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Standard Symbols for Heat Transmission[1]

This standard is issued under the fixed designation C 108; 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.

SPECIAL PRACTICES RELATING TO HEAT FLOW TERMS

Terms Ending in "ivity"—Terms ending in "ivity" designate characteristics of materials, normally independent of size or shape, sometimes called "specific properties."

Examples: Conductivity and resistivity.

Terms Ending in "ance"—Terms ending in "ance" designate properties of a particular object, depending not only on the material, but also upon size and shape, sometimes called "total quantities."

Examples: Conductance and transmittance.

Terms Ending in "ion"—Terms ending in "ion" designate time rate of the process of transfer; flux, flow rate.

Examples: Conduction and transmission.

Transmission—"Transmission," "transmissivity," "transmittance" usually refer to transfer by one or more of the processes of conduction, convection, and radiation.

Conduction—"Conduction," "conductivity," "conductance" usually refer to transfer within a medium, and without bodily displacement as occurs with convection, and without transfer at a distance as occurs with radiation.

HEAT FLOW SYMBOLS

A = area

p = density; pounds, kilograms, etc., per unit of volume

L = length of path of heat flow

Q = total quantity of heat transferred (with subscripts for particular cases and to distinguish for Q for volume rate)

Q = volume rate; discharge by volume; fluid rate of flow by volume. (There also is used q with a subscript to distinguish from heat flow rate.)

c = specific heat

T = temperature on absolute scale

t = temperature, degrees Celsius or Fahrenheit

t, τ = time

W = weight; quantity of matter measured in pounds, kilograms, etc.

w = flow rate; pounds, kiliograms, etc., per unit of time

q = heat flow rate; time rate of heat transferred for a particular setup with any value of area A

q is in general the time derivative of total quantity of heat transferred. For steady-state heat flow, q is total quantity of heat divided by time.

k = thermal conductivity; heat flow rate, per unit of area, per "degree per unit of length"

dq/d[mathit]A = −k (dt/dL) general expression giving value at each point

k = (q/A)/(Δt/L) for substantially uniform and steady-state heat flow through a homogeneous medium of thickness L, with plane parallel faces of area A, and a constant temperature difference Δt applied to the faces

$1/k$ = thermal resistivity; reciprocal of conductivity

R = thermal resistance; degrees, per unit of heat flow rate, for a particular body or setup (where the area may not be known)

$R = \Delta t/q$ for substantially uniform and steady-state heat flow, generally

R = L/kA for substantially uniform and steady-state heat flow through a homogeneous medium of thickness L with plane parallel faces of area A

$1/R$ = thermal conductance; reciprocal of thermal resistance (C is also used)

$1/RA$ = thermal conductance per unit of area; heat flow, rate, per unit of area, per degree

RA = thermal resistance of unit area; degrees, per "unit of heat flow rate per unit of area." R is used for resistance for a setup with a particular area (which may not be known) and RA for resistance of unit area. In some British texts R is used for thermal resistance of unit area, here called RA

h = surface coefficient of heat transfer; heat flow rate, per unit of area, per degree, across a boundary surface

$dq/dA = h\Delta t$ general expression giving value at each point

$h_m = (q/A)/\Delta t_m$ for substantially uniform and steady-state heat flow, where h_m and Δt_m are constant over the area A or where one (but not both) of them varies but may substantially be represented by a mean value. h is an average property of a particular boundary condition or film and is not necessarily inversely proportional to film thickness. Δt_m is the mean absolute difference between the temperature t_s of the surface and t, the bulk temperature of the ambient fluid, or the temperature of the surface of an adjacent solid.

U = overall coefficient of heat transfer; sometimes called thermal transmittance per unit of area; heat flow rate, per unit of area, per degree, for a particular setup of one or more bodies and films.Then for substantially uniform and steady-state heat flow

$U = (q/A)/\Delta t$ Some particular area in the setup, A, may be chosen as a reference. Then for a setup of homogeneous bodies, area A_x, and adjacent films, area A_{fx}, where the corresponding values of h and k are substantially constant over the areas considered,

$$1/U = \Sigma(L/kA_xA) + \Sigma[1/(hA_{fx}/A)]$$

[1] These symbols are under the jurisdiction of ASTM Committee C08 on Refractories and are the direct responsibility of Subcommittee C08.02 on Thermal Properties.

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These symbols for heat transmission are identical with those appearing in the American National Standard Letter Symbols for Heat and Thermodynamics Including Heat Flow (ANSI Y10.4) of the American National Standards Institutes.

For parallel walls,

$1/U = \Sigma(L/k) + \Sigma(1/h)$ *or*,

$1/U = \Sigma RA + \Sigma(1/h)$

S = shape factor of a structure; heat flow rate, divided by equivalent thermal conductivity and by the temperature difference between inner and outer surfaces,

$$S = q/k\Delta t_s$$

ε = total emissivity; ratio of radiant flux from a source to that for a blackbody of the same size and shape, at the same temperature, according to the Stefan-Boltzmann law which is,

$$\Phi = \sigma\varepsilon AT^4$$

Φ = radiant flux; radiant energy per unit of time, for any area A

α = thermal diffusivity; thermal conductivity divided by heat capacity per unit volume,

$$\alpha = k/c\rho$$

G = flow rate in pounds per unit of time, per unit of area of cross section; called weight velocity, or mass velocity,

$$G = V\rho$$

Δ = difference between values, often taken as positive when it is that difference causing flow.