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Standard Reference Material 1450

Thermal Resistance - Fibrous Glass Board

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Thermal Resistance *(R) of a 2.54 cm Thick Specimen as a Function of Density (ρ) and Temperature (T)

Temperature	Density				
	100 $kg \cdot m^{-3}$	120 $kg \cdot m^{-3}$	140 $kg \cdot m^{-3}$	160 $kg \cdot m^{-3}$	180 $kg \cdot m^{-3}$
255 K	0.927 $m^2 \cdot K \cdot W^{-1}$	0.903 $m^2 \cdot K \cdot W^{-1}$	0.880 $m^2 \cdot K \cdot W^{-1}$	0.858 $m^2 \cdot K \cdot W^{-1}$	0.838 $m^2 \cdot K \cdot W^{-1}$
260	.913	.890	.868	.847	.827
265	.900	.877	.856	.835	.816
270	.886	.864	.843	.823	.804
275	.873	.851	.831	.812	.793
280	.859	.838	.819	.800	.782
285	.845	.825	.806	.788	.770
290	.831	.812	.793	.776	.759
295	.817	.799	.781	.764	.747
300	.804	.785	.768	.752	.736
305	.790	.772	.755	.739	.724
310	.776	.759	.743	.727	.712
315	.762	.746	.730	.715	.701
320	.748	.733	.718	.703	.689
325	.735	.720	.705	.691	.678
330	.721	.707	.693	.679	.666

*The last digit is provided for accurate interpolation.

The tabulated values of thermal resistance were computed using an empirical equation obtained from a least squares analysis of 121 thermal resistance measurements made on 71 pairs of specimens taken from this particular lot of material. These certified values apply only to this lot of fibrous glass board. Values of thermal resistance of this SRM are expected to be within 2 percent of the computed values. This estimate is based on the experimental data and is believed to include both material variability and measurement uncertainty.

The direction of the technical measurements and statistical analysis was performed under the supervision of Frank J. Powell and H. H. Ku, respectively.

The technical support aspects involved in the preparation, certification, and issuance of Standard Reference Material 1450 were coordinated through the Office of Standard Reference Materials by R. K. Kirby.

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Introduction - Background

SRM 1450 consists of fine fibered glass formed into a semi-rigid board with phenolic binder. SRM 1450 is available as a 2.54 cm (1 in) thick semi-rigid board 60 cm (24 in) square. The bulk density of the material ranges from about 110 to 170 $kg \cdot m^{-3}$ (7 to 11 $lb \cdot ft^{-3}$). The material was donated by Owens-Corning Fiberglas Corporation.

This SRM should not be heated above 375 K (215 °F). With proper handling this material appears to be stable for a period of at least 20 years.

Base Measurements

Thermal resistance measurements of SRM 1450 were made on the NBS 20-cm square guarded hot-plate apparatus (conforming to ASTM C-177**). Specimens were air dried in an oven at 373 K for 24 hours before placement into the apparatus. Measurements were made at mean specimen temperatures from 255 to 330 K with temperature gradients from 9 to 12 $K \cdot cm^{-1}$.

Data were fitted to an equation of the form

$$\lambda(\rho,T) = \frac{L}{R} = a_0 + a_1\rho + a_2T^3 \qquad \text{(Eq. 1)}$$

$\lambda(\rho,T)$ = thermal conductivity, $W \cdot m^{-1} \cdot K^{-1}$
R = thermal resistance, $m^2 \cdot K \cdot W^{-1}$
L = thickness, m
ρ = bulk density, $kg \cdot m^{-3}$
T = mean specimen temperature, K

by the method of least squares using the Omnitab Fit routine. The values of the coefficients obtained are

$a_0 = 1.7062 \times 10^{-2}\ W \cdot m^{-1} \cdot K^{-1}$
$a_1 = 3.648 \times 10^{-5}\ W \cdot m^2 \cdot K^{-1} \cdot kg^{-1}$
$a_2 = 4.037 \times 10^{-10}\ W \cdot m^{-1} \cdot K^{-4}$

The standard deviation computed from residuals of the fit is 2.7×10^{-4} (~1 percent). All of the measured values were within 3 standard deviations of the computed values and examination of the residuals did not reveal any systematic trends.

***Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate,* Annual Book of ASTM Standards, Part 18, pp. 19-52, American Society for Testing and Materials, Philadelphia, Pa., 1977.

Calculations

The thermal resistance of SRM 1450 at density ρ and temperature T is obtained by first measuring its thickness and density using the procedures specified in ASTM C-177. If the measured thickness is 0.0254 m then the R-values can be interpolated directly from the tabulated values. If the measured thickness is different from 0.0254 m then the R-values must be calculated by substitution in Eq. 1. For example, the thermal resistance of SRM 1450 of thickness 0.0250 m, density 137 $kg \cdot m^{-3}$ and temperature 283 K is:

$$R = \frac{0.0250}{1.7062 \times 10^{-2} + 3.648 \times 10^{-5} \times 137 + 4.037 \times 10^{-10} \times 283^3}$$

$$R = 0.801\ m^2 \cdot K \cdot W^{-1}$$

Conversions

Parameters	SI Units	Factors to Convert (Multiply SI Units)	Conventional Units
Density, ρ	$kg \cdot m^{-3}$	0.06243	$lb \cdot ft^{-3}$
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