



Designation: C1699 – 09 (Reapproved 2023)

# Standard Test Method for Moisture Retention Curves of Porous Building Materials Using Pressure Plates<sup>1</sup>

This standard is issued under the fixed designation C1699; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method specifies a laboratory procedure for the determination of the water retention curve (or moisture storage capacity) of porous building materials at very high relative humidity (RH) levels ( $\approx 95$  to 100% RH) corresponding to the capillary moisture region of the sorption isotherm. This is achieved by using the pressure plate test apparatus. This technique was originally developed to study soil moisture content and eventually had been adapted to building construction materials.

1.2 At higher RH levels ( $\approx 95$  to 100% RH) of the sorption isotherm (see Test Method C1498), use of climatic chamber is not an option. This technique uses overpressure to extract water out of the pore structure of porous materials until equilibrium between the moisture content in the specimens and the corresponding overpressure is achieved. Using the pressure plate extractors, equilibrium can only be reached by desorption.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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.*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.33 on Insulation Finishes and Moisture.

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## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

C1498 Test Method for Hygroscopic Sorption Isotherms of Building Materials

D2325 Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus (Withdrawn 2007)<sup>3</sup>

D3152 Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus (Withdrawn 2007)<sup>3</sup>

E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *desorption isotherm*—the sorption isotherm measured exclusively during the hygroscopic desorption process started from the condition of full water saturation of the material.

3.1.2 *sorption isotherm*—relationship between the relative humidity (see Test Method E337) and the equilibrium moisture content of the material, at a specified temperature.

3.1.3 *pressure-plate facility*—Heavy steel vessel capable of holding different pressure levels.

3.1.4 *moisture content, by mass*—mass of water retained in the specimen divided by the dry mass of the specimen.

## 4. Significance and Use

4.1 The purpose of this test is to obtain, by means of a specified laboratory procedure, the values of the equilibrium moisture content at higher RH levels ( $\approx 95$  to 100%). These values are used either as means to characterize the material or as material characteristics needed as input to appropriate computer models that can simulate wetting or drying potential

<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

of individual building materials or material assemblies under specified environmental conditions.

**5. Apparatus**

5.1 *Pressure vessel*—Heavy-duty steel vessels of approximately 305 mm in diameter and about 75 mm or 250 mm high with heavy top lid tightly-held against O-ring gasket by clamping bolts (see Fig. 1).

5.2 *Porous ceramic plates*—This is the plate upon which the specimens sit and is composed of microscopic pores allowing only water to flow through it. The plate assembly is exposed to an overpressure that can be adjusted, while the other side of the plate is always at atmospheric pressure resulting in a pressure difference over the plate and the specimens.

5.3 *Balance*—An analytical balance capable of weighing within 1 mg shall be used. The accuracy of the balance shall be at least ± 0.1 percent of the total specimen weight.

5.4 *Drying oven*—A ventilated drying oven, capable of maintaining the required drying temperature within ±2K for temperatures less than 75°C and ±4K for temperatures above 75°C, and a relative humidity of less than 10%, shall be used. In warm-humid laboratory environment or at low drying temperatures, it will be necessary to provide a supply of dried air to achieve the less than 10 % relative humidity specification in the drying oven.

5.5 *Desiccator equipped with outflow knob*—Used as a vacuum chamber to remove air (that is, evacuate) from the water and evacuate specimens.

5.6 *Kaolin paste and acetate fabric*—This clay paste ensures good hydraulic contact between plate/specimen. The acetate fabric prevents contamination of the specimens by the clay.

5.7 *Pressure source*—Compressed air or nitrogen in cylinders, or high-pressure air compressor.

5.8 *Pressure manifold*—Assembly of conduits and valves regulating the air supplied to the extractors.

**6. Test Specimens**

6.1 A test specimen shall be cut to approximately 15 cm<sup>2</sup> and have a thickness as minimal as possible (≈ 5mm, depending on the structure of the material) to reduce the time to reach equilibrium.

6.2 A minimum of five specimens shall be tested in each pressure environment. The test procedure, as specified below, and the precision of weighing shall be applied to each specimen.

**7. Preparations of Test Specimens**

7.1 Dry specimens in oven to constant weight (see Note 1).

7.2 Measure and record dry specimen dimensions.

7.3 For vacuum saturation (see Note 2), follow steps 7.3.1 to 7.3.3

7.3.1 Place them in a vacuum chamber (that is, desiccator equipped with outflow knob and connected to vacuum pump) and evacuate for 24 hours. This ensures that no air remains in the pores when specimens are being saturated.

7.3.2 Evacuate distilled water by pumping air out for 1 to 2 hours.

7.3.3 Use this water to saturate the specimens under vacuum. The assembly remains under vacuum for at least 3 days or until no air bubbles are observed. Keep the specimens fully submerged in the vacuum chamber until ready for measurement. This minimizes the amount of drying that can occur.

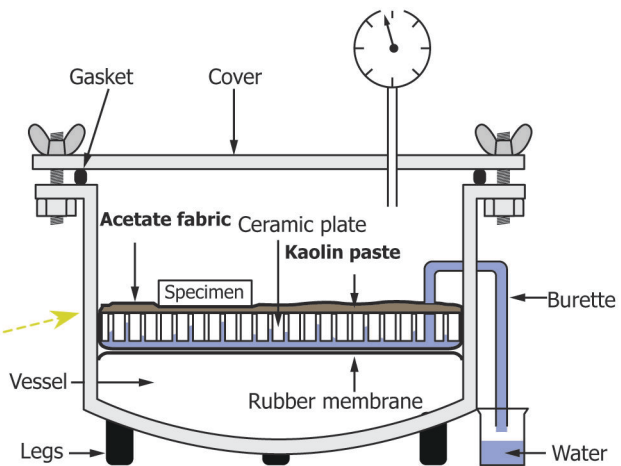
7.4 For capillary saturation (see Note 3), specimens shall be immersed completely in distilled water (kept at room temperature) until a constant weight is attained.

7.5 Soak the porous ceramic plate(s) in distilled water for a minimum of 8 hours.

7.6 Prepare the kaolin paste (see Note 4) by mixing 125g of kaolin powder with 150g distilled water and apply it directly onto the saturated plate.



(a) Test assembly



(b) Pressure chamber

FIG. 1 Pressure Plate Test Apparatus