Designation: C1789 – 24

Standard Test Method for Calibration of Hand-Held Moisture Meters on Gypsum Panels[1]

This standard is issued under the fixed designation C1789; 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 applies to the calibration of hand-held moisture meters for gypsum board, glass faced gypsum panels and fiber-reinforced gypsum panels by means of electrical conductance and dielectric meters. The test uses wetted test specimens which are dried down in at least five (5) steps to determine the moisture content based on the weight loss in comparison to the dry weight. The test also supplies the ERH values for each of the drying steps.

1.2 This test method has not been evaluated for the influence of paint or wall covering materials on the indicated moisture content of a gypsum board or panel substrate.

1.3 The values stated in SI (metric) are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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

1.5 *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]

C473 Test Methods for Physical Testing of Gypsum Panel Products

C1177/C1177M Specification for Glass Mat Gypsum Substrate for Use as Sheathing

C1178/C1178M Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel

C1278/C1278M Specification for Fiber-Reinforced Gypsum Panel

C1396/C1396M Specification for Gypsum Board

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

D4444 Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

2.2 *ASHRAE Standard:*[3]

2009 ASHRAE Handbook – Fundamentals, Chapter 1 – Psychrometrics, American Society of Heating, Refrigerating and Air-conditioning Engineers

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *absolute humidity, d_v, n*—the ratio of the mass of water vapor to the total volume of the moist air sample.

3.1.2 *admittance, n*—inverse of impedance, a measure of how easily an electric current can flow through a material.

3.1.3 *conductance meters, n*—conductance meters are those that measure predominantly ionic conductance between points of applied voltage, usually dc.

3.1.3.1 *Discussion*—Conductance meters generally have pins that penetrate into the material being measured. Direct-current conductance meters are commonly referred to as "resistance" meters. Most commercial conductance meters are high-input impedance (about 10^{12} Ω), wide-range (10^4 to 10^{12} Ω) ohmmeters. Their scales are generally calibrated to read directly in moisture content (oven-dry mass basis) for a particular calibration material and at a specific reference temperature.

3.1.4 *dew-point temperature, t_d, n*—the temperature at which a sample of moist air being cooled at constant pressure and moisture content reaches 100 % relative humidity.

[1] This test method is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.01 on Specifications and Test Methods for Gypsum Products.

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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.

[3] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

*A Summary of Changes section appears at the end of this standard

3.1.4.1 *Discussion*—The dew-point temperature is the temperature at which water condensation begins to occur on a cooled surface in contact with moist air.

3.1.5 *dielectric meters, n*—meters that measure primarily by admittance or power-loss.

3.1.5.1 *Discussion*—Dielectric meters generally do not have pins that penetrate into the material being measured. There are two (2) general types of dielectric meters that may be arbitrarily categorized by their predominant mode of response – admittance (or capacitance) and power-loss. Both have surface contact electrodes and readout scales that are usually marked in arbitrary units. Most dielectric meters operate in the r-f frequency range, generally between 1 MHz and 10 MHz. Admittance meters respond primarily to the capacitance (dielectric constant) of the material being measured. Power-loss meters react primarily to the resistance of the material. Readings of dielectric meters are significantly affected by the relative density (specific gravity) of the specimen material.

3.1.6 *equilibrium moisture content, EMC, n*—the moisture content of a material that is in thermodynamic equilibrium with the surrounding air at a given temperature and relative humidity.

3.1.7 *equilibrium relative humidity, ERH*—the relative humidity of the air in a sealed chamber that is in thermodynamic equilibrium with a sample of material in that chamber.

3.1.8 *humidity ratio, W, n*—the ratio of the mass of water vapor to the mass of dry air contained in a sample of moist air.

3.1.9 *moisture content, MC, n*—the ratio of the mass of water in a material to the oven-dry mass of the sample expressed as a decimal fraction or percentage.

3.1.9.1 *Discussion*—Oven-dry refers to the removal by heating of all adsorbed and free water in the interstitial pores of the material. Crystalline water such as contained in gypsum molecules is not included.

3.1.10 *relative humidity, ϕ, n*—the ratio of the amount of water vapor in air to the amount of water vapor in saturated air at the same temperature and pressure.

3.1.10.1 *Discussion*—Equivalent to the ratio of the partial pressure of water vapor in the air to the saturated vapor pressure at the same temperature and pressure.

3.1.11 *test uncertainty ratio, TUR, n*—comparison between the accuracy of the Unit Under Test (UUT) and the estimated calibration uncertainty stated with a confidence level of 95 % (K=2).

3.1.12 *water activity, A_w, n*—the ratio of the water vapor pressure in a material to the vapor pressure of pure water at the same temperature.

3.1.12.1 *Discussion*—Water activity is an intrinsic property derived from fundamental principles of thermodynamics and physical chemistry. It is a measure of the energy status of the water in a system. Commonly used for food preservation analyses, it can be interpreted here as the amount of water in a porous material that is available to impact the performance characteristics of the material or to support mold growth.

4. Summary of Test Method

4.1 These test methods provide a method for calibrating the scale on conductance and dielectric meters for various types of gypsum boards and panels for use in field measurement of moisture content during storage, construction and use in building assemblies.

4.2 The calibration is based on the MC of the test specimen. The corresponding ERH is determined by use of a calibrated direct read relative humidity meter.

4.3 ERH is essentially equivalent to water activity, A_w, which is a measure of the amount of moisture in a material that is available to impact the performance characteristics of that material.

4.4 Due to the various core and/or facing additives that are used to modify the moisture absorption characteristics, strength and/or other properties for specific applications, a separate calibration is required for each type of gypsum board or panel product to be measured.

4.5 The test method has the following steps:

4.5.1 Measure the dry weights of the test specimens.

4.5.2 Determine the time step for the drying intervals that will provide sufficient data points to develop a calibration curve.

4.5.3 Saturate the samples with water.

4.5.4 Dry the samples in steps, recording after each interval the moisture content by weight of each sample and the temperature, relative humidity (ERH), and absolute humidity of the atmosphere in moisture equilibrium with each sample.

5. Significance and Use

5.1 This Standard Test Method is intended for use in calibrating hand-held meters to accurately read from approximately 30 % to 90 % ERH. Moisture content is related to the ERH or A_w of a material.

5.2 Hand-held meters provide a rapid means of sampling the moisture content of gypsum boards and panels during manufacture and for field inspection during and after building construction. However, these measurements are inferential, that is, electrical parameters are measured and compared against a calibration curve to obtain an indirect measure of moisture content. The electrical measurements are influenced by the actual moisture content, a number of other gypsum board and panel variables, environmental conditions, the geometry of the measuring probe, and the design of the meter. The maximum accuracy can only be obtained by an awareness of the effect of each parameter on the meter output and correction of readings as specified by these test methods.

5.3 Electrical conductance and dielectric meters are not necessarily equivalent in their readings under the same conditions. When this test method is referenced, the type of meter that is being used must be reported with the relevant ranges for precision and bias as specified in this standard.

5.4 Both types of meters are to be calibrated with respect to ERH as described in this standard.