



Standard Test Method for Vapor Pressure of Liquefied Petroleum Gases (LPG) (Expansion Method)¹

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1. Scope*

1.1 This test method covers the use of automatic vapor pressure instruments to determine the vapor pressure of liquefied petroleum gas products at a temperature of 37.8°C, vapor to liquid ratio of 0.5:1, and pressures from 200 to 1550 kPa on a sample volume of 3.33 mL.

1.2 This test method is applicable to the determination of vapor pressures of liquefied petroleum gas products at temperatures from 37.8 to 70°C, vapor to liquid ratios of 0.1:1 to 4:1, and pressures up to 3500 kPa; however, the precision of the test method (see Section 15) has only been determined for a vapor to liquid ratio of 0.5:1, at a temperature of 37.8°C, and a pressure range from 300 to 1500 kPa.

NOTE 1—This test method is not intended to determine the true vapor pressure of LPG samples, but rather determine and report the vapor pressure of LPG at the 37.8°C temperature and 0.5:1 vapor to liquid ratio as the Test Method D 1267 method.

NOTE 2—This test method is not a true vapor pressure method and will not measure the full contribution from any dissolved gases such as nitrogen or helium if they are present. The contribution of light gases to the measured vapor pressure is highly dependent on the test temperature, type of gas, and V/L ratio of the test. A task group has been formed to determine or quantify the effect that the contribution of light gases have on the measured vapor pressure of LPG sample types as a function of the test temperature, type of gas, and V/L ratio of the test.

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

1.4 *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 warning statements, see Appendix X2.*

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.08 on Volatility.

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2. Referenced Documents

2.1 ASTM Standards:²

D 1265 Practice for Sampling Liquefied Petroleum (LP) Gases (Manual Method)

D 1267 Test Method for Gage Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method)

D 2892 Test Method for Distillation of Crude Petroleum (15-Theoretical Plate Column)

D 3700 Practice for Obtaining LPG Samples Using a Floating Piston Cylinder

D 5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)

D 6299 Practice for Applying Statistical Quality Assurance Techniques to Evaluate Analytical Measurement System Performance

2.2 Energy Institute Standards:³

IP 181 Sampling Petroleum Gases

3. Terminology

3.1 Definitions:

3.1.1 *liquefied petroleum gases (LPG), n*—narrow boiling range hydrocarbon mixtures, consisting mainly of propane or propylene, or both (**Warning**—Extremely flammable. Harmful if inhaled), butanes and butylenes, or both; in which the concentration of hydrocarbon compounds with boiling point greater than 0°C is less than 5 % by liquid volume, and whose vapor pressure at 37.8°C (100°F) is not greater than 1550 kPa.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *total pressure (P_{tot}), n*—the absolute pressure (relative to vacuum) exerted by the specimen at the specified temperature and vapor-liquid ratio.

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 Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K.

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

3.2.2 *true vapor pressure, n*—the physical property of a given liquid which specifies the maximum pressure at which a vapor phase can coexist with the liquid phase at a given equilibrium temperature condition.

3.2.3 *vapor pressure of LPG, n*—the total pressure corrected relative to normal barometric pressure.

3.2.4 *vapor to liquid ratio, n*—the ratio of the volume of the vapor in equilibrium to the fill volume of liquid.

4. Summary of Test Method

4.1 Employing a measuring chamber with a built-in piston, the chamber is rinsed three times with a portion of sample, which is then discarded. A sample of defined volume is drawn from a pressurized sampling system into the temperature-controlled chamber at 5°C by moving the piston to the filling position. After sealing the chamber, the volume is expanded by moving the piston until the final volume produces the desired vapor to liquid ratio of 0.5:1. The temperature of the measuring chamber is then regulated to the test temperature of interest, such as 37.8°C.

4.2 The observed total pressure at equilibrium is corrected relative to 101.3 kPa and reported as the LPG vapor pressure at the selected test temperature.

5. Significance and Use

5.1 Information on the vapor pressures of liquefied petroleum gas is pertinent to selection of properly designed storage vessels, shipping containers, and customer utilization equipment to ensure safe handling of these products.

5.2 Determination of the vapor pressure of liquefied petroleum gas is important for safety reasons to ensure that the maximum operating design pressures of storage, handling, and fuel systems will not be exceeded under normal operating temperature conditions.

5.3 For liquefied petroleum gases, vapor pressure can be considered a semi-quantitative measure of the amount of the most volatile material present in the product.

5.4 This test method uses a small sample volume and excludes any manual handling of a measuring chamber under high pressure.

6. Apparatus

6.1 *Vapor Pressure Apparatus*⁴—The type of apparatus suitable for this test method employs a small volume, cylindrically shaped measuring chamber with associated equipment to control the chamber temperature within the range of 5 to 70°C. The measuring chamber shall contain a movable piston with a maximum dead volume of less than 1 % of the total volume at the lowest position to allow sample introduction into the measuring chamber and expansion to the desired vapor-liquid ratio. A static absolute pressure transducer shall be incorporated in the piston. The measuring chamber shall contain an inlet/outlet valve combination for sample introduc-

tion and expulsion. The piston and the valve combination shall be at the same temperature as the measuring chamber to avoid any condensation or excessive evaporation.

6.1.1 The test chamber shall be designed to contain a total of 5 mL of liquid and vapor and be capable of maintaining a vapor-liquid ratio of 0.5:1 with a maximum deviation of 0.02.

NOTE 3—The test chamber employed by the instruments used in generating the precision and bias statements were constructed of nickel-plated aluminum and stainless steel.

NOTE 4—Test chambers exceeding a 5 mL capacity can be used, but the precision and bias statements (see Section 15) are not known to apply.

6.1.2 Electronic temperature control shall be used to maintain the measuring chamber at the prescribed temperature within $\pm 0.1^\circ\text{C}$ for the duration of the vapor pressure measurement.

6.1.3 The pressure transducer shall have a range of 0 to 3500 kPa with a minimum resolution of 1 kPa. The minimum accuracy shall be ± 1 kPa for pressures up to 700 kPa, ± 2 kPa for pressures up to 1750 kPa, and ± 4 kPa for pressures up to 3500 kPa.

6.1.4 A platinum resistance thermometer, or equivalent, shall be used for measuring the temperature of the test chamber. The minimum temperature range of the measuring device shall be from 0 to 80°C with a resolution of 0.1°C and a minimum accuracy of $\pm 0.1^\circ\text{C}$.

6.2 *Vacuum Pump for Calibration*, capable of reducing the pressure in the measuring chamber to less than 0.01 kPa absolute.

6.3 *McLeod Vacuum Gauge or Calibrated Electronic Vacuum Measuring Device for Calibration*, to cover at least the range from 0.01 to 0.67 kPa (0.1 to 5 mm Hg). The calibration of the electronic vacuum measuring device shall be regularly verified in accordance with A6.3 of Test Method D 2892.

6.4 *Pressure Measuring Device for Calibration*, capable of measuring local station pressure with an accuracy and a resolution of 0.1 kPa (1 mm Hg) or better, at the same elevation relative to sea level as the apparatus in the laboratory.

NOTE 5—This test method does not give full details of instruments suitable for carrying out this test. Details on the installation, operation, and maintenance of each instrument may be found in the manufacturer's manual.

7. Reagents and Materials

7.1 *Purity of Reagents*—Use chemicals of at least 99 % purity for quality control checks. Commonly used quality control check materials are propane, butane, and pentane (see Section 11). Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society⁵ where such specifications are available. Lower purities can be used,

⁴ The sole source of supply of the apparatus known to the committee at this time is Grabner Instruments, A-1220 Vienna, Dr. Otto Neurathgasse 1, Austria. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.

⁵ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.