



Designation: D2654 – 22

Standard Test Methods for Moisture in Textiles¹

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1. Scope

1.1 These test methods cover measurement of moisture in textile materials as (1) moisture content or pick-up using ambient air for oven-drying, (2) moisture content or pick-up using standard atmosphere for testing textiles for oven-drying, (3) moisture content or pick-up at moisture equilibrium, and (4) moisture regain. These test methods are applicable to all fibers natural or man-made, and in all forms from fiber or filament to finished fabric, subject to the limitations set forth in 1.1.1 through 1.1.4. Blends of fibers shall also be tested by these methods.

1.1.1 *Procedure 1*—This oven-drying technique, using ambient air heated to 105 °C, shall be used in any situation in which a simple and convenient method for routine process control or when in-plant evaluation is needed to determine an approximation of the moisture content or pickup. It is not recommended for jute or grease wool, or for acceptance testing in commercial transactions.

1.1.2 *Procedure 2*—Oven-drying technique, using air from the standard atmosphere air for testing textiles that is heated to 105 °C and other refinements in technique, shall be used as a basis for commercial transactions for all materials for which it is known that no significant quantity of non-aqueous volatile matter is present on, or in, the material to be tested.

NOTE 1—The air supply for Procedure 2 has been changed from desiccated air to the air from the standard atmosphere for testing textiles because the latter is in common use and is prescribed in Test Method D494 for commercial mass of a shipment. By agreement, however, desiccated air may be used.

1.1.3 *Procedure 3*—This oven-drying technique uses specimens in moisture-equilibrium under specified conditions and an oven with an air supply of specified temperature and relative humidity heated to 105 °C, and other refinements in technique. The procedure is used to determine the moisture content or pickup of a material in equilibrium conditions, usually the standard atmosphere for testing textiles.

¹ These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.51 on Conditioning, Chemical and Thermal Properties.

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NOTE 2—The previous Procedure 3 for determining moisture using distillation with toluene has been dropped from this method because it is essentially the same as Test Method D2462 which is the preferred method for jute and grease wool in any circumstance. Test Method D2462 is the preferred method for any material in which it is known, or suspected, that a significant quantity of nonaqueous and non-water miscible volatile matter is present.

1.1.4 *Procedure 4*—This new technique is for determination of actual moisture regained by a material under specified conditions after the material has been extracted by a suitable procedure, if surface materials are present, and dried in vacuum at a low temperature

1.2 In Procedures 1, 2, and 3, alternative techniques are described for weighing oven-dried specimens: in the oven while hot, and outside the oven at room temperature.

1.3 The word *water* refers to the chemical compound H₂O. The terms *water* and *moisture* are frequently used interchangeably in the literature and in the trade even when the “moisture” is known to contain other volatile materials. When the loss during oven exposure is not known to be all water, it shall be considered a “volatiles loss” rather than a “moisture loss” for technical accuracy.

1.4 Moisture calculations commonly involve the mass of a specimen that has been dried by heating in an oven. If the air in the oven contains moisture, the oven-dried specimen will contain moisture (in equilibrium with that in the oven air) even when it no longer shows a significant change in mass. Therefore, if a very precise measurement of the moisture present is required and oven drying is used, the mass must be exposed to desiccated air until it shows no further significant change in mass.

NOTE 3—Other ASTM Standards related to the determination of moisture of textile materials are Test Methods D1576, D2495, and D2118.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- D123 Terminology Relating to Textiles
- D494 Test Method for Acetone Extraction of Phenolic Molded or Laminated Products
- D584 Test Method for Wool Content of Raw Wool—Laboratory Scale
- D629 Test Methods for Quantitative Analysis of Textiles
- D1441 Practice for Sampling Cotton Fibers for Testing
- D1576 Test Method for Moisture in Wool by Oven-Drying (Withdrawn 2022)³
- D1776/D1776M Practice for Conditioning and Testing Textiles
- D1909 Standard Tables of Commercial Moisture Regains and Commercial Allowances for Textile Fibers
- D2118 Practice for Assigning a Standard Commercial Moisture Content for Wool and its Products
- D2258 Practice for Sampling Yarn for Testing
- D2462 Test Method for Moisture in Wool by Distillation With Toluene (Withdrawn 2022)³
- D2494 Test Method for Commercial Mass of a Shipment of Yarn or Manufactured Staple Fiber or Tow
- D2495 Test Method for Moisture in Cotton by Oven-Drying
- D2525 Practice for Sampling Wool for Moisture (Withdrawn 2022)³
- D3333 Practice for Sampling Manufactured Staple Fibers, Sliver, or Tow for Testing

3. Terminology

3.1 Definitions:

3.1.1 *commercial moisture regain*, *n*—an arbitrary value formally adopted as the regain to be used with the oven-dried mass when making certain calculations. (Compare *moisture regain* and *standard moisture regain*.)

3.1.1.1 *Discussion*—The assigned *commercial moisture regain* value is usually higher than the experimental moisture regain value for the same material.

3.1.2 *dew point*, *n*—the temperature below which condensation of water vapor begins to take place when the atmosphere is cooled.

3.1.2.1 *Discussion*—As air is cooled, the amount of water vapor which it can hold decreases. If air is cooled sufficiently, the saturation water-vapor pressure becomes equal to the actual water-vapor pressure and any further cooling beyond this point will normally result in the condensation of moisture.

3.1.3 *hygrometer*, *n*—any instrument for measuring the humidity of the atmosphere.

3.1.4 *moisture, n—as used with textiles*, water absorbed, adsorbed or resorbed by a material. (See also *water*.)

3.1.5 *moisture as-is, n*—deprecated term. See *moisture content*.

3.1.6 *moisture as-received, n*—deprecated term. See *moisture content*.

3.1.7 *moisture content, n*—that part of the total mass of a material that is absorbed or adsorbed water, compared to the total mass. (Compare *moisture pick-up* and *moisture regain*.)

3.1.7.1 *Discussion*—Moisture content is usually expressed as a percentage and is calculated using the equation:

$$C = 100 (A - D)/A$$

where:

- C* = moisture content, %,
- A* = mass of material before drying, and
- D* = mass of the dried material.

There is a relationship between *moisture content* and *moisture pick-up* since both shall be calculated from the same data. The difference is in the bases used for calculating the percentages, original versus dried material mass. The relationship between moisture content and moisture pick-up is shown by the equations:

$$C = 100 P/(100 + P)$$

$$P = 100C/(100 - C)$$

where:

- C* = moisture content, %, and
- P* = moisture pick-up, %.

3.1.8 *moisture content, n—at moisture-equilibrium*, the moisture content of a material in equilibrium with air of known, or specified, temperature and relative humidity.

3.1.8.1 *Discussion*—A frequently prescribed condition for determining *moisture content at moisture-equilibrium* is use of a standard atmosphere, for example, 21 °C ± 2 °C (70 °F ± 4 °F) and 65 ± 5 % relative humidity, for textiles both in establishing the equilibrium and air supply for the drying oven.

3.1.9 *moisture content (dry-basis), n*—deprecated term. See *moisture pick-up*.

3.1.10 *moisture (dry-basis), n*—deprecated term. See *moisture pick-up*.

3.1.11 *moisture equilibrium, n*—the condition reached by a material when it no longer takes up moisture from or gives up moisture to the surrounding atmosphere. (Compare *moisture-free*.)

3.1.11.1 *Discussion*—The establishment of equilibrium between a material and the surrounding atmosphere is dependent upon the exposure time, the difference in moisture levels between the material and the atmosphere, and motion of the air about the material. The level at which the moisture in the textile reaches equilibrium depends upon the side from which equilibrium is approached. Because of this difference equilibrium for textiles shall be approached from the dry (but not moisture-free) side which is faster. Equilibrium with air in motion is considered to be achieved when successive weighings at specified time intervals do not show a change in mass

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 The last approved version of this historical standard is referenced on www.astm.org.

greater than the tolerance established for the material. If there is no established tolerance, consider 0.1 % of the mass after a 2-h exposure as satisfactory.

3.1.12 *moisture-free, adj—in textiles*, a descriptive term for a material that (1) has been exposed to a flow of desiccated air at a specified temperature until there is no further significant change in mass, or (2) has been treated by a distillation process using a suitable solvent. (Syn. *zero moisture*.) (Compare *moisture equilibrium*.)

3.1.12.1 *Discussion*—Moisture determinations frequently involve the change in mass of an oven-dried specimen. If the air in the oven contains moisture, the oven-dried specimen will also contain some moisture even though it no longer shows a significant change in mass. This is due to the establishment of moisture equilibrium under the existing conditions. To ensure that the specimen is actually *moisture free*, it must be exposed to desiccated air until it shows no further significant change in mass. Although heating textiles in desiccated air to temperatures as high as 110 °C increases the rate of moisture loss without changing the final equilibrium mass of the moisture-free textile, heating also increases the possibility of removing other matter. The distillation process shall be substituted provided the textile does not contain any distillable, water-soluble matter.

3.1.13 *moisture pick-up, n*—the mass of absorbed and adsorbed water that is held by a material, compared to the mass of the dried material. (Compare *moisture content* and *moisture regain*.)

3.1.13.1 *Discussion*—*Moisture pick-up* is usually expressed as a percentage based on the dried mass of the material and is calculated using the equation:

$$P = 100 (A - D)/D$$

where:

P = moisture pick-up, %,
 A = mass of material before drying, and
 D = mass of the dried material.

(See equations in 3.1.7 for relationship between *moisture pick-up* and *moisture content*.) Since *moisture pick-up*, like *moisture content*, involves the “as-is, where-is” (from a location with unknown temperature and humidity conditions) state of the material, it is generally unknown if the loss in mass on drying is caused by the loss of any materials other than water.

3.1.14 *moisture pick-up, n—at moisture-equilibrium*, the moisture pick-up of a material in equilibrium with air of known, or specified, temperature and relative humidity.

3.1.14.1 *Discussion*—A frequently prescribed condition for determining moisture content at moisture-equilibrium is use of a standard atmosphere, for example, 21 °C ± 1 °C (70 °F ± 2 °F) and 65 ± 2 % relative humidity, for textiles, both in establishing the equilibrium and as air supply for the drying oven.

3.1.15 *moisture regain, n*—the amount of water resorbed by a dried material at specified equilibrium conditions of temperature and humidity, compared to the mass of the dried material.

(See *standard moisture regain*.) (Compare *commercial moisture regain*, *moisture content*, and *moisture pick-up*.)

3.1.15.1 *Discussion*—*Moisture regain* is usually expressed as a percentage and is calculated using the equation:

$$R = 100 (B - D)/D$$

where:

R = moisture regain, %,
 B = mass of material in moisture-equilibrium at specified conditions, and
 D = mass of the material dried under specified conditions.

Since most surface matter can be extracted without appreciably affecting the textile material, or the textile material can be produced without surface matter (except natural fibers), anything removed by drying or distillation after *moisture-equilibrium* is established is water. This is a key difference between *moisture regain* and *moisture pick-up*, which have been traditionally, but incorrectly, used synonymously.

3.1.16 *moisture, wet-basis, n*—deprecated term. See *moisture content*.

3.1.17 *oven-dried, adj*—a descriptive term for a material that has been heated under prescribed conditions of temperature and humidity until there is no further significant change in the mass of the material.

3.1.17.1 *Discussion*—An oven-dried material retains a small amount of moisture which is dependent upon the temperature and relative humidity of the air supplied to the oven. An oven-dried material will only be *moisture-free* if the air supplied to the oven has been desiccated.

3.1.18 *resorption, n*—the process by which a material that has given up another material by desorption takes up some more of the material given up.

3.1.19 *standard atmosphere for testing, n—in textiles*, an atmosphere for testing in which the air is maintained at a relative humidity of 65 ± 5 % and at a temperature of 21 °C ± 2 °C (70 °F ± 4 °F).

3.1.19.1 *Discussion*—Special conditions of humidity and temperature are sometimes prescribed for the testing of certain textiles for specific service predictions; resistance to water or biological action, etc. When international testing is involved, a standard temperature of 20 °C ± 2 °C, or, by agreement, 27 °C ± 2 °C is involved. A standard temperature of 20 °C ± 2 °C shall be used.

3.1.20 *standard condition, n—for glass textiles*, that condition reached by the material when in moisture equilibrium with a standard atmosphere having a relative humidity of 65 % at 21 °C (70 °F). A tolerance of ±2 % is permitted in relative humidity and ±2 °F (1 °C) in temperature.

3.1.21 *standard condition for physical testing, n*—the condition reached by a specimen or sample when, after being preconditioned in the standard atmosphere for preconditioning, it has been brought to moisture equilibrium for testing in the standard atmosphere for testing.

3.1.22 *standard moisture regain, n*—the moisture regain of a material at equilibrium with the standard atmosphere for testing textiles. (See *moisture regain*.)