



Designation: D 2029 – 97

## Standard Test Methods for Water Vapor Content of Electrical Insulating Gases by Measurement of Dew Point<sup>1</sup>

This standard is issued under the fixed designation D 2029; 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 describe the determination of the water vapor content of electrical insulating gases by direct or indirect measurement of the dew point and the calculation of the water vapor content.

1.2 The following four test methods are provided:

1.2.1 *Method A* describes the automatic chilled mirror method for measurement of dew point as low as  $-73^{\circ}\text{C}$  ( $-99^{\circ}\text{F}$ ).

1.2.2 *Method B* describes the manual chilled mirror or dew cup method for measurement of dew point as low as  $-73^{\circ}\text{C}$  ( $-99^{\circ}\text{F}$ ).

1.2.3 *Method C* describes the adiabatic expansion method for measurement of dew point as low as  $-62^{\circ}\text{C}$  ( $-80^{\circ}\text{F}$ ).

1.2.4 *Method D* describes the capacitance method for measurement of dew point as low as  $-110^{\circ}\text{C}$  ( $-166^{\circ}\text{F}$ ).

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 precautions, see 8.1.1, 9.2, 10.1.2 and 10.2.5.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 1933 Specification for Nitrogen Gas as an Electrical Insulating Material<sup>2</sup>

D 2472 Specification for Sulfur Hexafluoride<sup>2</sup>

D 3283 Specification for Air as an Electrical Insulating Material<sup>2</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *dew point*,  $n$ —the temperature to which a gas must be cooled at constant pressure and constant water vapor content in order for saturation to occur. Any further cooling usually results in formation of the first drop of dew.

3.1.2 *hygroscopic*, *adj*—readily taking up and retaining moisture.

### 4. Summary of Test Methods

4.1 *Method A*—The automatic chilled mirror method uses the chilled mirror dew point condensation principle to determine the water vapor content in gas mixtures. An internal mirror, which is in the path of the test gas, is automatically cooled. Internal electronics sense the presence of moisture on the mirror. The device then automatically brings itself to equilibrium and provides a direct reading of dew point temperature.

4.2 *Method B*—This method uses the same basic condensation principle in 4.1; however, the manual chilled mirror method uses a mixture of acetone and ice or other cooling media to manually chill the dew cup polished surface which acts as the mirror.

4.3 *Method C*—Adiabatic expansion uses a process in which the test gas is cooled rapidly to determine dew point temperature. This rapid exhausting of the test gas to atmosphere results in an expansion and cooling of the gas. If the cooling is sufficient to reduce the temperature of the gas to or below the dew point, water vapor will condense out in the form of a fine mist or fog. Successive trials will determine the minimum initial pressure that will produce a fog. From this, the dew point temperature can be calculated.

4.3.1 The relationship between pressure and temperature during adiabatic expansion is as follows:

$$T_F = T_I [P_F/P_I]^{[K-1/K]}$$

where:

$K$  = ratio of specific heats for a given gas,

$T_F$  = final temperature,

$T_I$  = initial temperature,

$P_F$  = final pressure, and

$P_I$  = initial pressure.

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D-27 on Electrical Insulating Liquids and Gases and are the direct responsibility of Subcommittee D27.07 on Physical Test.

Current edition approved April 10, 1997. Published November 1997. Originally published as D 2029 – 64T. Last previous edition D 2029 – 92.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 10.03.