



# Standard Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)<sup>1</sup>

This standard is issued under the fixed designation D4953; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This test method covers and is applicable to gasolines and gasoline-oxygenate blends with a vapor pressure range from 35 kPa to 100 kPa (5 psi to 15 psi) (see [Note 2](#)). This test method, a modification of Test Method [D323](#) (Reid Method), provides two procedures to determine the vapor pressure ([Note 1](#)) of gasoline and gasoline-oxygenate blends.

**NOTE 1**—Because the external atmospheric pressure is counteracted by the atmospheric pressure initially present in the air chamber, this vapor pressure is an absolute pressure at 37.8 °C (100 °F) in kilopascals (pounds-force per square inch). This vapor pressure differs from the true vapor pressure of the sample due to some small vaporization of the sample and air in the confined space.

**NOTE 2**—Vapor pressure of gasoline or gasoline-oxygenate blends below 35 kPa (5 psi) or greater than 100 kPa (15 psi) can be determined with this test method but the precision and bias (Section [11](#)) do not apply. For materials with a vapor pressure greater than 100 kPa (15 psi), use a 0 kPa to 200 kPa (0 psi to 30 psi) gauge as specified in the annex of Test Method [D323](#).

1.2 Some gasoline-oxygenate blends may show a haze when cooled to 0 °C to 1 °C. If a haze is observed in [9.4](#), it shall be indicated in the reporting of results. The precision and bias statements for hazy samples have not been determined (see [Note 7](#)).

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are 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.* Specific warnings are given in [7.5](#), [8.4.1](#), [8.5.1](#), [9.1](#), [A1.1](#), and [A1.1.3](#).

<sup>1</sup> This test method is under the jurisdiction of 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. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

[D323 Test Method for Vapor Pressure of Petroleum Products \(Reid Method\)](#)

[D4057 Practice for Manual Sampling of Petroleum and Petroleum Products](#)

[D4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants](#)

[D5190 Test Method for Vapor Pressure of Petroleum Products \(Automatic Method\)](#) (Withdrawn 2012)<sup>3</sup>

[D5191 Test Method for Vapor Pressure of Petroleum Products \(Mini Method\)](#)

[E1 Specification for ASTM Liquid-in-Glass Thermometers](#)

## 3. Terminology

3.1 *Definitions*:

3.1.1 *Bourdon spring gauge, n*—pressure measuring device that employs a bourdon tube connected to an indicator.

3.1.2 *Bourdon tube, n*—flattened metal tube bent to a curve that straightens under internal pressure.

3.1.3 *dry method, n*—in vapor pressure methods, a specific empirical test method ([D4953](#)) for measuring the vapor pressure of gasoline and other volatile products in which contact of the test specimen with water is not allowed.

3.1.4 *dry vapor pressure equivalent (DVPE), n*—value calculated by a defined correlation equation, that is expected to be comparable to the vapor pressure value obtained by Test Method [D4953](#), Procedure A.

3.1.5 *oxygenate, n*—oxygen-containing ashless organic compound, such as an alcohol or ether, which may be used as a fuel or fuel supplement. **D4175**

3.1.6 *vapor pressure, n*—pressure exerted by the vapor of a liquid when in equilibrium with the liquid **D4175**

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

### 3.2 Abbreviations:

3.2.1 *DVPE*, *n*—dry vapor pressure equivalent

## 4. Summary of Test Method

4.1 The liquid chamber of the vapor pressure apparatus is filled with the chilled sample and connected to the vapor chamber at 37.8 °C (100 °F). The apparatus is immersed in a bath at 37.8 °C (100 °F) until a constant pressure is observed. The pressure reading, suitably corrected, is reported as the vapor pressure.

4.2 Procedure A utilizes the same apparatus and essentially the same procedure as Test Method **D323** with the exception that the interior surfaces of the liquid and vapor chambers are maintained completely free of water. Procedure B utilizes a semi-automatic apparatus with the liquid and vapor chambers identical in volume to those in Procedure A. The apparatus is suspended in a horizontal bath and rotated while attaining equilibrium. Either a Bourdon gauge or pressure transducer can be used with this procedure. The interior surfaces of the liquid and vapor chambers are maintained free of water.

## 5. Significance and Use

5.1 Vapor pressure is an important physical property of liquid spark-ignition engine fuels. It provides an indication of how a fuel will perform under different operating conditions. For example, vapor pressure is a factor in determining whether a fuel will cause vapor lock at high ambient temperature or at high altitude, or will provide easy starting at low ambient temperature.

5.2 Petroleum product specifications generally include vapor pressure limits to ensure products of suitable volatility performance.

NOTE 3—Vapor pressure of fuels is regulated by various government agencies.

## 6. Apparatus

6.1 The apparatus for Procedure A is described in **Annex A1**.

6.2 The essential dimensions and requirements for the liquid and vapor chamber for Procedure B are identical with those for Procedure A and described in **Annex A1**. External fittings and features will vary depending on whether a gauge or transducer is used and the provision for rotating the apparatus in the bath. Details of a commercially available unit are shown in **Annex A2**.

## 7. Handling of Test Samples

7.1 This section applies to both Procedure A and B.

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

7.3 Sampling shall be done in accordance with the Reid Vapor Pressure section (10.3) of Practice **D4057** except for fuels containing oxygenates where the Water Displacement Procedure section (10.3.1.8) of **D4057** must not be used.

### 7.4 Sample Container Size:

7.4.1 The size of the sample container from which the vapor pressure sample is taken shall be 1 L (1 qt). It shall be 70 % to 80 % filled with sample.

7.4.2 The present precision statement has been derived using samples in 1 L (1 qt) containers. Samples taken in containers of other sizes as prescribed in Practice **D4057** can be used if it is recognized that the precision can be affected. In the case of referee testing the 1 L (1 qt) sample container shall be mandatory.

### 7.5 Hazards:

7.5.1 The vapor pressure determination shall be the first test withdrawn from the sample container. The remaining sample in the container cannot be used for a second vapor pressure determination. If necessary, obtain a new sample.

7.5.2 Samples shall be protected from excessive heat prior to testing.

7.5.3 Samples in leaky containers shall not be tested. Discard and obtain a new sample.

7.6 *Sample Handling Temperature*—In all cases, the sample container and contents shall be cooled to 0 °C to 1 °C (32 °F to 34 °F) before the container is opened. Sufficient time to reach this temperature shall be assured by direct measurement of the temperature of a similar liquid in a like container placed in the cooling bath at the same time as the sample. See **A1.3.1**.

## 8. Preparation of Apparatus

8.1 This section applies to both Procedure A and Procedure B.

8.2 *Verification of Sample Container Filling*—With the sample at a temperature of 0 °C to 1 °C, take the container from the cooling bath or refrigerator and wipe dry with absorbent material. If the container is not transparent, unseal it, and using a suitable gauge, confirm that the sample volume equals 70 % to 80 % of the container capacity (see **Note 4**). If the sample is contained in a transparent glass container, verify that the container is 70 % to 80 % full by suitable means (see **Note 4**).

NOTE 4—For non-transparent containers, one way to confirm that the sample volume equals 70 % to 80 % of the container capacity is to use a dipstick that has been pre-marked to indicate the 70 % and 80 % container capacities. The dipstick should be of such material that it shows wetting after being immersed and withdrawn from the sample. To confirm the sample volume, insert the dipstick into the sample container so that it touches the bottom of the container at a perpendicular angle, before removing the dipstick. For transparent containers, using a marked ruler or by comparing the sample container to a like container which has the 70 % and 80 % levels clearly marked, has been found suitable.

8.2.1 Discard the sample if its volume is less than 70 % of the container capacity.

8.2.2 If the container is more than 80 % full, pour out enough sample to bring the container contents within 70 % to 80 % range. Under no circumstance return any of the poured out sample to the container.

8.2.3 Reseal the container, if necessary, and return the sample container to the cooling bath.

### 8.3 Air Saturation of the Sample in Sample Container:

8.3.1 *Transparent Containers Only*—Since 8.2 does not require that the sample be opened to verify the sample capacity, it is necessary to unseal the cap momentarily before resealing it, so that the samples in transparent containers are treated the same as samples in non-transparent containers.

8.3.2 With the sample again at a temperature of 0 °C to 1 °C, take the container from the cooling bath or refrigerator, wipe it dry with an absorbent material, remove the cap momentarily, taking care that no water enters, reseal, and shake vigorously. Return it to the cooling bath or refrigerator for a minimum of 2 min.

8.3.3 Repeat 8.3.2 twice more. Return the sample to the cooling bath until the beginning of the procedure.

8.4 *Preparation of Liquid Chamber:*

8.4.1 Place the stoppered or closed liquid chamber and the sample transfer tube in a refrigerator or cooling bath for sufficient time to allow the chamber and the transfer tube to reach a temperature of 0 °C to 1 °C (32 °F to 34 °F). Keep the liquid chamber upright and not immersed over the top of the coupling threads. (**Warning**—The transfer connection must be kept completely dry during cooling. This can be accomplished by placing the transfer connection in a water tight plastic bag.)

8.5 *Preparation of the Vapor Chamber:*

8.5.1 Connect the gauge or pressure transducer to the vapor chamber and make a water tight closure of the lower opening of the chamber where the liquid chamber attaches. Make sure that the vent hole in the vapor chamber connection is also securely closed. (**Warning**—Making a water tight closure of both the liquid and vapor chambers is extremely important. For some samples containing oxygenated compounds, contact with water can cause phase separation and invalidate results.)

NOTE 5—For some Test Method D323 apparatus, a Number 6.5 rubber stopper has been found satisfactory. For the horizontal or Herzog apparatus, a Number 3 rubber stopper and a Number 000 cork in the vent hole is satisfactory. Another procedure is to attach a spare liquid chamber to the vapor chamber during the conditioning period. A third alternative is to utilize a cap threaded to match the threads of the vapor chamber. Several apparatus manufacturers have indicated the intention to supply such caps for equipment. In any procedure used, the interior surfaces of the vapor pressure apparatus and the sample must be kept completely free of water.

8.5.2 Immerse the vapor chamber in a water bath maintained at 37.8 °C ± 0.1 °C (100 °F ± 0.2 °F) for not less than 20 min. The top of the vapor chamber must be at least 25 mm (1 in.) below the surface of the water (Procedure A). (In Procedure B the vapor chamber lies horizontally, completely immersed in the water bath.) Do not remove the vapor chamber from the water bath until the liquid chamber has been filled with sample as described in 9.1.

9. Procedure

9.1 *Sample Transfer*—Remove the sample from the cooling bath, dry the exterior of the container with absorbent material, uncap, and insert the chilled transfer tube (see Fig. 1). Remove the liquid chamber from the cooling bath and, using an absorbent material, dry the threaded top and place the chamber in an inverted position over the top of the transfer tube. Invert the entire system rapidly so that the liquid chamber is upright with the end of the transfer tube approximately 6 mm (0.25 in.)

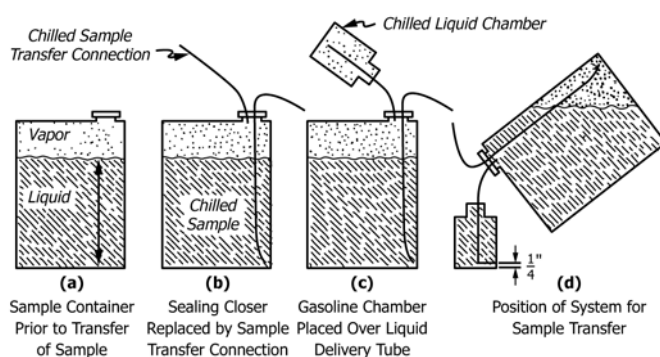


FIG. 1 Simplified Sketches Outlining Method Transferring Sample to Liquid Chamber from Open-Type Containers

from the bottom of the liquid chamber. Fill the chamber to overflowing. Withdraw the transfer tube from the liquid chamber while allowing the sample to continue flowing up to complete withdrawal. (**Warning**—Provision shall be made for suitable containment and disposal of the overflowing sample to avoid fire hazard.)

9.2 *Assembly of Apparatus*—Immediately remove the vapor chamber from the water bath and, as quickly as possible, dry the exterior of the chamber with absorbent material with particular care given to the connection between the vapor chamber and the liquid chamber. Remove the closure from the vapor chamber and couple the filled liquid chamber to the vapor chamber as quickly as possible without spillage. When the vapor chamber is removed from the water bath and dried and the closure is removed, connect it to the liquid chamber without undue movement that could promote exchange of room temperature air with the 37.8 °C (100 °F) air in the chamber. Not more than 10 s should elapse between removing the vapor chamber from the water bath and completion of the coupling of the two chambers. With Procedure B it is necessary to disconnect the spiral tubing at the quick action disconnect after removing from the water bath and before making the connection to the vapor chamber.

9.3 *Introduction of the Apparatus into Bath:*

9.3.1 *Procedure A*—Turn the assembled apparatus upside down and allow all the sample in the liquid chamber to drain into the vapor chamber. With the apparatus still inverted, shake it vigorously eight times lengthwise. With the gauge end up, immerse the assembled apparatus in the bath, maintained at 37.8 °C ± 0.1 °C (100 °F ± 0.2 °F), in an inclined position so that the connection of the liquid and vapor chambers is below the water level. Carefully examine for leaks. If no leaks are observed, further immerse the apparatus to at least 25 mm (1 in.) above the top of the vapor chamber. Observe the apparatus for leaks throughout the test and discard the test at anytime a leak is detected.

9.3.2 *Procedure B*—While holding the apparatus in a vertical position immediately reconnect the spiral tubing at the quick action disconnect. Tilt the apparatus to 20° to 30° downward for 4 s or 5 s to allow the sample to flow into the vapor chamber without getting into the tube extending into the vapor chamber from the gauge or pressure transducer. Place the assembled apparatus into the water bath maintained at 37.7 °C



$\pm 0.1\text{ }^{\circ}\text{C}$  ( $100\text{ }^{\circ}\text{F} \pm 0.2\text{ }^{\circ}\text{F}$ ) in such a way that the bottom of the liquid chamber engages the drive coupling and the other end of the apparatus rests on the support bearing. Observe the apparatus for leakage throughout the test. Discard the test anytime a leak is detected.

**9.4 Verification of Single Phase Sample**—After the apparatus has been immersed in the bath, check the remaining sample for phase separation. If the sample is contained in a transparent container, this observation can be made prior to sample transfer (9.1). If the sample is contained in a non-transparent container, mix the sample thoroughly and immediately pour a portion of the remaining sample into a clear glass container and observe for evidence of phase separation. A hazy appearance is to be carefully distinguished from separation into two distinct phases. The hazy appearance shall not be considered grounds for rejection of the fuel. If a second phase is observed, discard the test and the sample. Hazy samples may be analyzed (see Report section).

#### 9.5 Measurement of Vapor Pressure:

**9.5.1 Procedure A**—After the assembled apparatus has been in the water bath for at least 5 min, tap the pressure gauge lightly and observe the reading. Withdraw the apparatus from the bath and repeat the instructions of 9.3. At intervals of not less than 2 min, tap the gauge, observe the reading and repeat the instructions given in 9.3 until a total of not less than five shakings and gauge readings have been made and continuing thereafter if necessary until the last two consecutive gauge readings are constant, indicating that equilibrium has been attained. Read the final gauge pressure to the nearest 0.25 kPa (0.05 psi) and record this value as the uncorrected vapor pressure of the sample. Without undue delay remove the pressure gauge from the apparatus and, without attempting to remove any liquid that may be trapped in the gauge, check its reading against that of the pressure measuring device while both are subjected to a common steady pressure that is not more than 1.0 kPa (0.2 psi) from the recorded uncorrected vapor pressure. If a difference is observed between the gauge and the pressure measuring device readings, add to or subtract the difference from the uncorrected vapor pressure and record the resulting value as the vapor pressure of the sample.

**9.5.2 Procedure B**—After the assembled apparatus has been in the bath for at least 5 min, tap the pressure gauge lightly and observe the reading. Repeat the tapping and reading at intervals of not less than 2 min, until 2 consecutive readings are constant. (Tapping is not necessary with transducer model but the reading intervals are the same.) Read the final gauge or transducer pressure to the nearest 0.25 kPa (0.05 psi) and record this value as the uncorrected vapor pressure. Without undue delay, disconnect the gauge or pressure transducer from the apparatus and check its reading against that of the pressure measuring device while both are subjected to a common steady pressure that is not more than 1.0 kPa (0.2 psi) different from the recorded uncorrected vapor pressure. If a difference is observed between the gauge or transducer and the pressure measuring device, add to or subtract the difference from the uncorrected vapor pressure and record the resulting value as the vapor pressure of the sample.

NOTE 6—If it is suspected that phase separation of the sample may have

occurred during the test procedure, the following procedure can be performed to verify the integrity of the test sample. Perform the following operations as quickly as possible after removing the apparatus from the water bath in order to maintain the temperature of the sample at or near the test temperature. Quickly dry the exterior surfaces of the liquid and vapor chambers with absorbent material. With the apparatus in an upright position, disconnect the vapor and liquid chambers. Quickly drain the contents of the liquid chamber into a dry, clear, glass container and observe the sample. If the sample is not clear and bright and free of a second phase, cap the container, reheat the sample to  $37.8\text{ }^{\circ}\text{C}$  ( $100\text{ }^{\circ}\text{F}$ ), mix the sample well, and observe the sample again. If the sample is still not clear and bright and free of a second phase, phase separation has occurred and the test may not be valid.

**9.6 Preparation of Apparatus for Next Test**—Thoroughly purge the vapor chamber of residual sample by filling it with warm water above  $32\text{ }^{\circ}\text{C}$  ( $90\text{ }^{\circ}\text{F}$ ) and allowing it to drain. Repeat this purging at least five times. Purge the liquid chamber in the same manner. Rinse both chambers and the transfer tube several times with petroleum naphtha, then several times with acetone, then blow dry using dried air. Appropriately close the liquid chamber and place it in the cooling bath or refrigerator in preparation for the next test. Use an appropriate closure for the bottom connection (where liquid chamber attaches) of the vapor chamber and attach the gauge after the gauge has been prepared in accordance with 9.6.2.

**9.6.1** If the purging of the vapor chamber is done in a bath, be sure to avoid small films of floating sample by keeping the bottom and top openings of the chamber closed as they pass through the water surface.

**9.6.2 Preparation of Gauge (Procedure A)**—Disconnect the gauge from its manifold connection with the pressure measuring device, remove trapped liquid in the Bourdon tube of the gauge by repeated centrifugal thrusts. Accomplish this in the following manner: hold the gauge between the palms of the hands with the right palm on the face of the gauge and the threaded connection of the gauge forward, extend the arms forward and upward at an angle of  $45^{\circ}$ , and swing the arms rapidly downward through an arc of about  $135^{\circ}$  so that centrifugal force aids gravity in removing trapped liquid. Repeat this operation at least 3 times or until all liquid has been expelled from the gauge. Connect the gauge to the vapor chamber with the liquid connection closed and place in the  $37.8\text{ }^{\circ}\text{C}$  ( $100\text{ }^{\circ}\text{F}$ ) bath to condition for the next test.

**9.6.3 Preparation of Gauge or Transducer (Procedure B)**—In the correct operation of Procedure B liquid does not reach the gauge or transducer. If it is observed or suspected that liquid has reached the gauge, purge the gauge as described in 9.6.2. The transducer has no cavity to trap liquid. Ensure that no liquid is present in the T-handle fitting or spiral tubing by forcing a stream of dry air through the tubing. Connect the gauge or transducer to the vapor chamber with the liquid connection closed and place in the  $37.8\text{ }^{\circ}\text{C}$  ( $100\text{ }^{\circ}\text{F}$ ) bath to condition for the next test.

## 10. Report

**10.1 Reporting Results**—Report the vapor pressure to the nearest 0.25 kPa (0.05 psi) in kilopascals (pounds-force per square inch) without reference to temperature.

**10.2** If the sample was observed to be hazy in 9.4, report the test result as in 10.1, followed by the letter “H.”

NOTE 7—The precision and bias statements have not been determined for hazy samples, since these types of samples have not been evaluated as part of an interlaboratory study.

NOTE 8—The inclusion of the letter “H” in 10.2 is intended to alert the data recipient that the sample analyzed was hazy. In the event a laboratory has a computer system that is incapable of reporting alphanumeric results in accordance with the requirements in 10.2, it is permissible for the laboratory to report the result obtained as in 10.1, along with a statement or annotation that clearly conveys to the data recipient that the sample analyzed was hazy.

## 11. Precision and Bias<sup>4</sup>

11.1 The following criteria are to be used for judging the acceptability of results.

NOTE 9—The following precision data were developed in a 1991 interlaboratory cooperative test program. Participants analyzed sample sets comprised of blind duplicates of 14 types of hydrocarbons and hydrocarbonoxygenate blends. The oxygen content ranged from 0 to 15 % by volume nominal and the vapor pressure ranged from 14 kPa to 100 kPa (2 psi to 15 psi) nominal. A total of 60 laboratories participated. Some participants performed more than one test method, using separate sample sets for each. Twenty-six samples sets were tested by Test Method D4953, 13 by Test Method D5190, and 27 by Test Method D5191. In addition, six sets were tested by modified Test Method D5190 and 13 by modified Test Method D5191.

11.1.1 *Repeatability*—The difference between successive test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values in only one case in twenty:

Procedure A	3.65 kPa (0.53 psi)
Procedure B (See Note 10)	
Gauge (See Note 11)	4.00 kPa (0.58 psi)
Transducer (Herzog)	2.14 kPa (0.31 psi)
Transducer (Precision Scientific)	3.58 kPa (0.52 psi)

11.1.2 *Reproducibility*—The difference between two single and independent test 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 values only in one case in twenty:

Procedure A	5.52 kPa (0.80 psi)
Procedure B (See Note 10)	
Gauge (See Note 11)	5.38 kPa (0.78 psi)
Transducer (Herzog)	2.90 kPa (0.42 psi)
Transducer (Precision Scientific)	4.27 kPa (0.62 psi)

NOTE 10—The data from the three instruments that performed Procedure B, in the interlaboratory program described in Note 9 yielded precision figures that are different statistically and could not be pooled. Hence these figures are displayed individually.

NOTE 11—The precision figures are applicable only to gages manufactured by Armaturenbaue, GMBH, 0 psi to 15 psi, Bourdon tube volume of 38 mL nominal. Usage of gauges with other internal volumes may affect

the test method precision and bias.

### 11.2 Bias:

11.2.1 *Absolute Bias*—Since there is no accepted reference material suitable for determining the bias for the procedures in this test method for measuring vapor pressure of gasoline or gasoline-oxygenate blends, bias cannot be determined. The amount of bias between this test vapor pressure and true vapor pressure is unknown.

11.2.2 *Relative Bias*—Statistically significant relative biases between Procedures A and Procedure B were observed in the data from the cooperative program described in Note 9. These biases can be corrected by applying the appropriate correlation equation listed below, that calculates a dry vapor pressure equivalent value for Procedure A (DVPE, Procedure A), from values obtained by Procedure B:

11.2.2.1 For Procedure B, gauge See Note 10:

$$DVPE, \text{ Procedure A} = 1.029 X \quad (1)$$

11.2.2.2 For Procedure B, transducer, Herzog equipment:

$$DVPE, \text{ Procedure A} = 0.984 X \quad (2)$$

where:

$X$  = observed total vapor pressure from Procedure B

11.2.3 No relative bias was observed between Procedure A and the precision scientific equipment in the data obtained in the interlaboratory program described in Note 9.

11.2.4 Since Test Method D323 was not included in the 1991 interlaboratory test program described in Note 9, no statement can be made regarding the relative bias between any of the methods studied versus Test Method D323 based on data from this study. However, from a 1987 interlaboratory study,<sup>5</sup> no statistically significant bias was observed between Procedure A of this test method and Test Method D323 for samples containing hydrocarbons only or hydrocarbons and methyl *t*-butyl ether.

NOTE 12—In the 1991 interlaboratory test program described in Note 9, one jet fuel of type JP-4 was included. Statistically lower repeatability and reproducibility estimates for Procedure B were observed for this particular sample compared to all others in the sample set. Since only one jet fuel was tested in the program, these figures are not intended nor can it be technically considered as a precision statement regarding usage of this method on all jet fuels. This is provided as information only for those who are interested in the approximate precision of this method when applied to a jet fuel of type JP-4.

Procedure A	$r \cong 3.6 \text{ kPa (0.52 psi)}$	$R \cong 5.0 \text{ kPa (0.73 psi)}$
Procedure B (gauge)	$r \cong 0.69 \text{ kPa (0.10 psi)}$	$R \cong 2.3 \text{ kPa (0.33 psi)}$
Procedure B (Transducer—Herzog, Precision Scientific) <sup>5</sup>	$r \cong 1.3 \text{ kPa (0.19 psi)}$	$R \cong 2.3 \text{ kPa (0.33 psi)}$

<sup>4</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1286.

<sup>5</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1245.

ANNEXES

(Mandatory Information)

A1. APPARATUS FOR VAPOR PRESSURE TEST PROCEDURE A

A1.1 Vapor Pressure Apparatus—This consists of two chambers, a vapor chamber (upper section) and a liquid chamber (lower section), which shall conform to the requirements in this annex. (**Warning**—To maintain the correct volume ratio between the vapor chamber and the liquid chamber, the units shall not be interchanged without recalibration to ascertain that the volume ratio is within the required limits.)

A1.1.1 Vapor Chamber—The upper section of the vapor chamber, as shown in Fig. A1.1, shall be a cylindrical vessel having the inside dimensions of 51 mm ± 3 mm (2 in. ± 1/8 in.) in diameter and 254 mm ± 3 mm (10 ± 1/8 in.) in length, 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 vapor chamber, a suitable gauge coupling with an internal diameter of not less than 4.8 mm (3/16 in.) shall be provided to receive the 6.35 mm (1/4 in.) gauge connection. In the other end an opening approximately 12.7 mm (1/2 in.) in diameter shall be provided for

coupling with the liquid chamber. The connections to the openings shall not prevent the chamber from draining completely.

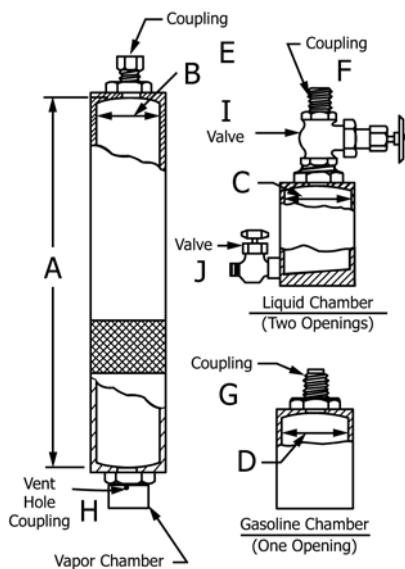
A1.1.2 Liquid Chamber—The lower section or liquid chamber, as shown in Fig. A1.1, shall be a cylindrical vessel of the same internal diameter as the vapor chamber and of such a volume that the ratio of the volume of the vapor chamber to the volume of the liquid chamber shall be between 3.8 and 4.2. In one end of the liquid chamber an opening of approximately 12.7 mm (1/2 in.) in diameter shall be provided for coupling with the vapor chamber. The inner surface of the coupling end shall be sloped to provide complete drainage when inverted. The other end of the chamber shall be completely closed.

A1.1.3 Method of Coupling Vapor and Liquid Chambers—Any method of coupling the vapor and liquid chambers can be employed, provided that no sample is lost from the liquid chamber during the coupling operation, that no compression effect is caused by the act of coupling, and that the assembly is free of leaks under the conditions of the tests. To avoid displacement of sample during assembly, the male fitting of the coupling must be on the liquid chamber. To avoid compression of air during assembly a vent hole must be present to ensure atmospheric pressure in the vapor chamber at the instant of sealing. (**Warning**—Some commercially available apparatus do not make adequate provision for avoiding air compression effects. Before employing any apparatus, it shall be established that the act of coupling the two chambers does not compress air in the vapor chamber. This can be accomplished by tightly stoppering the liquid chamber and coupling the apparatus in the normal manner, utilizing a 0 to 35 kPa (0 to 5 psi) gauge. Any observable pressure increase on the gauge is an indication that the apparatus does not adequately meet the specifications of the test method. If this problem is encountered, consult the manufacturer.)

A1.1.4 Volumetric Capacity of Vapor and Liquid Chambers—To ascertain if the volume ratio of the chambers is within the specified limits of 3.8 to 4.2, carefully measure a quantity of water greater than will be required to fill the 2 chambers. (A dispensing buret is a convenient vessel for this operation.) Without spillage, fill the liquid chamber completely. The difference between the original volume and the remaining volume is the volume of the liquid chamber. Without spillage, couple the liquid and vapor chambers and fill the vapor chamber to the seat of the gauge connection with more of the measured water. The difference in volumes is the volume of the vapor chamber. Calculate the volume ratio as follows:

$$\frac{\text{vapor chamber volume}}{\text{liquid chamber volume}} = \text{volume ratio} \quad (\text{A1.1})$$

A1.2 Pressure Gauge—The pressure gauge shall be a Bourdon type spring gauge of test gauge quality 100 mm to 150 mm (4.5 in. to 5.5 in.) in diameter provided with a nominal



DIMENSIONS OF VAPOR PRESSURE APPARATUS

Key	Description	mm	in.
A	Vapor chamber, length	254 ± 3	10 ± 1/8
B, C, D	Vapor and gasoline chambers, Liquid ID	51 ± 3	2 ± 1/8
E, G	Coupling, ID min	4.7	3/16
F, G	Coupling, OD	12.7	1/2
H	Coupling, ID	12.7	1/2
I	Valve	12.7	1/2
J	Valve	6.35	1/4

FIG. A1.1 Vapor Pressure Apparatus

6.35 mm (0.25 in.) male thread connection with a passageway not less than 4.7 mm ( $\frac{3}{16}$  in.) in diameter from the Bourdon tube to the atmosphere. The gauge range shall be 0 kPa to 100 kPa (0 psi to 15 psi) with intermediate graduations at 0.5 kPa (0.1 psi). Only accurate gages shall be continued in use. When the gauge reading differs from the pressure measuring device reading by more than 1.0 kPa (0.15 psi), discontinue use of the gauge.

### A1.3 Cooling Bath

A1.3.1 A suitable cooling bath shall be provided of such dimensions that the sample containers and the liquid chambers can be completely immersed. Either a water or air bath is acceptable. A means of maintaining the bath at a temperature of 0 °C to 1 °C (32 °F to 34 °F) must be provided.

A1.3.2 Solid carbon dioxide shall not be used to cool samples in storage or in the cooling bath of A1.3.1.

A1.4 *Water Bath*—The water bath shall be of such dimensions that the vapor pressure apparatus can be immersed to at least 25.4 mm (1 in.) above the top of the vapor chamber. Means for maintaining the bath at a constant temperature of

37.8 °C  $\pm$  0.1 °C (100 °F  $\pm$  0.2 °F) shall be provided. In order to check this temperature the bath thermometer shall be immersed to the 37 °C (98 °F) mark throughout the vapor pressure determination.

A1.5 *Thermometer*—An ASTM Reid Vapor Pressure thermometer 18C (18F) having a range from 34 °C to 42 °C (94 °F to 108 °F) and conforming to the requirements in Specification E1 shall be used in the water bath of A1.4.

A1.6 *Mercury Manometer*—A pressure measuring device having a range suitable for checking the pressure gauge employed shall be used. The pressure measuring device shall have a minimum accuracy of 0.5 kPa (0.07 psi) with no increments larger than 0.5 kPa (0.07 psi).

A1.6.1 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 A1.6.

## A2. APPARATUS FOR VAPOR PRESSURE TEST PROCEDURE B

A2.1 *Vapor Pressure Apparatus*—Refer to A1.1 – A1.1.4.

A2.2 *Pressure Gauge*—The pressure measuring system shall be a Bourdon type spring gauge as described in A1.2 or a suitable pressure transducer and digital readout. The pressure measuring system shall be remotely mounted from the vapor pressure apparatus and terminations provided for use of a quick connection type fitting.

A2.3 *Cooling Bath*—Refer to A1.3.

A2.4 *Water Bath*—The water bath shall be of such dimensions that the vapor pressure apparatus can be immersed in a horizontal position. Provision shall be made to rotate the apparatus on its axis 350° in one direction and then 350° in the opposite direction in repetitive fashion. Means for maintaining the bath at a constant temperature of 37.8 °C  $\pm$  0.1 °C (100 °F  $\pm$  0.2 °F) shall be provided. In order to check this temperature,

the bath thermometer shall be immersed to the 37 °C (98 °F) mark throughout the vapor pressure determination. A suitable bath is shown in Fig. A2.1 and is available commercially.

A2.5 *Thermometers*—Refer to A1.5.

A2.6 *Pressure Measuring Device*—Refer to A1.6.

A2.7 *Flexible Coupler*—A suitable flexible coupling shall be provided for connection of the rotating vapor pressure apparatus to the pressure measuring device.

A2.8 *Vapor Chamber Tube*—The vapor chamber tube of inner diameter 3 mm ( $\frac{1}{8}$  in.) and length of 114 mm (4.5 in.) shall be inserted into the pressure measuring end of the vapor chamber to prevent liquid from entering the vapor pressure measuring connections.



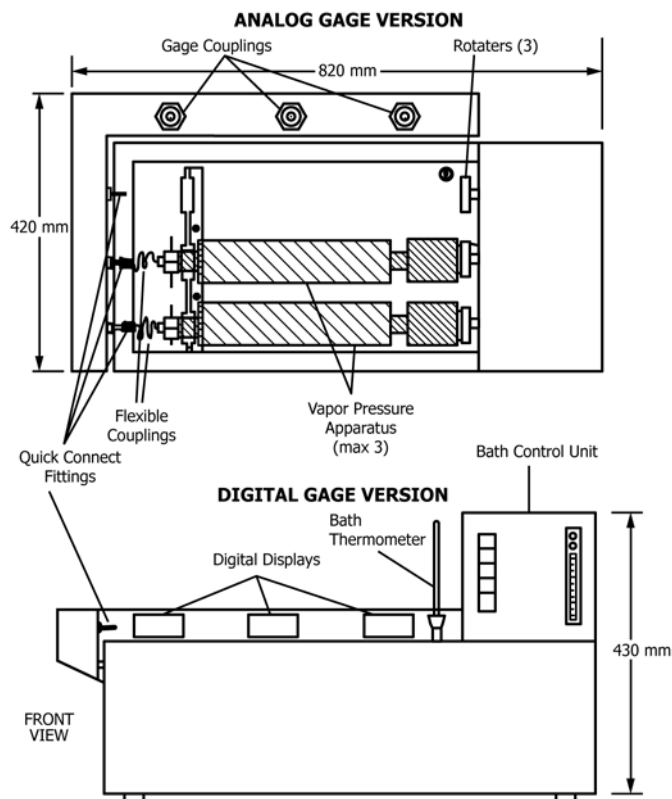


FIG. A2.1 Apparatus for Vapor Pressure, Procedure B

## SUMMARY OF CHANGES

Subcommittee D02.08 has identified the location of selected changes to this standard since the last issue (D4953 – 06 (2012)) that may impact the use of this standard. (Approved June 1, 2015.)

(1) Deleted former 3.1.5, definition for *gasoline-oxygenate blend*.

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