National Institute of Standards & Technology

Certificate

Standard Reference Material 1459

Thermal Resistance - Fumed Silica Board

Standard Reference Material (SRM) 1459 is intended for use in checking the performance of a guarded hot plate or in calibrating a heat flow meter used in measuring the thermal resistance of insulating materials. This SRM consists of a square panel of fumed silica board having nominal dimensions of 300 × 300 × 25.4 mm. The certified values of Thermal Resistance, R_O, of a nominal 25.4 mm thick specimen as a function of density and pressure, at a mean temperature of 297 K, are as follows:

Thermal Resistance, R_O ($m^2 \cdot K \cdot W^{-1}$)				
Pressure	Density ($kg \cdot m^{-3}$)			
(kPa)	300.0	310.0	320.0	330.0
97.0	1.253	1.240	1.227	1.215
98.0	1.249	1.236	1.223	1.211
99.0	1.245	1.232	1.219	1.207
100.0	1.240	1.227	1.215	1.203
101.0	1.236	1.223	1.211	1.199
102.0	1.232	1.219	1.207	1.195

The tabulated values of thermal resistance were computed using an empirical equation obtained from least squares analysis of 35 thermal resistance measurements made on 15 specimens taken from this particular lot of material. These certified values apply only to this lot of fumed silica board. Values of thermal resistance of this SRM are expected to be within 1.5 percent of the computed values at 297 K. This estimate is based on the experimental data and includes both material variability and measurement uncertainty.

The technical measurements and characterization of this SRM were performed in the Building Environment Division by R.R. Zarr and T.A. Somers under the leadership of R.R. Zarr.

The technical support involved in the preparation, certification, and issuance of this SRM were coordinated through the Office of Standard Reference Materials by R.L. McKenzie.

Gaithersburg MD 20899
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Thermal conductivity measurements were made on the NIST 1-m line-source guarded hot plate. This apparatus conforms to ASTM C-177 [1]. Measurements were made at a mean temperature of 297 K with a temperature difference of 28 K across the specimen. The ambient air pressure ranged from 97.51 to 101.59 kPa.

SRM 1449 consists of a mixture of 60% amorphous silica (SiO_2), 35% ilmenite ($FeTiO_3$), and 5% ceramic fibers, pressed into panel form. The panels were cured at 1170 K (900 °C) to burn out all organic material. After curing, this particular lot was heat-treated at 920 K (650 °C) an additional eight hours. The material was produced for NIST by Wacker-Chemie GmbH. The bulk density of the lot of material ranges from about 304.5 to 325.4 $kg \cdot m^{-3}$.

Directions for Use:

Specimens must be dried at 373 K (100 °C) for 24 hours before any measurements are made. See Precautions for Use listed on the next page. Because the as-tested thickness will most likely be different from 0.0254 m, the R-values of this SRM for a thickness L can be calculated from

$$R = \frac{R_0}{0.0254} \times L$$

where R is the thermal resistance at the tested thickness L (in meters) and R_0 is the certified value interpolated from the table or calculated from the equations given below.

Data were fitted to an equation of the form:

$$\lambda(\rho, P) = a_0 + a_1 \cdot \rho + a_2 \cdot P$$

where,

$\lambda(\rho, P)$ = thermal conductivity, $W \cdot m^{-1} \cdot K^{-1}$

ρ = bulk density - dry, $kg \cdot m^{-3}$

P = ambient air pressure, kPa

by the method of least squares. The values of coefficients are:

$a_0 = 6.9943 \times 10^{-3}$ $W \cdot m^{-1} \cdot K^{-1}$

$a_1 = 2.1375 \times 10^{-5}$ $W \cdot m^{2} \cdot K^{-1} \cdot kg^{-1}$

$a_2 = 7.0723 \times 10^{-5}$ $W \cdot m^{-1} \cdot K^{-1} \cdot kPa^{-1}$.

The last digit of the coefficients is provided to reduce rounding errors. The standard deviation computed from the residuals of the fit is 0.32 percent. All the measured values were within 3 standard deviations of the computed values.

The certified values of thermal resistance were calculated from smoothed values of thermal conductivity by using

$$R_0 = \frac{0.0254}{\lambda(\rho,P)}.$$

Precautions for Use:

This SRM should not be heated above 773 K (500 °C) at any time.

This SRM will experience permanent damage if brought in contact with liquids. Avoid contact with liquids.

The plates of the apparatus must be in good thermal contact with the specimen but the pressure from the clamping force should not exceed 2.5 kPa.

The density and as-tested thickness should be determined according to the procedure specified in ASTM C-177.

Conversions			
Parameters	SI Units	Factors to Convert (Multiply SI Units)	Conventional Units
Density, ρ	$kg \cdot m^{-3}$	0.06243	$lb \cdot ft^{-3}$
Pressure, P	kPa	0.2961	in Hg (60 °F)
Thermal conductivity, λ	$W \cdot m^{-1} \cdot K^{-1}$	6.9335	$Btu \cdot in \cdot h^{-1} \cdot ft^{-2} \cdot (°F)^{-1}$
Thermal resistance, R	$m^2 \cdot K \cdot W^{-1}$	5.6783	$h \cdot ft^2 \cdot °F \cdot Btu^{-1}$
Temperature, T	K	1.8(T - 273.15) + 32	°F

References:

1. Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate, Annual Book of ASTM Standards, Section 4, Volume 04.06, American Society for Testing and Materials, Philadelphia, PA, 1986.