The values stated in SI units are to be regarded as the standard. The U.S. customary units (inch-pound) may be approximate.

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]

D 123 Terminology Relating to Textiles

D 1776 Practice for Conditioning Textiles for Testing

D 5736 Test Method for Thickness of Highloft Nonwoven Fabrics

3. Terminology

3.1 *Definitions:*

3.1.1 *pressure*, *n*—the force or load per unit area.

3.1.1.1 *Discussion*—Pressure may be expressed in any appropriate or specified units, such as Pascals (Pa), Newtons per square meter (N/m2), or pounds-force per square inch (psi).

3.1.2 *thickness*, *n*—the distance between one surface and its opposite.

3.1.2.1 *Discussion—In textiles*, the distance between the upper and lower surfaces of the material, measured under a specified pressure. Thickness is usually determined as the distance between an anvil, or base, and a presser foot used to apply the specified pressure.

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

4. Summary of Test Method

4.1 The thickness of a textile material is determined by observing the linear distance that a movable plane is displaced from a parallel surface by the specimen while under a specified pressure.

5. Significance and Use

5.1 This test method is used in the trade for acceptance testing of commercial shipments of nonwoven fabrics; however, caution is advised since information about between-laboratory precision is incomplete. Comparative tests as directed in 5.1.1 may be advisable.

5.1.1 In case of a dispute arising from differences in reported test results when using this test method 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. Test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using the appropriate Student's t-test and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either is 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 Thickness is one of the basic physical properties of nonwoven fabrics. In certain industrial applications, the thickness may require rigid control within specified limits. Bulk and warmth properties of nonwoven fabrics are often estimated from their thickness values, and thickness is also useful in

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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.

measuring performance characteristics, such as, before and after abrasion and shrinkage.

5.3 The thickness values of most nonwoven fabrics will vary considerably depending on the pressure applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness varies inversely with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness value.

6. Apparatus

6.1 *Thickness Testing Gage*—of the dead-weight, calibrated spring force, or string gage type and having dimensions and capabilities specified below, unless otherwise agreed upon between the purchaser and the supplier.

6.1.1 *Presser foot*, circular presser foot 25.40 ± 0.02 mm (1.000 ± 0.001 in.) diameter.

6.1.2 *Anvil*, 38 mm (1.5 in.) diameter or greater.

6.1.3 *Anvil/Presser Foot Parallelism*, 0.01 mm (0.0005 in.).

6.1.4 *Foot Surface Parallelism*, 0.002 mm (0.0001 in.).

6.1.5 *Applied Force*, 4.14 ± 0.21 kPa (0.60 ± 0.03 psi).

6.1.6 *Readability*, 0.02 mm (0.001 in.).

6.1.7 *Automatic*, microprocessor data gathering systems, optional.

6.2 *Cutting Dies*—Dies to cut specimens having linear dimensions at least 20 % greater than the presser foot to be used in measuring the thickness, optional.

7. Sampling and Test Specimens

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls, or pieces, of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the rolls, or pieces, of fabric to be the primary sampling units. In the absence of such an agreement, take the number of fabric rolls specified in Table 1.

NOTE 1—An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls or pieces of fabric and between specimens from a swatch from a roll or pieces of fabric to provide a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—For the laboratory sample, take a swatch extending the width of the fabric and approximately 1 m (1 yd) along the machine direction from each roll, or piece, in the lot sample. For rolls of fabric, take a sample that will exclude fabric from the outer wrap of the roll or the inner wrap around the core.

7.3 *Test Specimens*—From each laboratory sampling unit, take ten specimens. Use the cutting die or template described in 6.2. It is permissible to make the thickness tests of a nonwoven fabric without cutting providing it can be maintained in a plane parallel to the presser foot and anvil while making measurements.

7.3.1 *Cutting Test Specimens*—When cutting specimens, cut having linear dimensions at least 20 % greater in size than the presser foot to be used. Label to maintain specimen identity.

7.3.1.1 Cut specimens representing a broad distribution within the laboratory sampling units and no nearer the edge than one-tenth its width. Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, etc. on the specimens when handling.

TABLE 1 Number of Rolls, or pieces, of Fabric in the Lot Sample

Number of Rolls, Pieces in Lot, Inclusive	Number of Rolls or Pieces in Lot, Sample
1 to 3	all
4 to 24	4
25 to 50	5
over 50	10 % to a max. of 10 rolls or pieces

8. Conditioning

8.1 *Condition 1, Unspecified Testing Conditioning*:

8.2 No conditioning is required unless otherwise specified in a material specification or contract order.

8.3 *Condition 2, Standard Testing Conditioning*:

8.3.1 When specified, precondition the specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning textiles as directed in Practice D 1776.

8.3.2 After preconditioning, bring the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D 1776 or, if applicable, in the specified atmosphere in which the testing is to be performed.

9. Procedure

9.1 Test the specimens in the environment as directed in an applicable material specification or contract order.

9.2 Verify calibration of the thickness gage as directed in the manufacturer's instructions.

9.3 When using microprocessor automatic data gathering systems, set the appropriate parameters as defined in the manufacturer's instructions.

9.4 Handle the test specimens carefully to avoid altering the natural state of the material. Place the specimen on the anvil of the test apparatus and bring the presser foot into contact with the opposite side of the material (often referred to as the "face").

9.5 Gradually increase the pressure to the specified level allowing approximately 5 s to apply the full pressure. Release the platen and record the thickness value to the nearest 0.02 mm (0.001 in.) 5 to 6 s after the full pressure has been applied.

NOTE 2—For most unwoven materials, 5 s after the full pressure is applied will represent a stable condition.

9.6 Continue as directed in 9.4–9.5 until ten specimens have been tested from each laboratory sample.

10. Calculation

10.1 *Thickness Average*—Calculate the average thickness for each the laboratory sample and the lot.

10.2 *Standard Deviation*, Coefficient of Variation-Calculate when requested.

10.3 *Computer Processed Data*—When data are automatically computer processed, calculations are generally contained in the associated software. Record values as read from the direct reading scale to the nearest 0.02 mm (0.001 in.) unless

otherwise specified. In any event, it is recommended that computer processed data be verified against known property values and its software described in the report.

11. Report

11.1 Report that the thickness was determined as directed in Test Method D 5729. Describe the material or product sampled and the method of sampling used.

11.2 Report the following information for both the laboratory sampling unit and the lot as applicable to a material specification or contract order.

11.2.1 Thickness.

11.2.2 When calculated, the standard deviation or the coefficient of variation.

11.2.3 For computer processed data, identify the program (software) used.

11.2.4 Any modification of the test method.

12. Precision and Bias

12.1 *Summary*—Preliminary interlaboratory test data have shown that the variance in testing thickness of nonwoven fabrics by this test method is dependent upon the nominal thickness and the manufacturing method of the material under evaluation; therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages of five observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal thickness as indicated:

Nominal Thickness (inches) (critical differences) Manufacturing Method	Thickness (inches) (critical differences)
0.005 (Resin Bonded)	0.0007
0.007 (Wet Laid)	0.0004
0.008 (Meltblown)	0.0006
0.008 (Thermal Bonded)	0.0010
0.014 (Hydroentangled)	0.0009
0.016 (Spunbonded)	0.0017
0.074 (Dry Laid)	0.0063
0.117 (Needlepunched)	0.0154

Larger differences are likely to occur under all other circumstances. This procedure for determining thickness has no other known bias and is considered a referee method.

12.2 *Interlaboratory Test Data*—A preliminary interlaboratory test was run in 1992 in which randomly drawn samples of eight materials were tested in each of five laboratories utilizing the "dry" conditions. Two operators in each laboratory tested five specimens of each material. The eight materials used in this evaluation were all manufactured by different processes. The pressure on the presser foot was varied according to the classification of the material under evaluation in accordance with the following:

Manufacturing Method	Classification	Presser Foot Pressure (psi)
Resin Bonded	Soft	0.1
Wet Laid	Firm	3.0
Meltblown	Soft	0.1
Thermal Bonded	Soft	0.1
Hydroentangled	Moderate	1.0
Spunbonded	Firm	3.0
Dry Laid	Moderate	1.0
Needlepunched	Moderate	1.0

Analysis of the data using the adjunct to D2904 suggested reporting the components of variance and least critical differences for each material. The components of variance, expressed as standard deviations, for material evaluated are listed in Table 2 (see Note 3). Further testing is in progress to elucidate the ruggedness of this test method, including the effect of presser foot dimensions and pressure during testing.

12.3 *Precision*—For the components of variance listed in Table 2, the averages of two observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 3 (see Note 4). Due to the dependence of the components of variance on the manufacturing process no meangingful statement can be made at this time relative to between material comparisons.

12.4 *Bias*—The procedure in Test Method D 5729 for determining the thickness of nonwoven fabrics has not been checked against accepted reference materials but contains no known bias other than those noted. This test method is accepted as a referee method.

NOTE 3—The square roots of the components of variance are listed in Table 1 so that the variability is expressed in the appropriate units of measure rather than as the square of those units of measure.

NOTE 4—The values of the tabulated differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as homogeneous as possible, and then randomly assigned in equal numbers to each of the laboratories.

13. Keywords

13.1 nonwoven fabric; thickness

TABLE 2 Components of Variance as Standard Deviations (Thickness in inches)

Nominal Thickness-Manufacturing Method	Single Operator Component	Within Laboratory Component	Between Laboratory Component
0.005 (Resin Bonded)	0.0006	0.0007	0.0007
0.007 (Wet Laid)	0.0004	0.0002	0.0006
0.008 (Meltblown)	0.0005	0.0011	0.0004
0.008 (Thermal Bonded)	0.0008	0.0006	0.0014
0.014 (Hydroentangled)	0.0007	0.0006	0.0016
0.016 (Spunbonded)	0.0014	0.0006	0.0000
0.074 (Dry Laid)	0.0051	0.0000	0.0126
0.117 (Needlepunched)	0.0124	0.0054	0.0113

TABLE 3 Critical Differences for Conditions Noted 95 % Probability Level (Tearing Strength expressed as pounds force)

Nominal Thickness-Mfg. Method	Observations in Each Average	Single Operator Precision	Within Laboratory Precision	Between Laboratory Precision
0.005 (Resin Bonded)	5	0.0007	0.0020	0.0029
	10	0.0005	0.0019	0.0028
0.007 (Wet Laid)	5	0.0004	0.0007	0.0017
	10	0.0003	0.0006	0.0017
0.008 (Meltblown)	5	0.0006	0.0032	0.0034
	10	0.0004	0.0032	0.0034
0.008 (Thermal Bonded)	5	0.0010	0.0018	0.0043
	10	0.0007	0.0017	0.0042
0.014 (Hydroentangled)	5	0.0009	0.0020	0.0058
	10	0.0006	0.0019	0.0058
0.016 (Spunbonded)	5	0.0017	0.0023	0.0023
	10	0.0012	0.0020	0.0020
0.074 (Dry Laid)	5	0.0063	0.0063	0.0354
	10	0.0045	0.0045	0.0351
0.117 (Needlepunched)	5	0.0154	0.0215	0.0381
	10	0.0109	0.0186	0.0365