

National Bureau of Standards

Certificate

Standard Reference Material 1452

Thermal Resistance

Fibrous Glass Blanket for High Precision Measurements

This Standard Reference Material (SRM) is intended for use in the evaluation of a guarded hot plate (GHP) or the calibration of a heat flow meter (HFM). Both of these apparatuses are used to measure the thermal resistance of insulating materials. Each unit of SRM 1452 is an individually characterized specimen from the same lot of material as SRM 1451 [4]. SRM 1452 consists of fibrous glass made into a low-density blanket bonded with phenolic resin. It is supplied as a fibrous glass batt of nominal dimensions 60 x 60 x 2.54 cm. The material was produced for NBS by Manville Corporation. The bulk density of the lot of material ranges from 10 to 16 kg/m³ (0.6 to 1.0 lb/ft³).

The certified value of the material resistance, R_0 , of specimen _____ at 297.1 K and at a thickness of 2.540 cm is _____ m²·K/W. The corresponding value of apparent thermal conductivity is _____ Wm⁻¹·K⁻¹. The certified value was established with an estimated uncertainty of ±1.4 percent for a 95 percent confidence level. The statistical bases for the estimated uncertainty and the experimental details are described in reference [1]. The specimen was measured on a HFM apparatus with a guard size of 61.0 x 61.0 cm square, and a metered-area size of 25.4 x 25.4 cm, according to ASTM Test Method C-518 [2]. This HFM apparatus was calibrated with the NBS one-meter GHP apparatus [1], according to ASTM Test Method C-177 [3]. The estimated uncertainty is applicable for an apparatus with a metered area of 25.4 x 25.4 cm square. The estimated uncertainty is greater for other metered areas [1]. For example, if a user apparatus has a metered area that is one-half or twice this assumed metered area, the estimated uncertainty is ±1.8 percent for a 95 percent confidence level. The estimated uncertainty for an apparatus with a 10.2 x 10.2 cm metered area is ±2.1 percent for a 95 percent confidence level.

The overall direction and coordination of the certification of this SRM and technical measurements were performed by B.G. Rennex; assistance in certification measurements was given by T. Somers both of the Building Physics Division; and technical advice and collaboration was provided by J. Hust of the Chemical Engineering Science Division.

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

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Gaithersburg, MD 20899

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(Over)

Directions for Use:

Specimens should be air-dried in an oven at a temperature not exceeding 375 K for 24 hours before any measurements are made. See the precautions below. Because the user test thickness will most likely be slightly different from the nominal thickness of 2.54 cm, the R-value, R, at a particular thickness, L, must be calculated from the relationship:

$$R = R_0 (L/2.54 \text{ cm}), \quad (1)$$

where R_0 is the certified R-value at 2.54 cm. This equation should be restricted to thicknesses (L) between 2.29 and 2.54 cm.

Use at Other Temperatures:

For SRM 1452 specimens, the apparent thermal conductivity at temperatures other than 297.1 K, $\lambda(T)$ can be calculated. First, a coefficient, a_1 , is calculated based on the λ -value at 297.1 K for a particular specimen.

$$\lambda(297.1 \text{ K}) = 0.0254 \text{ m} / R_0 \quad (2)$$

$$a_1 = \lambda(297.1 \text{ K}) - a_2\rho - a_3 (297.1 \text{ K}) - a_4 (297.1 \text{ K})^3 / \rho - a_5 \exp[-(297.1-180)/75]^2 \quad (3)$$

This equation is based on data for the SRM 1451 lot, from which the 1452 specimens were selected [5]. It expresses the dependence of λ on the specimen mean temperature, T, and the specimen bulk density, ρ .

The other coefficient values are:

$$\begin{aligned} a_2 &= 1.378 \times 10^{-4} \\ a_3 &= 7.714 \times 10^{-5} \\ a_4 &= 8.472 \times 10^{-9} \\ a_5 &= 1.339 \times 10^{-3} \end{aligned}$$

Then, the apparent thermal conductivity can be calculated for any temperature within the range from 100 K to 330 K, the range over which the material was tested [5].

$$\lambda(T, \rho) = a_1 + a_2\rho + a_3T + a_4T^3 / \rho + a_5 \exp[-(T-180)/75]^2 \quad (4)$$

Finally, the certified R-value at T can be calculated.

$$R_0(T) = \frac{0.0254}{\lambda(T, \rho)} \quad (5)$$

The estimated uncertainties will increase from the values given on the previous page for 297.1 K to 3 percent at the upper limit of 330 K and to 5 percent at the lower limit of 100 K.

Precautions:

- 1) This SRM should not be heated above 375 K (215 °F).
- 2) The density and the thickness should be determined in accordance with ASTM C-177 [3].
- 3) The apparatus plates must be in good thermal contact with the specimen, but the specimen should not be compressed to below 2.3 cm.

References:

1. Rennex, B.G., Somers, T., "Apparent Thermal Conductivity Characterization of Low-Density, Glass-Fiber Insulation Material", Journal of Thermal Insulation, Vol. 8, No. 3, pp. 175-197, January, 1985.
2. 1984 Annual Book of ASTM Standards, Vol. 04.06, ANSI/ASTM C-518-76, "Standard Test Method for STEADY-STATE THERMAL TRANSMISSION PROPERTIES BY MEANS OF THE HEAT FLOW METER," American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.
3. 1984 Annual Book of ASTM Standards, Vol. 04.06, ANSI/ASTM C-177-76, "Standard Test Method for STEADY-STATE THERMAL TRANSMISSION PROPERTIES BY MEANS OF THE GUARDED HOT PLATE," American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, pp. 20-53.
4. National Bureau of Standards Certificate Standard Reference Material 1451 for the Thermal Resistance of Fibrous Glass Blanket, available from the Office of Standard Reference Materials, National Bureau of Standards, Gaithersburg, MD 20899.
5. Hust, J., "Standard Reference Materials: Glass-Fiber Blanket SRM for Thermal Resistance," NBS Special Publication 260-103, 1985.