



Designation: D5454 – 11 (Reapproved 2020)

# Standard Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers<sup>1</sup>

This standard is issued under the fixed designation D5454; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the water vapor content of gaseous fuels by the use of electronic moisture analyzers. Such analyzers commonly use sensing cells based on phosphorus pentoxide,  $P_2O_5$ , aluminum oxide,  $Al_2O_3$ , or silicon sensors piezoelectric-type cells and laser based technologies.

1.2 *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.*

1.3 *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:*<sup>2</sup>

[D1142 Test Method for Water Vapor Content of Gaseous Fuels by Measurement of Dew-Point Temperature](#)

[D1145 Test Method for Sampling Natural Gas \(Withdrawn 1986\)](#)<sup>3</sup>

[D4178 Practice for Calibrating Moisture Analyzers](#)

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *capacitance-type cell*—this cell uses aluminum coated with  $Al_2O_3$  as part of a capacitor. The dielectric  $Al_2O_3$  film

changes the capacity of the capacitor in relation to the water vapor present. Silicone cells also operate on this principal by reporting a capacitance change when adsorbing or desorbing water vapor.

3.1.2 *electrolytic-type cell*—this cell is composed of two noble metal electrode wires coated with  $P_2O_5$ . A bias voltage is applied to the electrodes, and water vapor chemically reacts, generating a current between the electrodes proportional to the water vapor present.

3.1.3 *piezoelectric-type cell*—sensor consists of a pair of electrodes which support a quartz crystal (QCM) transducer. When voltage is applied to the sensor a very stable oscillation occurs. The faces of the sensor are coated with a hygroscopic polymer. As the amount of moisture absorbed onto the polymer varies, a proportional change in the oscillation frequency is produced.

3.1.4 *laser-type cell*—consists of a sample cell with an optical head mounted on one end and a mirror mounted on the other; however, some models will not need a mirror to reflect the light wavelength emitted from the laser. The optical head contains a NIR laser, which emits light at a wavelength known to be absorbed by the water molecule. Mounted, the laser is a detector sensitive to NIR wavelength light. Light from the laser passes through the far end and returns to the detector in the optical head. A portion of the emitted light, proportional to the water molecules present, is absorbed as the light transits the sample cell and returns to the detector.

3.1.5 *water content*—water content is customarily expressed in terms of dewpoint, °F or °C, at atmospheric pressure, or the nonmetric term of pounds per million standard cubic feet, lb/MMSCF. The latter term will be used in this test method because it is the usual readout unit for electronic analyzers. One lb/MMSCF = 21.1 ppm by volume or 16.1 mgm/m<sup>3</sup> of water vapor. Analyzers must cover the range 0.1 to 50 lb/MMSCF.

3.1.6 *water dewpoint*—the temperature (at a specified pressure) at which liquid water will start to condense from the water vapor present. Charts of dewpoints versus pressure and water content are found in Test Method [D1142](#).

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.05 on Determination of Special Constituents of Gaseous Fuels.

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

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

#### 4. Significance and Use

4.1 Water content in fuel gas is the major factor influencing internal corrosion. Hydrates, a semisolid combination of hydrocarbons and water, will form under the proper conditions causing serious operating problems. Fuel heating value is reduced by water concentration. Water concentration levels are therefore frequently measured in natural gas systems. A common pipeline specification is 4 to 7 lb/MMSCF. This test method describes measurement of water vapor content with direct readout electronic instrumentation.

#### 5. Apparatus

5.1 The moisture analyzer and sampling system will have the following general specifications:

5.1.1 *Sampling System*—Most errors involved with moisture analysis can be eliminated with a proper sampling system.

5.1.1.1 A pipeline sample should be obtained with a probe per Method **D1145**. The sample temperature must be maintained 2 °C (3 °F) above the dewpoint of the gas to prevent condensation in the sample line or analyzer. Use of insulation or heat tracing is recommended at cold ambient temperatures.

5.1.1.2 Analyzer sensors are very sensitive to contamination. Any contaminants injurious to the sensor must be removed from the sample stream before reaching the sensor. This must be done with minimum impact on accuracy or time of response. If the contaminant is an aerosol of oil, glycol, and so forth, a coalescing filter or semipermeable membrane separator must be used.

5.1.2 *Construction*—Sampling may be done at high or low pressure. All components subject to high pressure must be rated accordingly. To minimize diffusion and absorption, all materials in contact with the sample before the sensor must be made of stainless steel. Tubing of 1/8-in. stainless steel is recommended. (**Warning**—Use appropriate safety precautions when sampling at high pressure.)

5.1.2.1 Pressure gages with bourdon tubes should be avoided as a result of water accumulation in the stagnant volume.

5.1.2.2 Sample purging is important to satisfactory response time. There must be a method to purge the sample line and sample cleanup system.

5.1.3 *Electronics*—Output from the sensor will be linearized for analog or digital display in desired units (usually lb/MMSCF). There must be an adjustment for calibration accuracy available that can be used in the field if a suitable standard is available. (This does not apply to instruments that assume complete chemical reaction of water. Their accuracy still must be verified as in Section 6.)

5.1.4 *Power Supply*—Analyzers for field use will have rechargeable or easily replaceable batteries. (**Warning**—Analyzers for use in hazardous locations because of combustible gas must be certified as meeting the appropriate requirements.)

#### 6. Calibration

6.1 A calibration technique is described in Practice **D4178** that should be used to verify the accuracy of the analyzer. This method uses the known vapor pressure of water at 0 °C and mixes wet gas and dry gas to make up the total pressure so that a standard gas of known water concentration is achieved.

6.1.1 Instruments very sensitive to sample flow must be compensated for barometric pressure.

6.2 A commercially made water vapor calibrator is shown in **Fig. 1**, which uses essentially the same technique. This method is useful only between 5 to 50 lb/MMSCF.

6.3 Low-range water vapor standards may be obtained by the use of water permeation tubes. Permeation rates must be established by tube weight loss.

6.4 Compressed gas water vapor standards may be used, provided they are checked by an independent method once a month.

6.5 Calibrate the analyzer using one of the standards in **6.3** and **6.4** and respective procedures. Calibration must be at two points, one higher and one lower than average expected readings. Some analyzers can have large nonlinear errors. Use the calibration adjustment if applicable.

#### 7. Procedure

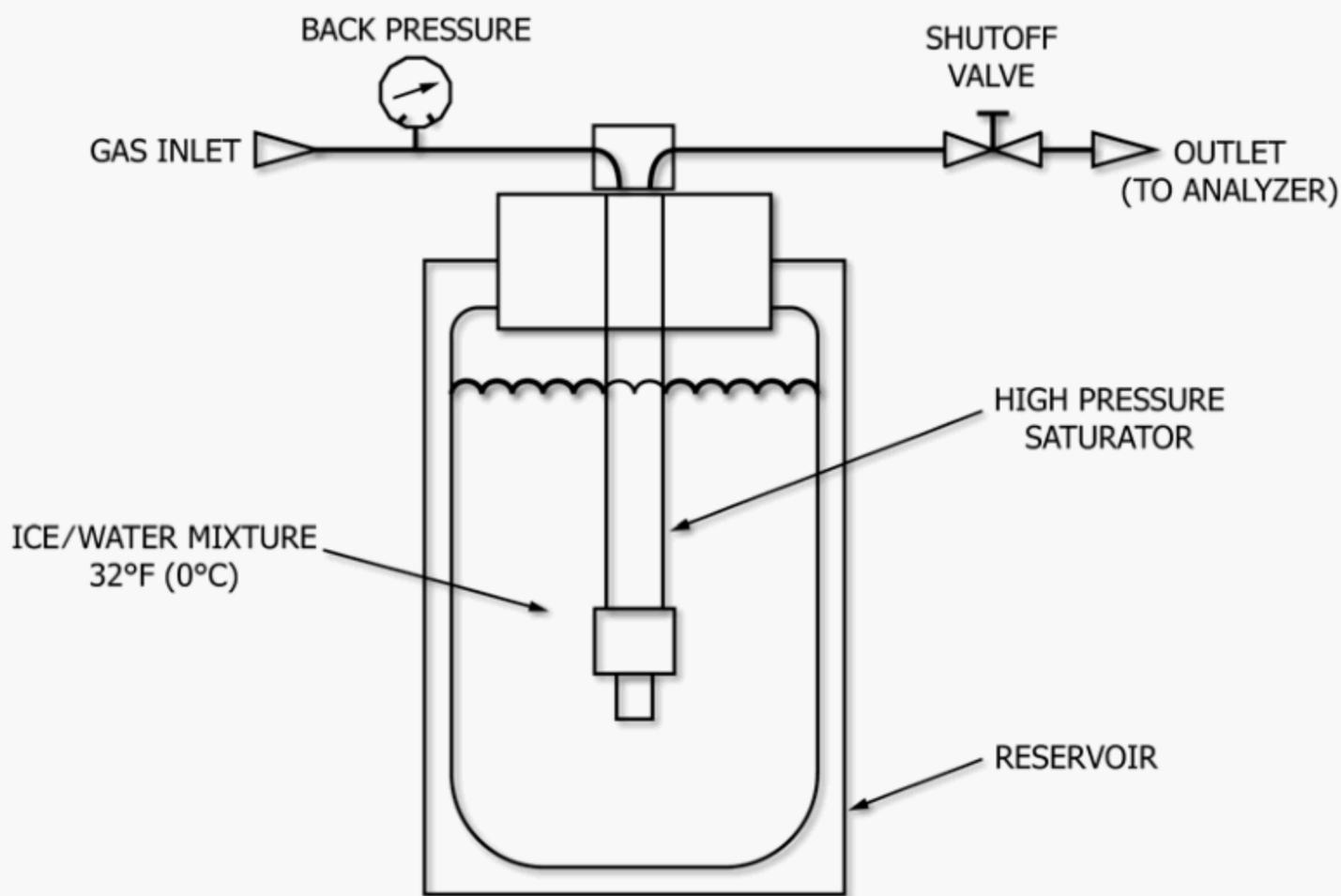
7.1 *Preparation*—The analyzer operation and calibration should be checked according to the manufacturer's recommendations prior to use. See Section 6. Verification of a dry instrument using dry compressed nitrogen to get a reading below 1 lb/MMSCF is recommended before field use.

7.2 *Sample Procedure*—Sample as in **5.1.1.1**. Use as short a sample line as practical. Purge the sample for 2 min before valving to the sensor.

7.3 *Reading*—The time for a sensor to come to equilibrium is variable depending on its type and condition. The analyzer may require 20 min to stabilize. Some analyzers have an external recorder output, and these can be used with a chart recorder to become familiar with the true equilibrium response time.

#### 8. Precision and Bias

8.1 Precision data is being prepared for this test method by an interlaboratory study.



## Flow Diagram

FIG. 1 Moisture Calibrator

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