



Designation: D5191 – 22

Standard Test Method for Vapor Pressure of Petroleum Products and Liquid Fuels (Mini Method)¹

This standard is issued under the fixed designation D5191; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the use of automated vapor pressure instruments to determine the total vapor pressure exerted in vacuum by air-containing, volatile, liquid petroleum products and liquid fuels, including automotive spark-ignition fuels with or without oxygenates and with ethanol blends up to 85 % (volume fraction) (see **Note 1**). This test method is suitable for testing samples with boiling points above 0 °C (32 °F) that exert a vapor pressure between 7 kPa and 130 kPa (1.0 psi and 18.6 psi) at 37.8 °C (100 °F) at a vapor-to-liquid ratio of 4:1. Measurements are made on liquid sample sizes in the range from 1 mL to 10 mL. No account is made for dissolved water in the sample.

NOTE 1—The precision (see Section 16) using 1 L containers was determined in a 2003 interlaboratory study (ILS);² the precision using 250 mL containers was determined in a 2016 ILS.³

NOTE 2—Samples can also be tested at other vapor-to-liquid ratios, temperatures, and pressures, but the precision and bias statements need not apply.

NOTE 3—The ILS conducted in 1988, 1991, 2003, and 2016 to determine the precision statements in Test Method D5191 did not include any crude oil in the sample sets. Test Method D6377, as well as IP 481, have been shown to be suitable for vapor pressure measurements of crude oils.

1.1.1 Some gasoline-oxygenate blends may show a haze when cooled to 0 °C to 1 °C. If a haze is observed in 8.5, it shall be indicated in the reporting of results. The precision and bias statements for hazy samples have not been determined (see **Note 15**).

1.2 This test method is suitable for calculation of the dry vapor pressure equivalent (DVPE) of gasoline and gasoline-

oxygenate blends by means of a correlation equation (see **Eq 1** in 14.2). The calculated DVPE very closely approximates the dry vapor pressure that would be obtained on the same material when tested by Test Method D4953.

1.3 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.

1.4 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use Caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.

1.5 *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 safety warning statements, see 7.2 through 7.8.

1.6 *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:⁴

D2892 Test Method for Distillation of Crude Petroleum (15-Theoretical Plate Column)

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

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 D02.08 on Volatility.

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² Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1619. Contact ASTM Customer Service at service@astm.org.

³ Research Report IP 394 (EN 13016-1) and IP 619 (EN 13016-3) 2016, available from the Energy Institute, 61 New Cavendish Street, London W1G 7AR, UK, email: ILS@energyinst.org.

⁴ 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.

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

- D4177** Practice for Automatic Sampling of Petroleum and Petroleum Products
- D4306** Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
- D4953** Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
- D5798** Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines
- D5842** Practice for Sampling and Handling of Fuels for Volatility Measurement
- D5854** Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D6299** Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance
- D6377** Test Method for Determination of Vapor Pressure of Crude Oil: VPCR_x (Expansion Method)
- D6378** Test Method for Determination of Vapor Pressure (VP_x) of Petroleum Products, Hydrocarbons, and Hydrocarbon-Oxygenate Mixtures (Triple Expansion Method)
- D7717** Practice for Preparing Volumetric Blends of Denatured Fuel Ethanol and Gasoline Blendstocks for Laboratory Analysis
- 2.2 *IP Standard:*
- IP 481** Test Method for Determination of the Air Saturated Vapour Pressure (ASVP) of Crude Oil⁵

3. Terminology

3.1 Definitions:

3.1.1 *fuel ethanol (Ed75–Ed85)*, *n*—blend of ethanol and hydrocarbon, of which the ethanol portion is nominally 75 % to 85 % by volume denatured fuel ethanol.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *absolute vapor pressure*, *n*—the pressure of the air-free sample. It is calculated from the total vapor pressure of the sample by subtracting out the partial pressure of the dissolved air.

3.2.2 *dry vapor pressure equivalent (DVPE)*, *n*—a value calculated by a correlation equation (see 14.2) from the total vapor pressure.

3.2.2.1 *Discussion*—The DVPE is expected to be equivalent to the value obtained on the sample by Test Method **D4953**, Procedure A.

3.2.3 *total vapor pressure (P_{tot})*, *n*—the observed pressure measured in the experiment that is the sum of the partial pressure of the sample and the partial pressure of the dissolved air.

3.3 Abbreviations:

3.3.1 *DVPE*—dry vapor pressure equivalent

3.3.2 *P_{tot}*—total vapor pressure

4. Summary of Test Method

4.1 A known volume of chilled, air-saturated sample is introduced into a thermostatically controlled, evacuated test

chamber, or a test chamber with a moveable piston that expands the volume after sample introduction, the internal volume of which is five times that of the total test specimen introduced into the chamber. After introduction into the test chamber, the test specimen is allowed to reach thermal equilibrium at the test temperature, 37.8 °C (100 °F). The resulting rise in pressure in the chamber is measured using a pressure transducer sensor and indicator. Only total pressure measurements (sum of the partial pressure of the sample and the partial pressure of the dissolved air) are used in this test method, although some instruments can measure the absolute pressure of the sample as well.

4.2 The measured total vapor pressure is converted to a dry vapor pressure equivalent (DVPE) by use of a correlation equation (see Eq 1 in 14.2).

5. Significance and Use

5.1 Vapor pressure is a very important physical property of volatile liquids.

5.2 The vapor pressure of gasoline and gasoline-oxygenate blends is regulated by various government agencies.

5.3 Specifications for volatile petroleum products generally include vapor pressure limits to ensure products of suitable volatility performance.

5.4 This test method is more precise than Test Method **D4953**, uses a small sample size (1 mL to 10 mL), and requires about 7 min to complete the test.

6. Apparatus

6.1 *Vapor Pressure Apparatus*—The type of apparatus suitable for use in this test method employs a small volume test chamber incorporating a transducer for pressure measurements and associated equipment for thermostatically controlling the chamber temperature and for evacuating the test chamber prior to sample introduction or expanding the volume after sample introduction by a moveable piston.

6.1.1 The test chamber shall be designed to contain between 5 mL and 50 mL of liquid and vapor and be capable of maintaining a vapor-to-liquid ratio between 3.95 to 1.00 and 4.05 to 1.00.

NOTE 4—The test chamber employed by the instruments used in generating the precision and bias statements were constructed of stainless steel, aluminum, or brass.

NOTE 5—Test chambers exceeding a 15 mL capacity can be used, but the precision and bias statements (see Section 16) are not known to apply.

6.1.2 The pressure transducer shall have a minimum operational range from 0 kPa to 177 kPa (0 psi to 25.7 psi) with a minimum resolution of 0.1 kPa (0.01 psi) and a minimum accuracy of ±0.8 kPa (±0.12 psi). The pressure measurement system shall include associated electronics and readout devices to display the resulting pressure reading.

6.1.3 A thermostatically controlled heater shall be used to maintain the test chamber at 37.8 °C ± 0.1 °C (100 °F ± 0.2 °F) for the duration of the vapor pressure measurement.

6.1.4 A platinum resistance thermometer shall be used for measuring the temperature of the test chamber with a resolution of 0.1 °C (0.2 °F) and an accuracy of 0.1 °C (0.2 °F).

⁵ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.