

British Standard Methods of test for
Petroleum and its products
Part 69. Reid vapour pressure of petroleum products

(Identical with IP 69/78)

Méthodes d'essai pour le pétrole et les produits pétroliers
Partie 69. Pression de vapeur Reid des produits pétroliers

Prüfmethoden für Erdöl und Erdölprodukte
Teil 69. Dampfdruck von Erdölprodukten nach Reid

Foreword

BS 2000 comprises a series of test methods for petroleum and its products that have been published previously by the Institute of Petroleum (IP) and have been accorded the status of British Standards. Each method should be read in conjunction with BS 2000 : Part 0 'General introduction', which gives details of the BSI/IP agreement for publication of the series, lists more than 60 methods scheduled to be published in this way in 1982, and provides general information on safety precautions, sampling and other matters.

The numbering of the other Parts follows that of the corresponding methods published in 'IP Standards for petroleum and its products, Part 1 Methods for analysis and testing'. BS 2000 : Part 69 is thus identical with IP 69/78. IP 69/60 was previously published in A5 format as BS 3325* and has now been re-numbered and issued in the BS 2000 series. It is intended to issue further revisions when necessary in line with changes that may be made in subsequent editions of the IP method.

This Part is similar in many respects to ISO 3007-1974, but in other respects it differs technically from that standard. This method is also under consideration by the European Committee for Standardization (CEN) as prEN 12.

Caution. Attention is drawn to the safety precautions mentioned in Part 0 of this British Standard, and also to the specific hazards referred to in 12.2 and A1.

NOTE. The titles of the publications referred to in this Part of this British Standard are listed on the inside back cover.

* Now withdrawn.

Method (identical with IP 69/78¹).

1. SCOPE

1.1. This method covers the determination of the absolute vapour pressure [Note 1] of volatile, non-viscous petroleum materials, volatile crude oils, and natural gas liquids having nominal vapour pressures at 37.8°C up to 7 bar (700 kPa).

Use Method IP 161 (which employs a different vapour-to-liquid ratio) for liquefied petroleum gases.

NOTE 1: Because the external atmospheric pressure is counteracted by the atmospheric pressure initially present in the air chamber, the measured Reid vapour pressure is approximately the vapour pressure of the material, in bars absolute,² at the test temperature and at a vapour-to-liquid ratio of 4 to 1.

NOTE to 1.1. BS 3324, which is the dual-numbered version of ISO 4256, is technically equivalent to IP 161.

2. SUMMARY OF METHOD

2.1. The sample is placed in the liquid chamber of the apparatus which is connected to an air chamber fitted with a pressure gauge or a prepressurized mercury manometer. The apparatus is then heated to a temperature of 37.8°C and shaken periodically until a constant pressure reading is obtained. This reading is the Reid Vapour Pressure of the sample.

2.2. The method provides three variations of the procedure (Procedures A, B, and C) to suit the types of material under test.

2.3. *Procedure A* is used for refined products with a Reid vapour pressure of less than 1 bar (100 kPa). In this, the sample is completely saturated with air at 0 to 1.1°C. The liquid chamber is filled with air-saturated sample at this temperature and is connected to the air chamber at 37.8°C. The apparatus is immersed in a constant-temperature bath at $37.8 \pm 0.1^\circ\text{C}$ and is shaken periodically until equilibrium is reached. The equilibrium pressure is measured by means of a mercury manometer. After applying certain corrections, this pressure is recorded as the Reid vapour pressure of the product.

2.4. *Procedure B* is used for refined products having Reid vapour pressures between 1.0 to 1.8 bar (100 to 180 kPa) and for semi-refined products and crude oils having Reid vapour pressures below 1.8 bar (180 kPa). In this the sample is completely saturated with air at 0 to 1.1°C. The liquid chamber of the vapour pressure apparatus is filled with the chilled sample and connected to the air chamber at 37.8°C or other temperature. The apparatus is immersed in a constant-temperature bath at $37.8 \pm 0.1^\circ\text{C}$ and is shaken periodically until equilibrium is reached. The equilibrium pressure is measured either by a gauge checked against a manometer or directly by a mercury manometer. This pressure, suitably corrected if the air chamber was initially at a temperature other than 37.8°C, is recorded as the Reid vapour pressure.

2.5. *Procedure C* is used for all materials with Reid vapour pressures greater than 1.8 bar (180 kPa). Such materials are handled in a closed liquid chamber with no air saturation step. The liquid chamber is provided with two openings. The other features of Procedure C are the same as those described for Procedure B.

3. APPARATUS

3.1. The construction of the apparatus and the various auxiliary equipment is described in Annex A. For samples having vapour pressures below 1.8 bar (180 kPa), use the liquid chamber with one opening (Section A1.2) and for samples having vapour pressures above 1.8 bar (180 kPa), use the liquid chamber with two openings (Section A1.3).

¹ The corresponding ASTM method is D323. The IP method requires the use of a prepressurized mercury manometer for measuring RVP below 1.0 bar (100 kPa) for refined products and allows it as an alternative to a pressure gauge for unrefined and semi-refined products.

² The SI unit of pressure is the N/m². For the measurement of pressure the IP use the bar; ASTM use the kilopascal. 1 bar = 10^5 N/m^2 = 10^5 Pa = 10^2 kPa .

NOTE to footnote 1. The prepressurized mercury manometer is not specified in ISO 3007 but it has been proposed by the UK to be incorporated in a revision.

4. PRECAUTIONS

4.1. Gross errors can be obtained in vapour pressure measurements if the prescribed procedure is not carefully followed. The following list emphasizes the importance of strict adherence to the precautions given in the procedure.

4.1.1. *Sampling* – Because the initial sampling and the handling of samples will greatly affect the final results, employ the utmost precaution and the most meticulous care to avoid losses through evaporation and slight changes in composition (Sections 5 and 7.1). In no case shall any part of the vapour pressure apparatus itself be used as the sample container previous to actually conducting the test.

4.1.2. *Air Saturation of Sample* – Ensure that the sample has reached a temperature of 0 to 1.1°C. Check that the liquid content is between 70% and 80% of the container capacity. Open and close the sample container and shake vigorously to ensure equilibrium of the sample with the air in the container (Section 6.1). Repeat this operation twice.

4.1.3. *Purging the Apparatus* – Thoroughly purge the pressure gauge or the alternative pressure measurement device, the liquid chamber, and the air chamber to ensure that they are free of residual sample. (This is most conveniently done at the end of the previous test.) (Section 7.7 and 9.6).

4.1.4. *Coupling the Apparatus* – Carefully observe the requirements of Sections 7.2 and 9.2.

4.1.5. *Checking for Leaks* – Check all apparatus before and during each test for liquid and vapour leaks (Section A1.6 and Note 3).

4.1.6. *Shaking the Apparatus* – Shake the apparatus ‘vigorously’ as directed in Section 7.5 and 9.4 in order to ensure equilibrium.

4.1.7. *Checking the Pressure Gauge* – Check all gauges against a manometer after each test in order to ensure high precision of results (Section 9.5). Read all gauges while they are in a vertical position.

4.1.8. *Temperature Control* – Carefully control the temperature at the time of air saturation and the temperature of the 37.8°C bath (Sections A4 and A5 respectively). Be certain that the temperature of the air in the air chamber at the time of coupling with the liquid chamber (Section 7.2 and 9.2) has remained constant within 0.5°C for a period of 5 min or more.

5. HANDLING OF SAMPLES

5.1. *General* – The following sections 5.2 to 5.6 shall apply to all samples for vapour pressure determinations, except as specifically excluded for the samples having vapour pressures above 1.8 bar (180 kPa) (see Section 10). Vapour pressure measurements are extremely sensitive to losses through evaporation and to slight changes in composition. For that reason they require the utmost precaution and the most meticulous care in the handling of samples.

5.2. *Sampling* – Sampling shall be carried out using the procedure for Reid vapour pressure described in Part IV of IP Standards for Petroleum and its Products (Methods for Sampling).

5.3. *Sample Container Size* – The size of the sample container shall be not less than 1 litre nor more than 9 litres.

5.4. *Sample Handling Temperature* – In all cases the sample container and its contents shall be cooled to 0 to 1.1°C before opening.

NOTE to 5.2. BS 3195 : Part 1, which is the dual-numbered version of ISO 3170, is technically equivalent to IP 51/76 ‘Sampling liquid petroleum products – Manual methods’, which is published in ‘IP Standards : Part IV’ and covers the sampling procedures relevant to the determination of Reid vapour pressure.

5.5. *Sample Transfer* – The Reid vapour pressure determination shall be the first test run on a sample. In the instances of transfer of liquids from larger sample containers, or of withdrawal of samples for other tests, the transfer connexion of Fig. 1 shall be used.

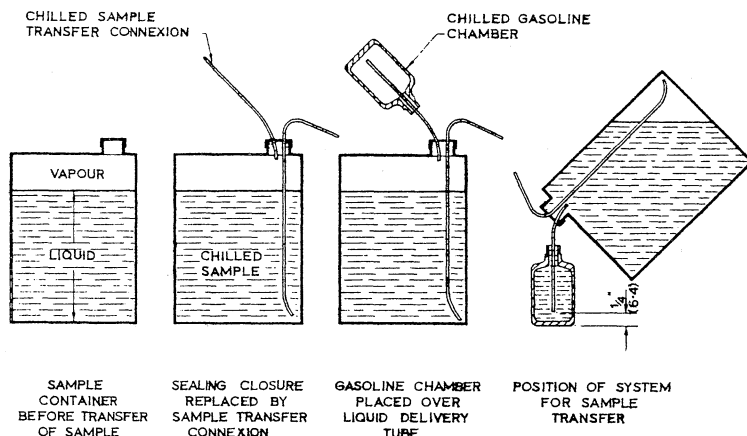


Fig. 1. Simplified sketches outlining method of transferring sample to liquid chamber from open-type containers.

NOTE 2: Crude oils which are fluid at room temperature can be very viscous at the sample transfer temperature. In these cases use sample transfer tubes of suitably large diameter.

5.6. *Care of Samples* – Put samples in a cool place as soon as possible after they have been obtained and hold them there until the test has been completed. Discard samples in leaky containers and obtain new samples for test.

PROCEDURE A FOR REFINED PETROLEUM PRODUCTS HAVING A REID VAPOUR PRESSURE LESS THAN 1 BAR (100 kPa)

6. PREPARATION FOR TEST

6.1. *Air Saturation of Sample in Sample Container* – Place the sample, in its container, into the water cooling bath. With the sample at a temperature of 0 to 1.1°C, remove the container from the water-cooling bath, unseal it, and check it for liquid content which shall be between 70 and 80% of the container capacity. After the correct liquid content has been checked reseal the container, shake it vigorously, and return it to the water-cooling bath. Repeat this procedure of unsealing momentarily, resealing, shaking vigorously, and returning to the bath three times at intervals of not less than 2 min to ensure complete air saturation.

6.2. *Preparation of Liquid Chamber* – Completely immerse the open liquid chamber and the sample-transfer connexion in the water-cooling bath for a sufficient time to allow the chamber and connexion to reach the bath temperature 0 to 1.1°C.

6.3. *Preparation of Air Chamber (37.8°C)* – After purging and rinsing the air chamber with warm water, and purging the needle valve and coupling assembly with air in accordance with Section 7.7, connect the coupling and needle valve assembly to the air chamber. Tightly close the valve. Immerse the air chamber and its entrapped air content to approximately 25 mm above the top of the chamber and just below the needle valve in the vapour pressure water bath maintained at $37.8 \pm 0.1^\circ\text{C}$ for not less than 10 min just before coupling it to the liquid chamber. Do not remove the air chamber from the bath until the liquid chamber has been filled with sample as described in Section 7.1.

7. TEST PROCEDURE

7.1. *Sample Transfer* – Remove the chilled sample container from the bath, uncap it, and insert the chilled transfer connexion and air tube (Fig. 1). Quickly empty the chilled liquid chamber and place it over the sample delivery tube of the transfer connexion. Invert the entire system rapidly so that the liquid chamber is finally in an upright position with the delivery tube extending to within 6 mm of the bottom of the liquid chamber. Fill the liquid chamber to overflowing. Lightly tap it against the work bench to ensure that the sample is free of air bubbles. If any sample is displaced, refill the chamber to over-flowing.

7.2. *Assembly of Apparatus* – Without delay, attach the air chamber to the liquid chamber. Check again to ensure that the needle valve on the air chamber is tightly closed. Then attach the manometer hose to the top of the air chamber. Complete the assembly of the apparatus within 20 sec of filling the liquid chamber using the following sequence of operations:

- 7.2.1. Add additional sample to the liquid chamber to fill it to overflowing.
- 7.2.2. Remove the air chamber from the 37.8°C water bath (Section 6.3).
- 7.2.3. Connect the air chamber to the liquid chamber.
- 7.2.4. Check to see that the needle valve is closed.
- 7.2.5. Connect the manometer hose to the top of the air chamber.

7.3. *Introduction of Apparatus into Bath* – Turn the assembled vapour pressure apparatus upside down to allow the sample in the liquid chamber to run into the air chamber and shake vigorously in a direction parallel to the length of the apparatus.

Immerse the assembled apparatus in the bath, maintained at $37.8 \pm 0.1^\circ\text{C}$, in an inclined position so that the connexion of the liquid and air chambers is just below the water level and may be observed closely for possible leaks. If no leaks are observed, immerse the apparatus to 25 mm above the top of the air chamber. Observe the apparatus for leaks throughout the test. If at any time a leak is detected, discard the test.

NOTE 3: Liquid leaks are more difficult to detect than vapour leaks; because the much-used coupling device between the chambers is normally in the liquid section of the apparatus, give it particular attention. A convenient method for checking an apparatus suspected of leaking at this point is to assemble the apparatus without a sample and pressurize the assembled apparatus with air to the maximum permissible pressure of the procedure being followed. The pressurized apparatus is then placed in the bath and observed for leaks.

7.4. *Prepressurizing the Manometer* – After the assembled vapour pressure apparatus has been immersed in the bath and checked for leaks as described in Section 7.3, prepressurize the manometer and flexible hose to the expected vapour pressure of the sample [Note 4], and record this value as the 'initial manometer setting.' While the sample is being brought to equilibrium as described in Section 7.5, observe the manometer occasionally to check for leaks in the manometer assembly. Any change in the 'initial manometer setting' indicates a leak, in which case, the vapour pressure apparatus should be detached and connected to an alternative manometer.

NOTE 4: For purposes of prepressurizing and to avoid the necessity for re-running determinations, knowledge of the expected vapour pressure is very helpful. An indication of the expected vapour pressure level should be given, where possible, on the sample identification label. It is also helpful to maintain a list of current vapour pressures of samples being tested on a routine basis.