U.S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 1450b

Thermal Resistance – Fibrous Glass Board

J.G. Hust

This Standard Reference Material (SRM) 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.

Certified values of Thermal Resistance of a nominal 2.54 cm thick specimen, R_o, as a function of density and temperature. (These values have been corrected for the thermal expansion of the measurement plates.)

Temperature (K)	Density ($kg \cdot m^{-3}$)				
	110	120	130	140	150
	Thermal Resistance, R_o ($m^2 \cdot K \cdot W^{-1}$)				
100	2.143	2.094	2.049	2.004	1.961
110	1.946	1.906	1.867	1.831	1.795
120	1.780	1.747	1.714	1.683	1.653
130	1.640	1.611	1.583	1.557	1.531
140	1.519	1.495	1.471	1.448	1.426
150	1.416	1.395	1.374	1.354	1.334
160	1.327	1.308	1.290	1.272	1.255
170	1.250	1.234	1.217	1.202	1.186
180	1.184	1.169	1.154	1.140	1.126
190	1.126	1.112	1.099	1.086	1.073
200	1.074	1.062	1.050	1.038	1.027
210	1.028	1.017	1.006	0.995	0.985
220	0.987	0.977	0.966	.956	.947
230	.949	.939	.930	.921	.912
240	.913	.905	.896	.887	.879
250	.880	.872	.864	.856	.848
260	.848	.841	.833	.826	.818
270	.818	.811	.804	.797	.790
280	.790	.783	.776	.770	.764
290	.762	.756	.750	.744	.738
300	.736	.730	.724	.719	.713
310	.711	.706	.700	.695	.690
320	.687	.682	.677	.672	.667
330	.665	.660	.655	.651	.646

The tabulated values of thermal resistance were computed using an empirical equation obtained from a least squares analysis of 114 thermal resistance measurements made on 33 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 at temperatures from 250 to 330 K and increasing to 3 percent at 100 K. This estimate is based on the experimental data and includes both material variability and measurement uncertainty.

Gaithersburg, MD 20899
May 20, 1985
(Revision of Certificate
dated 5-21-82)

Stanley D. Rasberry Chief
Office of Standard Reference Materials

(over)

Thermal conductivity measurements were made on the NBS 20-cm square guarded hot plate by M.C.I. Siu in the Building Physics Division and on a 20-cm round guarded hot plate by J.G. Hust in the Chemical Engineering Science Division. Both of these guarded hot plates conform to ASTM C-177**. Measurements were made at mean temperatures ranging from 100 to 335 K with a temperature difference of about 24 K across the test specimen. The measurements of the two laboratories differed by 1.2 percent at 260 K, 0.0 percent at 295 K, and 0.0 percent at 330 K.

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

SRM 1450b is a semirigid board formed from fine-glass fibers in a phenolic binder, that was donated by Owens-Corning Fiberglas Corporation. The bulk density of the lot of material ranges from about 110 to 145 $kg \cdot m^{-3}$ (7 to 9 $lb \cdot ft^{-3}$).

With proper handling this material appears to be stable for a period of at least 20 years.

Directions for Use

Specimens must be air dried in an oven at 373 K for 24 hours before any measurements are made. See precaution on following page. Because the as-tested thickness will most likely be different from 0.0254 m, the R values of this SRM can be calculated from:

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

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

Data were fitted to an equation of the form:

$$\lambda(T,\rho) = a_1 + a_2\rho + a_3T + a_4T^3 + a_5\exp -[(T-180)/75]^2$$

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

ρ = bulk density, $kg \cdot m^{-3}$

T = mean specimen temperature, K

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

$$a_1 = -2.228 \cdot 10^{-3}$$

$$a_2 = 2.743 \cdot 10^{-5}$$

$$a_3 = 1.063 \cdot 10^{-4}$$

$$a_4 = 6.473 \cdot 10^{-11}$$

$$a_5 = 1.157 \cdot 10^{-3}$$

The standard deviation computed from residuals of the fit is 0.76 percent. All but one of 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

$$R_o = \frac{0.0254}{\lambda(T,\rho)}.$$

**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., 1984.

Precautions:

1) This SRM should not be heated above 375 K (215 °F) at any time.

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

3) 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. Compression of the specimen to less than 2.4 cm thickness should be avoided.

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	$W \cdot m^{-1} \cdot K^{-1}$	6.9348	$Btu \cdot in \cdot h^{-1} \cdot ft^{-2} \cdot (°F)^{-1}$
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