



Standard Test Method for Measuring Heat Flux Using Flush-Mounted Insert Temperature-Gradient Gages¹

This standard is issued under the fixed designation E2683; 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 describes the measurement of the net heat flux normal to a surface using gages inserted flush with the surface. The geometry is the same as heat-flux gages covered by Test Method E511, but the measurement principle is different. The gages covered by this standard all use a measurement of the temperature gradient normal to the surface to determine the heat that is exchanged to or from the surface. Although in a majority of cases the net heat flux is to the surface, the gages operate by the same principles for heat transfer in either direction.

1.2 This general test method is quite broad in its field of application, size and construction. Two different gage types that are commercially available are described in detail in later sections as examples. A summary of common heat-flux gages is given by Diller (1).² Applications include both radiation and convection heat transfer. The gages used for aerospace applications are generally small (0.155 to 1.27 cm diameter), have a fast time response (10 μ s to 1 s), and are used to measure heat flux levels in the range 0.1 to 10 000 kW/m². Industrial applications are sometimes satisfied with physically larger gages.

1.3 The values stated in SI units are to be regarded as the standard. The values stated in parentheses are provided for information only.

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.*

¹ This test method is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.08 on Thermal Protection.

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

2. Referenced Documents

2.1 ASTM Standard:³

E511 Test Method for Measuring Heat Flux Using a Copper-Constantan Circular Foil, Heat-Flux Transducer

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *heat flux*—the heat transfer per unit area, q , with units of W/m² (Btu/ft²-s). Heat transfer (or alternatively heat transfer rate) is the rate of thermal energy movement across a system boundary with units of watts (Btu/s). This usage is consistent with most heat transfer books.

3.1.2 *heat transfer coefficient, (h)*—an important parameter in convective flows with units of W/m²-K (Btu/ft²-s-F). This is defined in terms of the heat flux q as

$$h = \frac{q}{\Delta T} \quad (1)$$

where ΔT is a prescribed temperature difference between the surface and the fluid. The resulting value of h is intended to be only a function of the fluid flow and geometry, not the temperature difference. If the surface temperature is non-uniform or if there is more than a single fluid free stream temperature, the proper definition of ΔT may be difficult to specify (2). It is always important to clearly define ΔT when calculating the heat transfer coefficient.

3.1.3 *surface emissivity, (ϵ)*—the ratio of the emitted thermal radiation from a surface to that of a blackbody at the same temperature. Surfaces are assumed to be gray bodies where the emissivity is equal to the absorptivity.

4. Summary of Test Method

4.1 A schematic of the sensing technique is illustrated in Fig. 1. Temperature difference is measured across a thermal-resistance layer of thickness, δ . This is the heat flux sensing

³ 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.