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Standard Terminology Relating to Thermal Insulation[1]

This standard is issued under the fixed designation C168; 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 standard provides definitions, symbols, units, and abbreviations of terms used in ASTM standards pertaining to thermal insulating materials, and to materials associated with them.

1.2 This terminology is not intended to be used to classify insulation materials as having particular properties. Rather, classification of insulation materials is to be done by the material standards themselves.

1.3 *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.*

1.4 *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]

D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams

E456 Terminology Relating to Quality and Statistics

E2282 Guide for Defining the Test Result of a Test Method

2.2 *ISO Standard:*

ISO 7345 Thermal Insulation—Physical Quantities and Definitions[3]

3. Terminology

3.1 *Definitions:*

absorptance, *n*—the ratio of the radiant flux absorbed by a body to that incident upon it.

absorption, *n*—transformation of radiant energy to a different form of energy by interaction with matter.

apparent thermal conductivity, λ_a, k_a, *n*—a thermal conductivity assigned to a material that exhibits thermal transmission by several modes of heat transfer resulting in property variation with specimen thickness, or surface emittance. See **conductivity, thermal**.

Discussion—Thermal conductivity and resistivity are normally considered to be intrinsic or specific properties of materials and, as such, should be independent of thickness. When nonconductive modes of heat transfer are present within the specimen (radiation, free convection) this may not be the case. To indicate the possible presence of this phenomena (for example, thickness effect) the modifier "apparent" is used, as in apparent thermal conductivity.

Discussion—Test data using the "apparent" modifier must be quoted only for the conditions of the measurement. Values of thermal conductance (material *C*) and thermal resistance (material *R*) calculated from apparent thermal conductivity or resistivity, are valid only for the same conditions.

Discussion—Test data labeled with "apparent" shall not include any equipment related measurement errors induced due to measurement attempts beyond an apparatus range or calibration.

Discussion—Use of the "apparent" modifier with system *C* or system *R* measurements is not permitted.

apparent thermal resistivity, r_a, *n*—a thermal resistivity assigned to a material that exhibits thermal transmission by several modes of heat transfer resulting in property variation with specimen thickness, or surface emittance. See **resistivity, thermal**.

Discussion—See entire discussion under **apparent thermal conductivity.**

area weight, *n*—weight per unit area for a specified sample, in units of lb/ft^2 (kg/m^2).

aerogel, *n*—a homogeneous, low-density solid phase material derived from a gel, in which the liquid component of the gel has been replaced with a gas.

Discussion—The resulting material has a porous structure with an average pore size below the mean free path of air molecules at standard atmospheric pressure and temperature.

batt, *n*—blanket insulation manufactured to dimensions as required by a specific application.

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[1] This terminology is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.94 on Terminology.

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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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

blackbody, *n*—the ideal, perfect emitter and absorber of thermal radiation. It emits radiant energy at each wavelength at the maximum rate possible as a consequence of its temperature, and absorbs all incident radiance.

blanket, *n*—flexible insulation product, supplied rolled or flat.

blanket insulation, *n*—a relatively flat and flexible insulation in coherent sheet form furnished in units of substantial area.

blanket insulation, metal mesh, *n*—blanket insulation covered by flexible metal-mesh facings attached on one or both sides.

block insulation, *n*—rigid insulation preformed into rectangular units.

board insulation, *n*—semirigid insulation preformed into rectangular units having a degree of suppleness particularly related to their geometrical dimensions.

calcium silicate, *n*—insulation composed principally of hydrous calcium silicate, and which usually contains reinforcing fibers.

cellular elastomeric, *n*—insulation composed principally of natural or synthetic elastomers, or both, processed to form a flexible, semirigid, or rigid foam which has a predominantly closed-cell structure.

cellular glass, *n*—insulation composed of glass processed to form a rigid foam having a predominantly closed-cell structure.

cellular polyimide, *n*—insulation composed of the reaction product in which the bonds formed between monomers during polymerization are essentially imide units forming a cellular structure.

cellular polystyrene, *n*—insulation composed principally of polymerized styrene resin processed to form a rigid foam having a predominantly closed-cell structure.

cellular polyurethane, *n*—insulation composed principally of the catalyzed reaction product of polyisocyanate and polyhydroxy compounds, processed usually with fluorocarbon gas to form a rigid foam having a predominantly closed-cell structure.

cellulosic fiber, *n*—insulation composed principally of cellulose fibers usually derived from paper, paperboard stock, or wood, with or without binders.

cement, finishing, *n*—a mixture of dry fibrous or powdery materials, or both, that when mixed with water develops a plastic consistency, and when dried in place forms a relatively hard, protective surface.

cement, insulating, *n*—a mixture of dry granular, flaky, fibrous, or powdery materials that when mixed with water develops a plastic consistency, and when dried in place forms a coherent covering that affords substantial resistance to heat transmission.

cladding, *n*—See **jacket** *(as related to insulation jacketing)*.

closed cell foam, *n*—a material comprised predominantly of individual non-interconnecting cellular voids.

coating, *n*—a liquid or semiliquid that dries or cures to form a protective finish, suitable for application to thermal insulation or other surfaces in thickness of 30 mils (0.76 mm) or less, per coat.

conductance, film, *n*—the time rate of heat flow from a unit area of a surface to its surroundings, induced by a unit temperature difference between the surface and the environment.

Discussion—The environment is a fluid (liquids or gases). *h* depends on the nature of fluid motion past the surface (laminar or turbulent). (*h* in SI units: $W/m^2 \cdot K$).

conductance, thermal, *C***,** *n*—the time rate of steady state heat flow through a unit area of a material or construction induced by a unit temperature difference between the body surfaces.

$$C = q/\Delta T$$

A conductance (C) associated with a material shall be specified as a material C. A conductance (C) associated with a system or construction of materials shall be specified as a system C. (C in SI units: W/m^2K.) (C in inch-pound units: $(Btu/h)/ft^2/F = Btu/h\ ft^2F$.)

Discussion—The average temperature of a surface is the area-weighted temperature of that surface.

Discussion—When the surfaces of a mass type thermal insulation are not of equal areas, as in the case of thermal transmission in the radial direction, or are not of uniform separation (thickness), the surface area and thickness to which the conductance is assigned must be defined.

Discussion—"Total" or "areal" thermal conductance are often used as synonyms for thermal conductance.

Discussion—Thermal conductance and thermal resistance are reciprocals of one another.

Discussion—See Discussion under **resistance, thermal.**

conductivity, thermal, λ or k, *n*—the time rate of steady state heat flow through a unit area of a homogeneous material induced by a unit temperature gradient in a direction perpendicular to that unit area. (λ or k in SI units: $(W/m^2)/(K/m) = W/m\ K$.) (λ or k in inch-pound units: $(Btu/h)/ft^2/(F/ft) = Btu/h\ ft\ F$) or $(Btu/h)/ft^2/(F/in.) = Btu\ in./h\ ft^2\ F$.) (See discussion under **apparent thermal conductivity**.)

Discussion—Thermal conductivity testing is usually done in one of two apparatus/specimen geometries: flat-slab specimens with parallel heat flux lines, or cylindrical specimens with radial heat flux lines. The operational definitions of thermal conductivity for these two cases are given as follows:

$$\text{Flat-slab geometry } \lambda = \frac{Q}{A}\frac{L}{\Delta T} \tag{1}$$

where:

Q = heat flow rate,
A = area through which Q passes, and
L = thickness of the flat-slab specimen across which the temperature difference ΔT exists.

The $\Delta T/L$ ratio approximates the temperature gradient.

$$\text{Cylindrical geometry } \lambda = \frac{Q}{2\pi l \Delta T}\log_e \frac{r_2}{r_1} \tag{2}$$