INTERNATIONAL

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Standard Test Method for Voltage Endurance of Solid Electrical Insulating Materials Subjected to Partial Discharges (Corona) on the Surface[1]

This standard is issued under the fixed designation D2275; 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.

1. Scope

1.1 This test method determines the voltage endurance of solid electrical insulating materials for use at commercial power frequencies under the action of corona (see Note 1). This test method is more meaningful for rating materials with respect to their resistance to prolonged ac stress under corona conditions for comparative evaluation between materials.

NOTE 1—The term "corona" is used almost exclusively in this test method instead of "partial discharge," because it is a visible glow at the edge of the electrode interface that is the result of partial discharge. Corona, as defined in Terminology D1711, is "visible partial discharges in gases adjacent to a conductor."

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 7.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D618 Practice for Conditioning Plastics for Testing

D1711 Terminology Relating to Electrical Insulation

D1868 Test Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation Systems

D3382 Test Methods for Measurement of Energy and Integrated Charge Transfer Due to Partial Discharges (Corona) Using Bridge Techniques

2.2 *Special Technical Publications:*[2]

Symposium on Corona, STP 198, ASTM, 1956

Corona Measurement and Interpretation, Engineering Dielectrics, Vol 1, STP 669, ASTM, 1979

2.3 *International Electrotechnical Commission (IEC) Documents*:[3]

IEC Publication 60343 Recommended Test Methods for Determining the Relative Resistance of Insulating Materials to Breakdown by Surface Discharges

IEEE/IEC 62539-2007 – IEC 62539 Ed.1 (IEEE Std 930™-2004) Guide for the Statistical Analysis of Electrical Insulation Breakdown Data[4]

3. Terminology

3.1 *Definitions*—For definitions of other terms used in this standard, refer to Terminology D1711 and Test Method D1868.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *surface corona, n*—corona that exists in the electrically stressed gas where electrodes are near insulation surfaces.

3.2.2 *threshold voltage*—that voltage below which failure will not occur under the test conditions irrespective of the duration of the test.

3.2.3 *voltage endurance, n*—the time that an insulating material can withstand a prolonged alternating voltage stress under the action of surface corona.

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[1] This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.12 on Electrical Tests.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, https://www.iec.ch.

[4] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.

3.2.4 *voltage stress-time curve, n*—a plot of the logarithm of the mean or median time to failure of a material against voltage stress (or the logarithm of voltage stress) for a particular set of test conditions.

3.2.4.1 *Discussion*—The plot is the quantitative depiction of the voltage stress endurance over a range of voltage stress for the conditions of test, and for the thickness tested. The curves of a material obtained at two thicknesses are different.

3.2.5 *volt-time curve, n*—a plot of the logarithm of the mean or median time to failure of a material against voltage (or the logarithm of voltage) for a particular set of test conditions.

3.2.5.1 *Discussion*—The plot is the quantitative depiction of the voltage endurance over a range of voltage for the conditions of the test, which includes the particular thickness tested.

4. Summary of Test Method

4.1 In this test method, voltage sufficient to produce surface corona is applied to nine samples from the same specimen until failure occurs. The voltage endurance is the relative time to failure, determined by the voltage-time curve or Weibull Probability Plot.

4.2 When there is a large dispersion of times to failure for a given sample, it is acceptable to use the median time of nine specimens (time of fifth failure) as the failure time for the sample. This removes the necessity of waiting for the last few to fail. The mean can also be determined statistically (see IEEE/IEC 62539-2007 for additional information).

4.3 Under the conditions outlined in Appendix X2 it is permissible for the test to be accelerated by increasing the frequency of the applied voltage. In cases agreed upon between the buyer and the seller, or required in relevant specifications to perform testing on specific specimens where a service condition is thought to alter the corona endurance, this factor shall be introduced as part of the test and reported.

4.4 It is possible to obtain additional information from the test if corona-voltage levels and corona intensity are measured at the start of the test and monitored at various stages of deterioration of the insulation. The voltage levels include corona-inception voltage, corona-extinction voltage, and corona intensity using Test Method D1868.

NOTE 2—Comparative measurements of corona power or energy by bridge and oscilloscope techniques can also be informative.

5. Significance and Use

5.1 This test method is useful in research and quality control for evaluating insulating materials and systems since they provide for the measurement of the endurance used to compare different materials to the action of corona on the external surfaces. A poor result on this test does not indicate that the material is a poor selection for use at high voltage or at high voltage stress in the absence of surface corona; surface corona is not the same as corona that occurs in internal cavities. (See Test Methods D3382.)

5.2 This test method is also useful for comparison between materials of the same relative thickness. When agreed upon between the buyer and the seller, it is acceptable to express any differences in terms of relative time to failure or the magnitude of voltage stress (kV/mm or kV/in.) required to produce failure in a specified number of hours.

5.3 It is possible for this test method to also be used to examine the effects of different processing parameters on the same insulating material, such as residual strains produced by quenching, high levels of crystallinity or molding processes that control the concentration and sizes of gas-filled cavities.

5.4 The data are generated in the form of a set of values of lifetimes at a voltage. The dispersion of failure times is analyzed using one of the methods below:

5.4.1 Weibull Probability Plot.

5.4.2 Statistically (see IEEE/IEC 62539-2007 for additional information), to yield an estimate of the central value of the distribution and its standard deviation.

5.4.3 Truncating a test at the time of the fifth failure of a set of nine and using that time as the measure of the central tendency. Two such techniques are described in 10.2.

5.5 This test method intensifies some of the more commonly met conditions of corona attack so that materials are able to be evaluated in a time that is relatively short compared to the life of the equipment. As with most accelerated life tests, caution is necessary in extrapolation from the indicated life to actual life under various operating conditions in the field.

5.6 The possible factors related to failures produced by corona are:

5.6.1 Corona eroding the insulation until the remaining insulation can no longer withstand the applied voltage.

5.6.2 Corona causing the insulation surface to become conducting due to carbonization, so that failure occurs quickly.

5.6.3 Forming of compounds such as oxalic acid crystals causing the surface conductance to vary with ambient humidity. It is possible conductance will be at a sufficient level to reduce the potential gradient at the electrode edge at moderate humidities, and thus cause either a reduction in the amount of corona, or its cessation, thus retarding failure.

5.6.4 Corona causing "treeing" within the insulation and consequently accelerating the time to failure.

5.6.5 Gases released within the insulation that change its physical dimensions.

5.6.6 Changes in the physical properties of an insulating material; embrittlement or cracking, for instance, causing the material to lose flexibility or crack, or both, and thus make it useless.

5.7 Tests are often made in open air, at 50 % relative humidity. In cases agreed upon between the buyer and the seller, additional information can be obtained for some materials with tests in circulating air at 20 % relative humidity or less (see Appendix X1).

5.7.1 If tests are made in an enclosure, the restriction in the flow of air can trap ozone and influence the results (see Appendix X2).

5.7.2 When tests are done outside the standard conditions, the report shall note the deviation and the alternative conditions.

5.8 The variability of the time to failure is a function of the consistency of the test parameters, such as voltage levels,