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Standard Test Method for Heat of Ablation¹

This standard is issued under the fixed designation E 458; 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.

ε¹ NOTE—Section 13 was added editorially in May 1996.

1. Scope

1.1 This test method covers determination of the heat of ablation of materials subjected to thermal environments requiring the use of ablation as an energy dissipation process. Three concepts of the property are described and defined: cold wall, effective, and thermochemical heat of ablation.

1.2 *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.*

2. Referenced Documents

2.1 ASTM Standards:

- E 285 Test Method for Oxyacetylene Ablation Testing of Thermal Insulation Materials²
- E 341 Practice for Measuring Plasma Arc Gas Enthalpy by Energy Balance²
- E 377 Practice for Internal Temperature Measurements in Ablative Materials²
- E 422 Test Method for Measuring Heat Flux Using a Water-Cooled Calorimeter²
- E 457 Test Method for Measuring Heat-Transfer Rate Using a Thermal Capacitance (Slug) Calorimeter²
- E 459 Test Method for Measuring Heat-Transfer Rate Using a Thin-Skin Calorimeter²
- E 470 Method for Measuring Gas Enthalpy Using Calorimetric Probes³
- E 471 Test Method for Obtaining Char Density Profile of Ablative Materials by Machining and Weighing²
- E 511 Test Method for Measuring Heat Flux Using a Copper-Constantan Circular Foil, Heat-Flux Gage²

3. Terminology

3.1 Descriptions of Terms Specific to This Standard:

3.1.1 *heat of ablation*—a property that indicates the ability of a material to provide heat protection when used as a

sacrificial thermal protection device. The property is a function of both the material and the environment to which it is subjected. In general, it is defined as the incident heat dissipated by the ablative material per unit of mass removed, or

$$Q^* = q/m \quad (1)$$

where:

- Q^* = heat of ablation, kJ/kg,
- q = incident heat transfer rate, kW/m², and
- m = total mass transfer rate, kg/m²·s.

3.2 The heat of ablation may be represented in three different ways depending on the investigator's requirements:

3.3 *cold-wall heat of ablation*—The most commonly and easily determined value is the cold-wall heat of ablation, and is defined as the incident cold-wall heat dissipated per unit mass of material ablated, as follows:

$$Q^* = q_{cw}/m \quad (2)$$

where:

- Q^*_{cw} = cold-wall heat of ablation, kJ/kg,
- q_{hw} = heat transfer rate from the test environment to a cold wall, kW/m², and
- m = total mass transfer rate, kg/m²·s.

The temperature of the cold-wall reference for the cold-wall heat transfer rate is usually considered to be room temperature or close enough such that the hot-wall correction given in Eq 7 is less than 5 % of the cold-wall heat transfer rate.

3.4 *effective heat of ablation*—The effective heat of ablation is defined as the incident hot-wall dissipated per unit mass ablated, as follows:

$$Q^*_{eff} = q_{hw}/m \quad (3)$$

where:

- Q^*_{eff} = effective heat of ablation, kJ/kg,
- q_{hw} = heat transfer rate from the test environment to a nonablating wall at the surface temperature of the material under test, kW/m², and
- m = total mass transfer rate, kg/m²·s.

3.5 *thermochemical heat of ablation*—The thermochemical heat of ablation is defined as the incident hot-wall heat dissipated per unit mass ablated, corrected for reradiation heat rejection processes and material eroded by mechanical removal, as follows:

¹ This test method is under the jurisdiction of ASTM Committee E-21 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 Annual Book of ASTM Standards, Vol 15.03.

³ Discontinued, see 1982 Annual Book of ASTM Standards, Part 41.