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An American National Standard

# Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method)[1]

This standard is issued under the fixed designation D 5191; 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 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. This test method is suitable for testing samples with boiling points above 0°C (32°F) that exert a vapor pressure between 7 and 130 kPa (1.0 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 to 10 mL. No account is made for dissolved water in the sample.

NOTE 1—Samples can also be tested at other vapor-to-liquid ratios, temperatures, and pressures, but the precision and bias statements need not apply.

1.1.1 Some gasoline-oxygenate blends may show a haze when cooled to 0 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 12).

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 13.2). The calculated DVPE very closely approximates the dry vapor pressure that would be obtained on the same material when tested by Test Method D 4953.

1.3 The values stated in SI units are regarded as standard. The inch-pound units given in parentheses are provided for information only.

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 Note 5.

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 2892 Test Method for Distillation of Crude Petroleum (15-Theoretical Plate Column)[2]

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products[2]

D 4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)[3]

D 5190 Test Method for Vapor Pressure of Petroleum Products (Automatic Method)[3]

## 3. Terminology

3.1 *Definition of Terms Specific to This Standard*:

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

3.1.2 *dry vapor pressure equivalent (DVPE)*—a value calculated by a correlation equation (see 13.2) from the total pressure.

3.1.2.1 *Discussion*—The DVPE is expected to be equivalent to the value obtained on the sample by Test Method D 4953, Procedure A.

3.1.3 *total pressure*—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.

## 4. Summary of Test Method

4.1 A known volume of chilled, air-saturated sample is introduced into an evacuated, thermostatically controlled test chamber, the internal volume of which is five times that of the total test specimen introduced into the chamber. After injection 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

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

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

vapor pressure equivalent (DVPE) by use of a correlation equation (see 13.2).

## 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 D 4953, uses a small sample size (1 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.

6.1.1 The test chamber shall be designed to contain between 5 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 2—The test chamber employed by the instruments used in generating the precision and bias statements were constructed of stainless steel or aluminum.

NOTE 3—Test chambers exceeding a 15 mL capacity can be used, but the precision and bias statements (see Section 14) are not known to apply.

6.1.2 The pressure transducer shall have a minimum operational range from 0 to 177 kPa (0 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 ± 0.1°C (100 ± 0.2°F) for the duration of the test.

6.1.4 A platinum resistance thermometer shall be used for measuring the temperature of the test chamber. The minimum temperature range of the measuring device shall be from ambient to 75°C (167°F) with a resolution of 0.1°C (0.2°F) and an accuracy of 0.1°C (0.2°F).

6.1.5 The vapor pressure apparatus shall have provisions for introduction of the test specimen into an evacuated test chamber and for the cleaning or purging of the chamber following the test.

6.2 *Vacuum Pump*, capable of reducing the pressure in the test chamber to less than 0.01 kPa (0.001 psi) absolute.

6.3 *Syringe*, (optional, depending on sample introduction mechanism employed with each instrument) gas-tight, 1 to 20 mL capacity with a ±1 % or better accuracy and a ±1 % or better precision. The capacity of the syringe should not exceed two times the volume of the test specimen being dispensed.

6.4 *Iced Water Bath or Air Bath*, for chilling the samples and syringe to temperatures between 0 to 1°C (32 to 34°F).

6.5 *Pressure Measuring Device*, capable of measuring local station pressure with an accuracy of 0.20 kPa (0.03 psi), or better, at the same elevation relative to sea level as the apparatus in the laboratory.

6.5.1 When a mercury manometer is not used as the pressure measuring device, the calibration of the pressure measuring device employed shall be periodically checked (with traceability to a nationally recognized standard) to ensure that the device remains within the required accuracy specified in 6.5.

6.6 *McLeod Vacuum Gage*, to cover at least the range from 0 to 0.67 kPa (0 to 5 mm Hg). Calibration of the McLeod gage is checked in accordance with Annex A6 of Test Method D 2892.

## 7. Reagents and Materials

7.1 *Purity of Reagents*—Use chemicals of at least 99 % purity for quality control checks (see Section 10). Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.[4] Lower purities can be used, provided it is first ascertained that the reagent is of sufficient purity to permit its use without lessening the accuracy of the determination.

NOTE 4—The chemicals in this section are suggested for use in quality control procedures (see 11.2) and are not used for instrument calibration.

7.2 *Cyclohexane* (**Warning**—See Note 5.)
7.3 *Cyclopentane* (**Warning**—See Note 5.)
7.4 *2,2-Dimethylbutane* (**Warning**—See Note 5.)
7.5 *2,3-Dimethylbutane* (**Warning**—See Note 5.)
7.6 *2-Methylpentane* (**Warning**—See Note 5.)
7.7 *Toluene* (**Warning**—See Note 5.)

NOTE 5—**Warning:** Cyclohexane, toluene, cyclopentane, 2,2-dimethylbutane, 2,3-dimethylbutane, and 3-methylpentane are flammable. Health Hazard.

## 8. Sampling

8.1 *General Requirements*:

8.1.1 The extreme sensitivity of vapor pressure measurements to losses through evaporation and the resulting changes in composition is such as to require the utmost precaution and the most meticulous care in the drawing and handling of samples.

8.1.2 Obtain a sample and test specimen in accordance with Practice D 4057, except do not use the "Sampling by Water Displacement" section for fuels containing oxygenates. Use a 1 L (1 qt) sized container filled between 70 and 80 with sample.

NOTE 6—The present precision statement was derived using samples in 1 L (1 qt) containers. However, samples in containers of other sizes, as prescribed in Practice D 4057, can be used, with the same ullage requirement, if it is recognized that the precision can be affected.

8.1.3 In the case of referee testing, the 1 L (1 qt) sample container is mandatory.

[4] *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.