



Designation: D1267 – 23

Standard Test Method for Gauge Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method)¹

This standard is issued under the fixed designation D1267; 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 determination of the gauge vapor pressures of liquefied petroleum gas products at temperatures of 37.8 °C (100 °F) up to and including a test temperature of 70 °C (158 °F). (**Warning**—Extremely flammable gas. May be harmful when inhaled.)

NOTE 1—An alternative method for measurement of vapor pressure of liquefied petroleum gases is Test Method D6897.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units 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 warning statements, see 1.1 and Annex A2.

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

D323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)

D1265 Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

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 March 1, 2023. Published March 2023. Originally approved in 1953. Last previous edition approved in 2018 as D1267 – 18. DOI: 10.1520/D1267-23.

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.

D6897 Test Method for Vapor Pressure of Liquefied Petroleum Gases (LPG) (Expansion Method)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.1.2 *liquefied petroleum gas (LP gas, LPG), n*—a narrow boiling range mixture of hydrocarbons consisting of propane, propylene, butanes, and butylenes, individually or in specified combinations, with limited amounts of other hydrocarbons (such as ethane) and may contain naturally occurring, petroleum-derived non-hydrocarbons.

3.1.3 *vapor pressure, n*—the pressure exerted by the vapor of a liquid when in equilibrium with the liquid.

4. Summary of Test Method

4.1 The test apparatus, consisting of two interconnected chambers and equipped with a suitable pressure gauge, is purged with a portion of the sample which is then discarded. The apparatus is then filled completely with the portion of the sample to be tested. Thirty-three and one-third to forty volume percent of the sample content of the apparatus is immediately withdrawn to provide adequate free space for product expansion. The apparatus is then immersed in a water bath maintained at the standard test temperature of 37.8 °C (100 °F) or, optionally, at some higher test temperature up to and including a test temperature of 70 °C (158 °F).

4.2 The observed gauge pressure at equilibrium, after correcting for gauge error and correcting to a standard barometric pressure, is 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 products under temperature conditions from 37.8 °C to 70 °C (100 °F to 158 °F) 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

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

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, and this can give an indication of low temperature operability.

6. Apparatus

6.1 *Vapor Pressure Apparatus*, constructed as illustrated in Fig. A1.1, and the various items of auxiliary equipment are completely described in Annex A1.

6.2 The vapor chamber of Test Method D323 can be interchangeable with the upper chamber of this method. Similarly, the liquid chamber (two-opening type) of Test Method D323 is interchangeable with the B, 20 % lower chamber in A1.1.4 of this method. Because of this interchangeability, the apparatus assembly of Test Method D323 shall pass, as a safety precaution, the hydrostatic test specified in A1.1.6 before using it in testing liquefied petroleum gas.

6.3 *Water Bath*, temperature controlled, of a size suitable for the vapor pressure apparatus. See A1.3.

6.4 *Temperature Measuring Device*, of verified accuracy and capable of monitoring the desired test temperature in the water bath in the range of 35 °C to 70 °C to within ± 0.1 °C.

6.5 *Barometer*—A pressure measuring device capable of measuring local station pressure with an accuracy of 0.1 kPa (1 mm Hg) or better, at the same elevation relative to sea level as the apparatus in the laboratory. (**Warning**—Do not take readings from ordinary aneroid barometers, such as those used at weather stations and airports, since these are pre-corrected to give sea level readings.)

7. Sampling and Sample Handling

7.1 Samples shall be obtained and stored in accordance with Practice D1265 unless the test samples can be taken directly from the source of the material to be tested.

7.2 Any method of coupling the vapor pressure apparatus to the sample source may be employed. Tubing, 6 mm to 7 mm ($\frac{1}{4}$ in.) in diameter, of minimum length, of suitable working pressure, and made of material corrosion-resistant to the products being sampled, is satisfactory for this purpose. A flexible tubing connection of a satisfactory type greatly facilitates the purging and sampling operations. The tubing should be a conducting material or constructed with a built-in ground connection to minimize the effect of static electricity.

8. Preparation of Apparatus

8.1 If the apparatus has been used for testing products other than the type of product to be tested, disassemble, clean thoroughly, and purge the parts in a stream of dry air.

8.2 Assemble the apparatus with the inlet valve of the lower chamber open, the straight-through valve between the two chambers open, the bleeder valve closed, and with the proper range pressure gauge attached.

9. Procedure

9.1 Safe means for the disposal of vapors and liquids during this operation and in the subsequent sampling operation shall be provided.

9.2 *Purging*—With the assembled apparatus in an upright position, connect the inlet valve of the lower chamber to the sample source with the sampling connection (7.2). Open the sample source valve to the apparatus. Cautiously open the bleeder valve on the upper chamber, permitting the air or vapors, or both, in the apparatus to escape until the apparatus is full of liquid. Close the lower chamber inlet valve and open the bleeder valve to its wide-open position. Allow the contained liquid to evaporate until the apparatus is covered with white frost (may require more than one chilling), then invert the assembly, and expel any residual material through the bleeder valve. Allow the residual vapors to escape until the pressure in the apparatus is essentially atmospheric, then close the bleeder valve.

9.3 *Sampling*—Return the apparatus, now containing only vapors, to its normal upright position and open the inlet valve. As soon as the apparatus attains essentially the same pressure as the pressure of the sample source, momentarily open the bleeder valve. If liquid does not promptly emerge, repeat the purging step (9.2). If liquid appears immediately, close the bleeder and inlet valves in that order (Note 2). Close the valve on the sample source, and disconnect the sampling line. Immediately close the straight-through valve between the two chambers and open the inlet valve, with the apparatus in an upright position. Close the inlet valve as soon as no more liquid escapes, and immediately open the straight-through valve.

NOTE 2—Transfer of the sample is facilitated by chilling the apparatus with a portion of the material under test.

9.3.1 When using the 33 $\frac{1}{3}$ % lower chamber (A1.1.3), proceed to 9.4.

9.3.2 When using the 20 % lower chamber (A1.1.4), close the straight-through valve and again open the inlet to permit expulsion of the lower chamber contents. As soon as no more liquid escapes from the lower chamber, close the inlet valve and immediately open the straight-through valve.

9.3.3 The upper chamber, prior to this operation, is liquid full at some temperature that is normally below the environmental temperature. *Since any warming of the apparatus would cause expansion of the liquid content of the upper chamber, leading to possible rupture of the chamber, it is necessary that the procedural steps of providing free space in the apparatus be completed promptly.*

9.4 Vapor Pressure Determination:

9.4.1 Invert the apparatus and shake it vigorously. Return the apparatus to its normal upright position and immerse it in the constant-temperature water bath maintained at the test temperature (4.1). The apparatus including the bleeder valve coupling, but not the pressure gauge, must be immersed. Throughout the determination, the temperature of the water bath shall be checked periodically by means of the temperature measuring device.

9.4.1.1 At test temperatures from 37.8 °C (100 °F) up to and including 50 °C (122 °F), maintain the bath at ± 0.1 °C

(0.2 °F). At test temperatures above 50 °C (122 °F), up to and including 70 °C (158 °F), maintain the bath at ± 0.3 °C (0.5 °F).

9.4.1.2 Observe the apparatus assembly throughout the test period to ensure freedom from leaks. Discontinue the test and discard the results at any time a leak is detected.

9.4.2 After 5 min have elapsed, withdraw the apparatus from the water bath, invert it, shake it vigorously, and then return it to the bath. Perform the shaking operation quickly to avoid excessive cooling of the apparatus and its contents. Thereafter, at intervals of not less than 2 min, withdraw the apparatus from the bath, invert, shake it vigorously, and then return it to the bath. Prior to each removal of the apparatus from the water bath, tap the gauge lightly and observe the pressure reading. These operations will normally require 20 min to 30 min to ensure equilibrium. After this time, if consecutive observed gauge readings are constant, record the pressure reading as the Uncorrected LP-Gas Vapor Pressure of the sample at the test temperature.

9.4.3 If a pressure gauge is used that is not calibrated against a dead-weight tester, it is necessary to determine if a gauge correction needs to be applied to the pressure gauge reading. Without removing the pressure gauge from the apparatus or the apparatus from the bath, attach a test gauge, previously calibrated against a dead-weight tester, to the bleeder valve outlet and open the bleeder valve. At the end of 5 min, compare the readings of the two gauges. Record any correction thus determined as gauge correction.

9.4.3.1 Alternatively, if a pressure gauge is used that has been calibrated against a dead-weight tester, then the gauge correction is zero and it is not necessary to determine a gauge correction as per 9.4.3, using a second test gauge that has been calibrated against a dead-weight tester.

10. Calculation

10.1 Correct the Uncorrected LP-Gas Vapor Pressure for gauge errors (see 9.4.3 and 9.4.3.1).

10.2 Convert the corrected vapor pressure = (test gauge reading) + (gauge correction) as calculated in 9.4.3 to a standard barometric pressure of 760 mm (29.92 in.) Hg by means of the following equation:

10.2.1 *LP-Gas Vapor Pressure:*

$$= \text{corrected vapor pressure, kPa} - (760 - P_1) 0.1333 \quad (1)$$

$$= \text{corrected vapor pressure, psi} - (760 - P_1) 0.0193 \quad (2)$$

where:

P_1 = observed barometric pressure, mm Hg.

10.2.2 *LP-Gas Vapor Pressure:*

$$= \text{corrected vapor pressure, kPa} - (29.92 - P_2) 3.3864 \quad (3)$$

$$= \text{corrected vapor pressure, psi} - (29.92 - P_2) 0.4912 \quad (4)$$

where:

P_2 = observed barometric pressure, in. Hg.

10.2.3 *Conversion Factors:*

$$1 \text{ kPa} = 7.50064 \text{ mmHg} = 0.295301 \text{ in. Hg} \quad (5)$$

$$1 \text{ psi} = 51.7151 \text{ mmHg} = 2.03603 \text{ in. Hg} \quad (6)$$

11. Report

11.1 Report the LP-Gas vapor pressure test results in terms of kilopascals to the nearest 5 kPa or pounds per square inch, to the nearest 0.5 psi gauge, the test temperature, and reference this test method.

12. Precision and Bias

12.1 The following shall be used as a basis for judging the acceptability of results (95 % probability).

12.1.1 *Repeatability*—The difference between two test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test materials would, in the normal and correct operation of the test method, exceed the following value only in one case in 20:

$$12 \text{ kPa (1.8 psi)} \quad (7)$$

12.1.2 *Reproducibility*—The difference between two single and independent results, obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following value only in one case in 20:

$$19 \text{ kPa (2.8 psi)} \quad (8)$$

12.2 *Bias*—The procedure in this test method for measuring vapor pressure has no bias because the value of vapor pressure is defined only in terms of this test method.

13. Keywords

13.1 liquefied petroleum gases; natural gas liquids; vapor pressure

(Mandatory Information)

A1. APPARATUS FOR VAPOR PRESSURE OF LIQUEFIED PETROLEUM (LP) GASES

A1.1 *Vapor Pressure Apparatus*, consisting of two chambers, designated as the upper and lower chambers, shall conform to the following requirements. To maintain the correct volume ratio between the upper and lower chambers, the units shall not be interchanged without recalibrating to ascertain that the volume ratio is within satisfactory limits.

A1.1.1 *Upper Chamber*—This chamber, as shown in Fig. A1.1 (c), shall be a cylindrical vessel 51 mm ± 3 mm (2 ± 1/8 in.) in diameter and 254 mm ± 3 mm (10 ± 1/8 in.) in length, inside dimensions, with the inner surfaces of the ends slightly sloped to provide complete drainage from either end when held in a vertical position. On one end of the chamber, a suitable bleeder valve coupling (Fig. A1.1 (e)) shall be provided to receive the bleeder valve assembly and the pressure gauge. In the other end of the chamber, an opening approximately 13 mm (1/2 in.) in diameter shall be provided for coupling with the lower chamber. Care shall be taken that the connections to the end openings do not prevent the chamber from draining completely.

A1.1.2 *Bleeder Valve Assembly*—The bleeder valve for purging the apparatus (Fig. A1.1) (d) shall be a normal 6 mm (1/4 in.) valve fitted into the side of the bleeder valve coupling (Fig. A1.1 (e)). The lower end shall be threaded to fit into the end fitting of the upper chamber, and the upper end shall be threaded to receive the gauge coupling (Fig. A1.1 (h)).

A1.1.3 *Lower Chamber 33 1/3 %* (Fig. A1.1 (b))—This chamber shall be a cylindrical vessel of such a volume that the ratio of the volume of the upper chamber to the volume of the lower chamber is between the limits of 1.97 to 2.03 (Note A1.2).

A1.1.4 *Lower Chamber 20 %* (Fig. A1.1 (b))—This chamber shall be a cylindrical vessel of such a volume that the ratio of the volume of the upper chamber to the volume of the lower chamber is between the limits of 3.95 to 4.05 (Note A1.2). In one end of the lower chamber, an opening approximately 19 mm (3/4 in.) in diameter shall be provided to receive a suitable straight-through valve (Fig. A1.1 (g)) having a minimum internal channel of 13 mm (1/2 in.) in diameter. The other end of the chamber shall be equipped with a nominal 6 mm (1/4 in.) inlet valve.

NOTE A1.1—In determining the volumetric capacities of the chambers, the volume of the lower chamber is considered as that which is below the “straight-through” valve closure. The volume above the “straight-through” valve closure, including the portion of the coupling attached to the upper chamber, is considered as a part of the upper chamber volume. The volume ratios of the chambers are determined in accordance with the procedure outlined in the Appendix of Test Method D323.

NOTE A1.2—The apparatus requirements for this method, excluding the bleeder valve assembly, are identical with those of Test Method D323 with the exception of the 33 1/3 % lower chamber. Although the test procedural details are different, the air and liquid chambers of Test Method D323 may be used in the present method provided they are of sufficient strength to

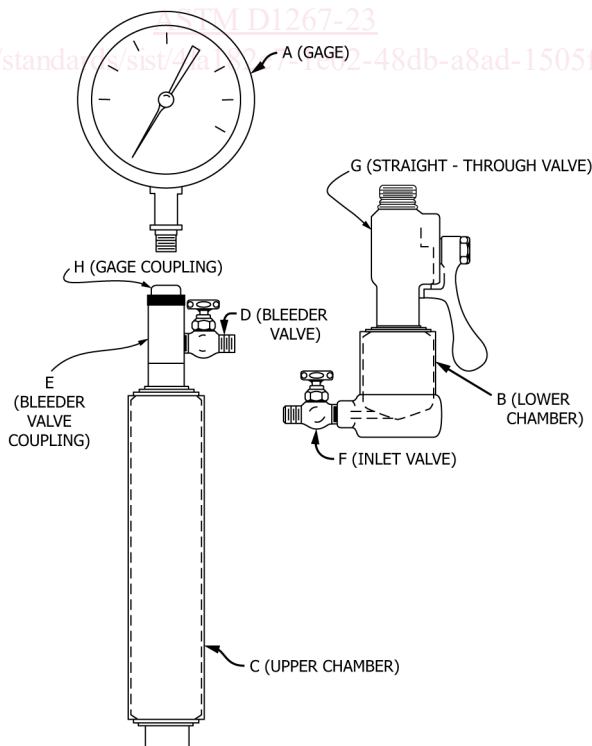


FIG. A1.1 Typical LPG Vapor Pressure Apparatus