Designation: D8094 – 21

Standard Test Method for Determination of Water Content of Liquefied Petroleum Gases (LPG) Using an Online Electronic Moisture Analyzer[1]

This standard is issued under the fixed designation D8094; 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 covers the quantitative determination of water in liquefied petroleum gases (LPG) from 1 mg⁄kg to 250 mg⁄kg using an online electronic moisture analyzer, also known as an electronic hygrometer or dew point analyzer, in the absence of methanol or other anti-freeze agent.

1.1.1 These analyzers commonly use sensing cells based on aluminum oxide, Al_2O_3, silicone, phosphorus pentoxide, P_2O_5, piezoelectric-type cells, or laser-based technologies to measure the dew point temperature of LPG.

1.1.2 Knowledge of the hydrocarbon composition of the LPG is required to calculate the water content on a mass basis from the dew point temperature of an LPG sample.

1.1.3 The LPG shall be free of alcohol (sometimes added as an anti-freeze agent) as it can interfere with the electronic moisture analyzer. Thus the method will be most useful in a process facility where it is known that no methanol has been added to the LPG product.

1.2 The values stated in SI units are to be regarded as standard.

1.2.1 There is an exception in Appendix X1, where the unit "mbar" is used in data provided by an external source, and parts per million by weight (ppm by weight) is widely used in industry.

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.*

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]

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)[3]

D1835 Specification for Liquefied Petroleum (LP) Gases

D2163 Test Method for Determination of Hydrocarbons in Liquefied Petroleum (LP) Gases and Propane/Propene Mixtures by Gas Chromatography

D2421 Practice for Interconversion of Analysis of C_5 and Lighter Hydrocarbons to Gas-Volume, Liquid-Volume, or Mass Basis

D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D6624 Practice for Determining a Flow-Proportioned Average Property Value (FPAPV) for a Collected Batch of Process Stream Material Using Stream Analyzer Data

D6849 Practice for Storage and Use of Liquefied Petroleum Gases (LPG) in Sample Cylinders for LPG Test Methods

D7453 Practice for Sampling of Petroleum Products for Analysis by Process Stream Analyzers and for Process Stream Analyzer System Validation

D7808 Practice for Determining the Site Precision of a Process Stream Analyzer on Process Stream Material

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *capacitance-type cell, n*—a sensor that can store electric charge which changes with the partial pressure of water vapor in the system.

3.1.1.1 *Discussion*—An example of capacitance-type 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.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.H0 on Liquefied Petroleum Gas.

Current edition approved July 1, 2021. Published July 2021. Originally approved in 2020. Last previous edition approved in 2020 as D8094 – 20. DOI: 10.1520/D8094-21.

[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] The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

3.1.1.2 *Discussion*—Silicone cells also operate on the same principal by reporting a capacitance change when adsorbing or desorbing water vapor.

3.1.2 *dew point, n*—the temperature, at a fixed pressure, where condensation of water first occurs.

3.1.2.1 *Discussion*—Charts of dew points versus pressure and water content are found in Test Method D1142.

3.1.2.2 *Discussion*—When water vapor is present in vaporized LPG at a constant pressure, liquid water will condense at its dew point temperature, which is directly related to the water vapor pressure.

3.1.3 *electrolytic-type cell, n*—a sensor composed of two noble metal electrode wires coated with P_2O_5.

3.1.3.1 *Discussion*—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.

3.1.4 *Henry's Law Constant (K), n*—a factor that, when multiplied by the partial pressure of water vapor in a system, gives the mass of the dissolved water in the liquid phase hydrocarbon.

3.1.4.1 *Discussion*—Henry's Law applies only to dissolved water in a liquid. If the saturation concentration of water in the LPG is exceeded, there will be free water in the system that is outside the scope of Henry's Law.

3.1.4.2 *Discussion*—The value of *K* will vary with the composition of the LPG and its temperature.

3.1.5 *laser-type cell, n*—a sensor with an optical head containing a near infrared (NIR) laser, which emits light at a wavelength known to be absorbed by water molecules, and a detector.

3.1.5.1 *Discussion*—A portion of the emitted NIR light, proportional to the water molecules present, is absorbed as the light transits the sample cell and is measured by the detector.

3.1.6 *piezoelectric-type cell, n*—a sensor consisting of a pair of electrodes which support a quartz crystal (QCM) transducer, coated with a hygroscopic polymer, used to determine the amount of water vapor present in a sample.

3.1.6.1 *Discussion*—As the amount of moisture absorbed onto the polymer varies, a proportional change in the oscillation frequency of the QCM is produced which is converted into water content.

3.1.7 *saturation constant, n*—the maximum mass of water that can dissolve in a given mass of hydrocarbon or mixture of hydrocarbons at a given temperature and pressure.

3.1.8 *water content, n*—the amount of water in a fuel expressed in mg/kg.

4. Summary of Test Method

4.1 An LPG sample from a flowing stream of LPG is introduced to an online electronic moisture analyzer. The electronic moisture analyzer measures the dew point in either the liquid or gaseous phase. The analyzer signal is integrated over time, and the total mass of water per mass of sample is calculated from the water vapor pressure, which is functionally related to the dew point and the hydrocarbon composition of the LPG.

5. Significance and Use

5.1 The moisture content of LPG can be critical to the use, transportation, or processing of LPG products, especially at cold ambient temperatures and during pressure throttling, when icing or hydrate formation, or both, are most likely to occur. In order to prevent ice or hydrate formation, or both, the water content has to be low enough to prevent the formation of free water in storage tanks and/or regulators over the entire range of operating conditions (temperatures, pressures, and compositions) encountered during normal service. For example, propane and propane-propene mixtures require moisture levels below the equilibrium saturation level of water at operating temperature and pressure for these hydrocarbons to meet specifications such as Specification D1835.

5.2 The presence of free water in a propane system can lead to ice or hydrate accumulation, the blockage of vapor or liquid fuel lines, and disrupt the operation of pumps, meters, filters, valves, regulators, safety shut-off valves, and other equipment.

5.3 This test method allows continuous monitoring of process flow streams and could be applied to monitoring of product dryness during transportation operations if it is known that methanol has not been added.

6. Interferences

6.1 Conductive particulates that become trapped across the capacitance-type sensor leads or the sensor surface will cause erroneously high dew point readings. The most common particulates of this type are carbon, metallic particles (for example, iron scale, corrosion products, etc.), and free water droplets.

6.1.1 Interferences due to particulate contamination can be minimized by installing filters upstream of the sensor. Coalescing filters can be used to protect the sensor from free water droplets, especially in butane systems.

6.2 Alcohols such as methanol and glycols used as anti-icing additives can also interfere by causing high readings.

7. Apparatus

7.1 *Sampling System:*

7.1.1 Most errors and interferences involved with moisture analysis can be eliminated with a proper sampling system. The sampling system shall meet Practice D7453.

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

7.2 *Electronic Moisture Analyzer:*

7.2.1 Since electronic moister analyzers are available from various suppliers which use different technologies, review the manufacturer's manual for specific details and concerns.

7.2.2 Analyzer sensors are very sensitive to contamination. Any contaminants injurious to the sensor shall be removed from the sample stream before reaching the sensor. This shall be done with minimum impact on accuracy or time of response.