



Standard Test Method for Using a Heat Flow Meter Apparatus for Measuring Thermal Storage Properties of Phase Change Materials and Products¹

This standard is issued under the fixed designation C1784; 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 measurement of non-steady-state heat flow into or out of a flat slab specimen to determine the stored energy (that is, enthalpy) change as a function of temperature using a heat flow meter apparatus (HFMA).

1.2 In particular, this test method is intended to measure the sensible and latent heat storage capacity for products incorporating phase-change materials (PCM).

1.2.1 The storage capacity of a PCM is well defined via four parameters: specific heats of both solid and liquid phases, phase change temperature(s) and phase change enthalpy (1).²

1.3 To more accurately predict thermal performance, information about the PCM products' performance under dynamic conditions is needed to supplement the properties (thermal conductivity) measured under steady-state conditions.

NOTE 1—This test method defines a dynamic test protocol for products or composites containing PCMs. Due to the macroscopic structure of these products or composites, small specimen sizes used in conventional Differential Scanning Calorimeter (DSC) measurements, as specified in E793 and E967, are not necessarily representative of the relationship between temperature and enthalpy of full-scale PCM products.

1.4 This test method is based upon the HFMA technology used for Test Method C518 but includes modifications for specific heat and enthalpy change measurements for PCM products as outlined in this test method.

1.5 Heat flow measurements are required at both the top and bottom HFMA plates for this test method. Therefore, this test method applies only to HFMA's that are equipped with at least one heat flux transducer on each of the two plates and that have the capability for computerized data acquisition and temperature control systems. Further, the amount of energy flowing

through the transducers must be measureable at all points in time. Therefore, the transducer output shall never be saturated during a test.

1.6 This test method makes a series of measurements to determine the thermal energy storage of a test specimen over a temperature range. First, both HFMA plates are held at the same constant temperature until steady state is achieved. Steady state is defined by the reduction in the amount of energy entering the specimen from both plates to a very small and nearly constant value. Next, both plate temperatures are changed by identical amounts and held at the new temperature until steady state is again achieved. The energy absorbed or released by the specimen from the time of the temperature change until steady state is again achieved will be recorded. Using a series of temperature step changes, the cumulative enthalpy stored or released over a certain temperature range is determined.

1.6.1 The specific heats of the solid and liquid phases are determined from the slope of the temperature-dependant enthalpy function during sensible heating/cooling, before and after the phase change process.

1.7 Calibration of the HFMA to determine the 'correction factors' for the energy stored within the plate heat flux transducers and any material placed between the test specimen and the HFMA plates must be performed following Annex A1. These correction factors are functions of the beginning and ending temperatures for each step, as described in Annex A1.

1.8 This test method applies to PCMs and composites, products and systems incorporating PCMs, including those with PCM dispersed in or combined with a thermal insulation material, boards or membranes containing concentrated or dispersed PCM, etc. Specific examples include solid PCM composites and products, loose blended materials incorporating PCMs, and discretely contained PCM.

1.9 This test method may be used to characterize material properties, which may or may not be representative of actual conditions of use.

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

¹ This test method is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement.

Current edition approved Oct. 1, 2014. Published December 2014. Originally approved in 2013. Last previous edition approved in 2013 as C1784-13. DOI: 10.1520/C1784-14.

² The boldface numbers in parentheses refer to the list of references at the end of this standard.