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Standard Test Method for Thickness of Highloft Nonwoven Fabrics[1]

This standard is issued under the fixed designation D 5736; 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 describes the measurement of thickness of highloft nonwoven fabrics. For thickness of nonwoven fabrics other than highloft, see Test Method D 5729.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses may be approximate.

1.3 *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[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 1777 Test Method for Measuring Thickness of Textile Materials[2]

D 2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data[3]

D 5729 Test Method for Thickness of Nonwoven Fabrics[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *highloft nonwoven fabric*, *n*—a low-density fiber network structure characterized by a high ratio of thickness to mass per unit area. (Syn. highloft).

3.1.2 *nonwoven fabric*, *n*—a textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means, or combination thereof.

3.1.3 *pressure*, *n*—the force per unit area.

3.1.3.1 *Discussion*—Pressure may be expressed in any appropriate or specified units, such as pascals (Pa), newtons per square metre (N/m^2), or pound-force per square inch (psi).

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

3.1.4.1 *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.

3.1.5 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 highloft nonwoven fabric 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; however, 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 of nonwoven fabrics, 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 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 Thickness is one of the basic physical properties of highloft nonwoven fabrics. In certain industrial applications, the thickness may require rigid control within specified limits. Bulk and warmth properties of highloft nonwoven fabrics are often estimated from their thickness values, and thickness is also useful in measuring performance characteristics, such as before and after abrasion or shrinkage.

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[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.64 on Nonwoven Fabric.

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

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

5.3 The thickness value of highloft 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*[4]—Having dimensions appropriate to the highloft nonwoven material to be tested and shall permit the gradual application of the specified pressure within ±5 %. The anvil and presser foot shall be plane and parallel within 0.13 mm (0.005 in.) and provided with a scale for indicating the distance between the anvil and the presser foot, having a readability of 0.02 mm (0.001 in.) with an accuracy of at least 0.1 mm (0.005 in.). The length and width of the anvil shall be at least 10 mm (0.5 in.) greater than the presser foot. The presser foot shall be 300 by 300 mm (12 by 12 in.). The tester shall be equipped with a counter balance to balance the platen as specified.

6.1.1 Because of the linkage ratios, the dial indicator movement will represent a tenfold movement of the platen. For example, a reading of 0.25 mm (0.01 in.) on the dial indicator indicates a travel of the platen of 2.5 mm (0.1 in.). The dial indicator is typical for measurements of thickness and includes two indicators. The small indicator counts the revolution of the large indicator pointer. A specimen whose thickness is, for example, 90 mm (3.5 in.) will read 75 mm (3 in.) on the small indicator and 13 mm (0.5 in.) on the larger indicator.

6.2 *Cutting Dies or Template*, to cut specimens 300 by 300 ± 2-mm (12 by 12 ± 0.01-in.); dies are recommended.

NOTE 1—A study of the impact of the sample size on the accuracy of the method indicated that because of the large specimen size it is not necessary to cut specimens larger than the anvil as is the case in Test Method D 1777.

6.3 *Mass*—An appropriate size weight with a mass of 288 g ± 1 % (0.63 lb).

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 2—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 a 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 2 m (2 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.

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

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

7.3 *Test Specimens*—From each laboratory sampling unit, take five specimens. Use the cutting die or template described in 6.2. Thickness tests may be made on laboratory sampling units without cutting providing it can be maintained in a plane parallel to the presser foot and anvil while making measurements.

7.3.1 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, and so forth, on the specimens when handling.

8. Conditioning

8.1 *Condition 1, Unspecified Testing Conditioning*—No conditioning is required unless otherwise specified in a material specification or contact order.

8.2 *Condition 2, Standard Testing Conditioning*:

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

8.2.2 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 Handle the test specimens carefully to avoid altering the natural state of the material.

9.4 With the platen and base separated by 50 mm (2 in.), adjust the counter balance at the rear of the apparatus until the platen will remain at rest.

9.5 Raise the platen and place a specimen of the material to be tested on the base plate. Add the mass to the platen and gradually lower the platen until it contacts the surface of the specimen. Release the platen and read the thickness to the nearest 0.02 mm (0.001 in.) 9 to 10 s after release of the platen.

9.6 Test the remaining specimens.

10. Calculation

10.1 *Thickness, Individual Specimens*—Record the thickness for individual specimens to the nearest 0.02 mm (0.001

[4] Apparatus is available from Certain-Teed Corporation, P.O. Box 860, Valley Forge, PA 19482. Design details are available from Spartan Engineering Co., 816 Commercial, Atchison, KS 66002.

in.) as read directly from the data collection system unless otherwise specified in a material specification or contract order.

10.2 *Average Values*—Calculate the average thickness for each of the laboratory sample units and the lot.

10.3 *Standard Deviation, Coefficient of Variation*—Calculate when requested.

11. Report

11.1 Report that the thickness was determined as directed in this test method. 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, and

11.2.3 Any modification of the test method.

12. Precision and Bias

12.1 *Summary*—Interlaboratory test data have shown that the variance in thickness testing is dependent upon the nominal thickness 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 in the range indicated:

Nominal Thickness, mm	Thickness, mm
6.35 to 12.70	0.25
12.70 to 25.40	0.53
25.40 to 63.50	1.37
63.50 to 101.60	2.39

Larger differences are likely to occur under all other circumstances.

12.2 *Interlaboratory Test Data*[5]—An interlaboratory test was run in 1992 in which randomly drawn samples of six materials were tested in each of five laboratories. Two operators in each laboratory tested five specimens of each material. The six materials used in this evaluation were resin-bonded polyester highloft nonwovens produced at nominal thicknesses of: 6.35 mm (0.250 in.), 12.70 mm (0.500 in.), 19.05 mm (0.750 in.), 38.1 mm (1.500 in.), 69.85 mm (2.750 in.), and 101.60 mm (4.000 in.). Data was collected in inch-pound units as shown in the research report and the results of statistical analysis were then converted to SI units for inclusion in this test method. Analysis of the data using the adjunct to Practice D 2904 suggested grouping of the materials based on residual variances. The components of variance, expressed as standard deviations, for each group are listed in Table 2 (see Note 3).

TABLE 2 Components of Variance as Standard Deviations

NOTE 1—Thickness expressed in millimetres.

Nominal Thickness Range	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
6.35 to 12.70	0.20	0	0.20
12.70 to 25.40	0.43	0	1.07
25.40 to 63.50	1.09	0	1.45
63.50 to 101.60	1.93	0	0.71

12.3 *Precision*—For the components of variance listed in Table 2, the average 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).

12.4 *Bias*—The procedure in this test method for determining the thickness of highloft nonwoven fabrics has not been checked against accepted reference materials but contains no known bias other than the effect of nominal thickness, as noted. This test method is accepted as a referee method.

NOTE 3—The square roots of the components of variance are listed in Table 2 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 3 Critical Differences for Conditions Noted 95 % Probability Level

NOTE 1—Thickness expressed in millimetres.

Nominal Thickness Range	Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
6.35 to 12.70	1	0.56	0.56	0.79
	5	0.25	0.25	0.61
	10	0.18	0.18	0.58
12.70 to 25.40	1	1.19	1.19	3.18
	5	0.53	0.53	2.97
	10	0.38	0.38	2.95
25.40 to 63.50	1	3.05	3.05	5.03
	5	1.37	1.37	4.24
	10	0.97	0.97	4.11
63.50 to 101.60	1	5.33	5.33	5.72
	5	2.39	2.39	3.12
	10	1.70	1.70	2.62