Designation: D 6651 – 01

Standard Test Method for Determining The Rate of Sorption and Sorptive Capacity Of Nonwoven Fabrics[1]

This standard is issued under the fixed designation D 6651; 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 quantifying of the rate of sorption of textile fabrics.

1.2 This test method applies to all textile fabrics used as wiping materials for spill removal. For additional literature see the International Nonwovens Journal[2,3].

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as the standard. Within the text, the inch-pound units are shown 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 nonconformance with the specification.

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:*

D 123 Terminology Relating to Textiles[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *extrinsic rate of sorption*, *n*—in textile fabrics, the rate at which a specified liquid is sorbed by a fabric on a per-unit-area basis under specified conditions.

3.1.1.1 *Discussion*—While extrinsic sorptive capacity is expressed in terms of volume per unit area, intrinsic capacity (below) has been used to describe capacity in terms of volume per unit mass. By way of example, if a fabric exhibited an intrinsic capacity of 5 mL/g, that mass of fabric would hold 5 mL whether is was part of a 50 g/m^2 or a 200 g/m^2 fabric. The extrinsic sorptive capacity would, however, be four (4) times higher for the 200 g/m^2 fabric than for the lighter weight material.

3.1.2 *intrinsic rate of sorption*, *n*—in textile fabrics, the rate at which a specified liquid is sorbed by a fabric on a per-unit-mass basis under specified conditions.

3.1.3 *sorption*, *n*—in textile fabrics, a process in which liquid molecules are taken up either by absorption or adsorption, or both.

3.1.4 *sorptive capacity*, *n*—in textile fabrics, the maximum amount of liquid absorbed and adsorbed under specified conditions.

3.1.5 *wiper*, *n*—in textile fabrics, fabric swatches used for housekeeping, cleaning, polishing, spill clean-up or removal.

3.2 For definitions of terms used in this test method refer to Terminology D 123.

4. Summary of Test Method

4.1 A stack of wiping material squares of known mass and dimensions is placed on the surface of a thermostatically controlled tank of liquid. The time required for the stack to wet out is recorded. From these measurements and from the mass of the wetted stack of wipers, a rate of sorption through the plane of the wiper can be calculated.

5. Significance and Use

5.1 This test method can be used for acceptance testing of commercial shipments, but comparisons should be made with caution because information on estimates of between-laboratory precision is limited as noted in the precision and bias section of this test method.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, samples used for such comparative tests should be as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. Other fabrics with established test values may also be used for these comparative tests. The test results from the laboratories involved should be compared

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.90 on Executive.

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[2] C. F. Mattina and J. M. Oathout, "A New Method for Determining the Rate of Sorption of Wiping Materials," Cleanrooms, 8 (4), 18–24 (1994) and *International Nonwovens Journal*, 7(1), 48 (1995).

[3] J. M. Oathout and C. F. Mattina, "A Comparison of Selected Industrial and Household Wiping Materials for Rate of Sorption, Sorptive Capacity and Strength," *International Nonwovens Journal*, 7(1), 58 (1995).

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

using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

5.2 When the rate is calculated as a flux on a per-unit-area basis, it is termed the extrinsic rate of sorption, R_e[mL/m^2/s]. The rate calculated on a per-unit-mass basis is termed the intrinsic rate of sorption, R_i[mL/g/s]. If basis weight (mass per unit area) is given in units of grams per square meter, then the two rates of sorption are related via the equation ($R_e = R_i \times$ basis weight).

5.3 This test method rests primarily on three hypotheses: that the rate of sorption is independent of the area of the specimens, that the rate of sorption is independent of the number of plies used to do the test, and that the sorptive capacity of the wiper is independent of the number of plies used to do the test. These hypotheses have been shown to be valid in most cases within the limits described in this test method. However, in certain cases, ply dependency on rate of sorption may exist, in particular, for materials that are slow absorbers, which generally are not considered superior wipers. (See 10.11).

5.4 This test method is useful to select fabrics with superior cleaning and drying properties that can minimize the costs for spill removal. It can also be used to research fabrics for improved spill removal and for production control.

5.5 In addition to the measurement of rate of sorption and sorptive capacity, this method also permits the determination of basis weight (mass per unit area).

6. Apparatus and Materials [5]

6.1 *Balance*, top loading, with a sensitivity of at least 0.01g.

6.2 *Water Bath*, thermostatically controllable to 25 ±1 °C (77 ± 2 °F), having dimensions of at least 400 mm (16 in.) by 300 mm (12 in.) and deep enough so that the topmost ply of a stack of fully wetted wiper specimens is at least 25 mm (1.0 in.) below the surface of the liquid.

6.2.1 Alternatively, any suitable container with dimensions of at least 400 mm × 300 mm × 200 mm, (16 in. × 12 in. × 8 in.) filled with liquid and fitted with a temperature controller can be used. The thermostat should be controllable to 25 ± 1 °C (77 ± 2 °F) and of sufficient depth that the topmost ply of a stack of fully wetted wipers is at least 25 mm (1.0 in.) below the surface of the liquid.

6.3 *Liquid*, usually tap water, or other liquid when specified.

6.4 *Measuring Rule*, metal, graduated in 1 mm (0.05 in.).

6.5 *Stopwatch*, digital electronic capable of reading to 0.01 s.

6.5.1 As an option, the stopwatch can be operated by a foot-switch, thereby allowing both hands to be free to handle the test specimen during the test.

6.6 *Die Cutter*, or equivalent, to meet the test specimen size requirements of 7.3.

6.7 *Utility Knife*.

[5] Apparatus and materials are commercially available.

7. Sampling and Test Specimens

7.1 *Primary Sampling Unit*—Consider rolls, bolts, or pre-packaged pieces of fabric to be the primary sampling unit, as applicable.

7.2 *Laboratory Sampling Unit*—As a laboratory sampling unit, use the primary sampling unit, as a source of test specimens and prepare the test specimens as directed in 7.3 and 7.4.

7.2.1 For primary sampling units having narrow widths or short lengths, use a sufficient number of pieces to prepare the test specimen stacks as described in 7.3 and 7.4.

7.3 *Test Specimen Size*—From each laboratory sampling unit, cut square or rectangular test swatches, such that the specimen area is no less than 25600 mm^2 (39 in.^{2}) and no greater than 64500 mm^2 (100 in.^{2}) with no side less than 160 mm (6.3 in.) nor greater than 250 mm (10 in.).

7.3.1 In any event, the specimen side length-width aspect ratio must not be greater than 2:1.

NOTE 1—Specimen swatches having smaller dimensions than specified in 7.3 may have an edge effect and may lead to erroneous results. Specimen swatches having larger dimensions than specified in 7.3 are cumbersome to handle and may lead to erroneous results.

7.4 *Number of Swatches Per Test Specimen Stack and Number of Test Specimen Stacks*—The number of swatches (fabric layers) can vary. As a minimum, prepare two specimen stacks, each with 10 fabric layers, two specimen stacks, each with fewer layers, such as 5, and two specimen stacks, each with more layers, such as 15. This will help to establish whether there is any ply dependency on the rate of sorption.

7.4.1 Primary sampling units may consist of pre-packaged wiping material that are nominally 229 mm by 229 mm (9.00 in. by 9.00 in.) material squares. In those cases, use the entire square as the test specimen.

7.4.2 If prepackaged wiping material squares are quarter-folded or C-folded, unfold them and place in stacks. If the stack of material squares do not lie flat after stacking, apply modest compression. When necessary, bend previously folded creases backward to flatten.

7.4.3 Prepare specimen stacks, such that the same fabric surface is facing up for all stacks so they can be identified when testing.

7.4.4 Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, grease, etc. on the specimens when handling.

7.5 *Test Specimen Preparation*—Select test specimens as follows:

7.5.1 *For Prepackaged Wipes, Nominal 229 by 229 mm (9.00 by 9.00 in.)*—Open the package. Select a stack of wipes that is sufficient to provide the necessary number of layers needed for each test specimen set. Use the entire square as the test specimen.

7.5.2 *For Rolls or Bolts of Fabric, (Preferred)*—Using a utility knife, cut a suitable number of plugs, approximately 300 by 300 mm (12 by 12 in.) and about 25 mm (1.0 in.) deep from the roll or bolt to provide fabric layers for the necessary specimen stacks. Using the die cutter, or equivalent, cut through the plugs to provide the specimen stacks necessary to meet the requirements of 7.3 and 7.4.