



Standard Test Method for Measurement of the Specific Electrical Impedance of Electrical-Grade Magnesium Oxide for Use in Sheathed-Type Heating Elements¹

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1. Scope

1.1 This test method covers the determination of specific electrical impedance of electrical-grade magnesium oxide by externally heating a test cell to elevated temperatures using typical materials.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

B 344 Specification for Drawn or Rolled Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating Elements²

D 2755 Test Method of Sampling and Reduction to Test Weight of Electrical Grade Magnesium Oxide³

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *measured impedance, Z , n* —the ratio of the root mean square of the voltage applied between two electrodes that are in contact with the specimen to the root mean square of the current distributed throughout the volume of the specimen (neglecting phase effects).

3.1.2 *shape factor, F , n* —the ratio of the test cell length to the logarithm of the ratio of the test-cell diameters, relating the current flow per unit length to the logarithmic mean potential gradient across the insulation.

3.1.3 *specific electrical impedance, Z_s , n* —the ratio of the root mean square of an alternating potential gradient parallel to the current in the material to the root mean square of the

current density, and equal to the product of the measured impedance Z and a geometrical shape factor F . (The impedance is essentially resistive and phase effects are ignored).

4. Summary of Test Method

4.1 The specimen of magnesium oxide is poured into a length of tubing around a centrally located rod, and the assembly is compacted to form a test cell simulating a sheathed heating element. The test cell is placed in a heated furnace. Voltage is applied across the magnesium oxide in the test cell in series with a known resistance. The leakage current is measured in milliamperes. The leakage current and the geometric factor are used to calculate the specific impedance.

5. Significance and Use

5.1 The specific electrical impedance can be used to indicate whether or not the magnesium oxide provides sufficient impedance to perform satisfactorily in high-temperature heating elements.

6. Apparatus

6.1 *Tube Furnace*,⁴ horizontal, having a uniformly hot zone at least 178 mm (7 in.) long. A maximum temperature spread of $\pm 5.5^\circ\text{C}$ ($\pm 10^\circ\text{F}$) between three thermocouples is acceptable.

6.2 *Tube Loading Devices* (see Fig. 1 for suggested design).

6.3 *Swaging Machine*.⁵

6.4 *Swaging Dies*, 12.06 mm (0.475 in.), 11.43 mm (0.450 in.), and 11.18 mm (0.440 in.).

6.5 *Metal Trimming Device*.

6.6 *Vibrator*.⁶

6.7 *Spot Welding Machine*.

6.8 *Thermocouples*, three, Type R, No. 24 B & S gage,

⁴ A Lindberg Single Zone Tube Furnace, Type 59545, 12 in., 500 to 1500°C, available from Lindberg Co., 304 Hart St., Watertown, WI 53094, with Temperature Control using Type R Thermocouple and suitable Ceramic Tube and Plugs, or equivalent, has been found suitable for this purpose.

⁵ Size 4 swaging machines available from either the Torrington Co., 59 Field St., Torrington, CN 06790, or the Fenn Mfg. Co., 200 Fenn Rd., Newington, CN 06111, or their equivalent, are satisfactory for this test method.

⁶ The L & A vibrator, Model F-769, Type B, Size 3, available from the Pressed Steel Co., 705 N. Pennsylvania Ave., Wilkes-Barre, PA 18703, or its equivalent, is satisfactory.

¹ This test method is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.14 on Electric Heating Unit Insulation.

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² *Annual Book of ASTM Standards*, Vol 03.04.

³ *Annual Book of ASTM Standards*, Vol 10.02.