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Standard Test Method for Temperature Corresponding to Vapor-Liquid Ratio of 20 for Gasoline and Gasoline-Oxygenate Blends (Bomb Method)[1]

This standard is issued under the fixed designation D 5189; 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 (see Note 1) covers a procedure to determine the temperature at which the vapor formed from a gasoline or a gasoline-oxygenate blend, saturated with air at 0 to 1°C (32 to 34°F), produces a calculated partial pressure equal to 101.3 kPa (1 atm). This test method is performed with a metal fuel chamber, originally filled with the chilled liquid fuel, connected to a vapor chamber 20.0 times the volume of the liquid chamber. This temperature is considered to be comparable to the temperature at which the vapor-liquid ratio of the fuel (see Note 2) is equal to 20 as determined by Test Method D 2533. This test method is not applicable to samples having a vapor pressure above 180 kPa (26 psi) as determined by Test Method D 323 or by Test Method D 4953.

NOTE 1—This test method is also known as the "Bomb V/L Test Method."

NOTE 2—Test Method D 2533 is applicable to gasoline-oxygenate blends only when mercury is used as the confining medium. Subcommittee D02.08 is currently evaluating the suitability of D 2533 using glycerol as the confining medium for certain gasoline-oxygenate blends.

1.2 The actual vapor-liquid ratio under these conditions is not exactly 20.0 since no corrections are made for the expansion of the liquid sample with increasing temperature, the decrease in liquid sample volume because of partial vaporization, the dissolved air in the liquid sample, and the effect of the air originally present in the vapor chamber.

1.3 In this test method the partial pressure of the fuel is observed as a gage pressure in the presence of air. In Test Method D 2533 the vapor pressure of the fuel is measured as an absolute pressure. Strict correspondence between the temperature at which the vapor-liquid ratio is 20, as determined by these two test methods, is hence only valid for ideal mixtures. For practical purposes results by these two test methods can be expected to be comparable.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.5 *This standard does not purport to address all of the safety problems, 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.* Specific precautionary statements are given in Section 7, Hazards, and Notes 9, 10, and 14.

2. Referenced Documents

2.1 *ASTM Standards:*

D 323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)[2]

D 2533 Test Method for Vapor-Liquid Ratio of Spark-Ignition Engine Fuels[3]

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products[4]

D 4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)[4]

3. Terminology

3.1 *Description of Terms Specific to This Standard:*

3.1.1 $T_{(V/L=20)}$, *n*—the equilibrium temperature at which the partial pressure of a fuel, under the test conditions, is equal to 101.3 kPa (1 atm). At these conditions the volume of the vapor is equal to 20 times the volume of the liquid sample charged at 0 to 1°C (32 to 34°F).

3.1.2 *uncorrected vapor pressure, n*—the observed experimental pressure at that particular temperature.

3.1.3 *vapor-liquid (V/L) ratio, n*—the value calculated by Eq. 1 or 2 in Section 11 of this test method.

4. Summary of Test Method

4.1 The liquid chamber of the V/L apparatus, having a volume of approximately 25 mL, is filled with the chilled fuel at 0 to 1°C (32 to 34°F) and connected to the vapor chamber, having a volume 20 times the volume of the liquid chamber. The apparatus is immersed in a constant temperature bath set in the approximate temperature range of interest. A portion of the liquid will vaporize and a positive pressure will be observed. The assembly is shaken periodically until a constant pressure is observed on the pressure readout device attached to the apparatus. After recording this pressure and the corresponding temperature, the apparatus is moved to another constant temperature bath set at a temperature 5 to 15°C (9 to 27°F) higher than the previous bath. The apparatus is shaken periodically until a constant pressure is observed. This pressure and the corresponding temperature are again recorded.

4.2 Using the equation shown in 11.1, the corresponding V/L ratios for these temperatures are calculated. The temperature corresponding to a V/L of 20 is then determined by interpolation. This temperature is also known as $T_{(V/L=20)}$.

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.08 on Volatility.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 05.02.

[4] *Annual Book of ASTM Standards*, Vol 05.03.

5. Significance and Use

5.1 The $T_{(V/L=20)}$ is a measure of the tendency of a fuel to vaporize in automotive engine fuel systems. For high ambient temperatures, a fuel with a high value of $T_{(V/L=20)}$ is specified, indicating a fuel with a low tendency to vaporize; conversely, for low ambient temperatures a fuel with a low value of $T_{(V/L=20)}$ would be specified.

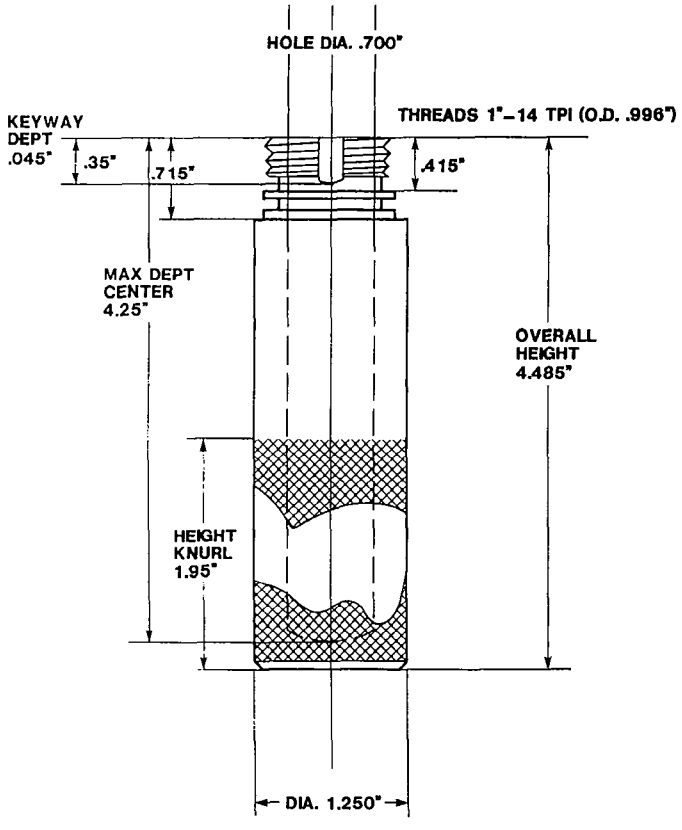
6. Apparatus

6.1 The required apparatus consists of two chambers connected to each other. Connected to the top of the upper chamber is a pressure measuring device.

6.1.1 The upper chamber, also known as the vapor chamber, shall be constructed of stainless steel or chrome-plated brass and have the same dimensions as the air chamber described in Test Method D 323 or in Test Method D 4953 (See Note 3).

NOTE 3—A vapor chamber of a Test Method D 323 unit or a Test Method D 4953 unit can be used for this test method.

6.1.2 The lower chamber, also known as the liquid chamber, shall be a cylindrical vessel constructed of stainless steel as shown in Fig. 1 (See Note 4). The dimensions given in Fig. 1 for the liquid chamber provide the necessary 20:1 vapor to liquid ratio, when this chamber is used with the vapor chamber designated in 6.1.1.



NOTE—The threads as shown on this drawing will fit a Precision Scientific[5] Test Method D 323 vapor chamber. Modify threads and sealing design as appropriate if a different vapor chamber is used.

FIG. 1 Liquid Chamber

NOTE 4—Figure 1 shows the threads for a liquid chamber that will fit a Precision Scientific[5] air chamber. For air chambers from other manufacturers use the same threads or fittings as found on the corresponding Test Method D 323 liquid chambers.

6.1.3 When the two chambers are coupled together, no liquid fuel shall be lost during the coupling operation, nor shall any compression effects be caused by the act of coupling. The assembly must be free of leaks during the conditions of the test (See Note 5).

NOTE 5—With some commercially available equipment, there is no adequate provision for avoiding compression effects. Before employing any apparatus, establish that the act of coupling does not compress the air in the vapor chamber. This can be checked by tightly stoppering the liquid chamber opening and assembling the apparatus with a sensitive pressure readout device attached to the top of the vapor chamber. A pressure increase of more than 0.1 kPa (0.01 psi) is an indication that the apparatus does not adequately meet the specifications of this test method. If this problem is encountered, a vent hole can be drilled to ensure atmospheric pressure in the air chamber at the instant of sealing.

6.1.4 Check the volumetric capacities of both the vapor and the liquid chamber to ascertain that the volume ratio of the two chambers is between 19.80 and 20.20. Disconnect the gage from the V/L unit. Weigh the cleaned and dried vapor chamber and liquid chamber separately. Fill the liquid chamber with water and determine the weight of the water required. Then connect the two chambers together and determine the weight of the water required to fill both units to the point in the neck of the vapor chamber corresponding to the lowest point of the gage connection when assembled. The difference in weights shall be the weight of the amount of water corresponding to the vapor chamber (See Note 6). The volume of the pressure gage or pressure transducer cavity, as determined in 6.2.4, must be added to the volume of the vapor chamber.

NOTE 6—Temperature correction for the expansion of the water is not required if ambient temperature water is used and the temperature remains constant within 0.5°C (1°F) during these measurements.

6.1.5 Before placing a new apparatus in service and as often as necessary thereafter, check the assembled system for freedom of leaks by filling with air through the top opening to 350 to 700 kPa (50 to 100 psi) gage pressure and completely immersing the system in a water bath.

6.2 *Pressure Gage:*

6.2.1 The pressure gage can be a Bourdon[6] type spring gage with a passageway of not less than 4.8 mm (3/16 in.) in diameter with a range of 0 to 150 kPa (0 to 20 psi) gage pressure and with graduations of not more than 1 kPa (0.1 psi) apart. Only accurate gages shall be continued in use. The gage shall be considered inaccurate if the calibration correction, based on comparison against a mercury manometer or a dead-weight tester, is greater than 2 kPa (0.3 psi).

6.2.2 The pressure gage can also be a pressure transducer that, with the appropriate electronic signal conditioner and display, will have a rated accuracy of 0.5 % of span or better under the conditions of the test and show a resolution of 0.1 kPa (0.01 psi) or better (See Note 7). Prior to its use, the

[5] The Precision Scientific air chamber is a product of Precision Scientific Inc., 3739 W. Cortland Street, Chicago, IL 60647.

[6] A Bourdon spring test gage with a range of 0 to 20 psi graduated in 0.1 psi increments is available from Petrolab Corp., 874 Albany-Shaker Rd, Latham, New York 12110, Part No. 13-0219A.