



Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation¹

This standard is issued under the fixed designation D 150; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods cover the determination of relative permittivity, dissipation factor, loss index, power factor, phase angle, and loss angle of specimens of solid electrical insulating materials when the standards used are lumped impedances. The frequency range that can be covered extends from less than 1 Hz to several hundred megahertz.

NOTE 1—In common usage, the word relative is frequently dropped.

1.2 These test methods provide general information on a variety of electrodes, apparatus, and measurement techniques. The reader should also consult ASTM standards or other documents directly applicable to the material to be tested.^{2,3}

1.3 *This standard does not purport to address all of the safety concerns, 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.* For specific hazard statements, see 7.2.6.1 and 10.2.1.

2. Referenced Documents

2.1 ASTM Standards:

D 374 Test Methods for Thickness of Solid Electrical Insulation⁴

D 618 Practice for Conditioning Plastics for Testing⁵

D 1082 Test Method for Dissipation Factor and Permittivity (Dielectric Constant) of Mica⁴

D 1531 Test Method for Relative Permittivity (Dielectric

Constant) and Dissipation Factor by Fluid Displacement Procedures⁶

D 1711 Terminology Relating to Electrical Insulation⁴

D 5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions⁶

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions⁷

E 197 Specifications for Enclosures and Servicing Units for Tests Above and Below Room Temperature.⁸

3. Terminology

3.1 Definitions:

3.1.1 *capacitance, C, n*—that property of a system of conductors and dielectrics which permits the storage of electrically separated charges when potential differences exist between the conductors.

3.1.1.1 *Discussion*—Capacitance is the ratio of a quantity, *q*, of electricity to a potential difference, *V*. A capacitance value is always positive. The units are farads when the charge is expressed in coulombs and the potential in volts:

$$C = q/V \quad (1)$$

3.1.2 *dissipation factor, (D), (loss tangent), (tan δ), n*—the ratio of the loss index (κ'') to the relative permittivity (κ') which is equal to the tangent of its loss angle (δ) or the cotangent of its phase angle (θ) (see Fig. 1 and Fig. 2).

$$D = \kappa''/\kappa' \quad (2)$$

3.1.2.1 *Discussion*— *a*:

$$D = \tan \delta = \cot \theta = X_p/R_p = G/\omega C_p = 1/\omega C_p R_p \quad (3)$$

where:

G = equivalent ac conductance,

X_p = parallel reactance,

R_p = equivalent ac parallel resistance,

C_p = parallel capacitance, and

$\omega = 2\pi f$ (sinusoidal wave shape assumed).

The reciprocal of the dissipation factor is the quality factor, *Q*, sometimes called the storage factor. The dissipation factor,

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² R. Bartnikas, Chapter 2, "Alternating-Current Loss and Permittivity Measurements", Engineering Dielectrics, Vol. IIB, Electrical Properties of Solid Insulating Materials, Measurement Techniques, R. Bartnikas, Editor, STP 926, ASTM, Philadelphia, 1987.

³ R. Bartnikas, Chapter 1, "Dielectric Loss in Solids", Engineering Dielectrics, Vol. IIA, Electrical Properties of Solid Insulating Materials: Molecular Structure and Electrical Behavior, R. Bartnikas and R. M. Eichorn, Editors, STP 783, ASTM Philadelphia, 1983.

⁴ Annual Book of ASTM Standards, Vol 10.01.

⁵ Annual Book of ASTM Standards, Vol 08.01.

⁶ Annual Book of ASTM Standards, Vol 10.02.

⁷ Annual Book of ASTM Standards, Vol 11.03.

⁸ Discontinued, see 1980 Annual Book of ASTM Standards, Parts 40 and 41.