INTERNATIONAL STANDARD

ISO 3007

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Petroleum products and crude petroleum — Determination of vapour pressure — Reid method

Produits pétroliers et pétrole brut — Détermination de la pression de vapeur — Méthode Reid

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standard are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 3007 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

This third edition cancels and replaces the second edition (ISO 3007:1986), of which it constitutes a technical revision.

Annexes A, B and C form an integral part of this International Standard.

Petroleum products and crude petroleum — Determination of vapour pressure — Reid method

WARNING — The use of this International Standard may involve hazardous materials, operations and equipment. This International Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies a method for the determination of the vapour pressure of liquid petroleum products consisting of essentially or wholly of hydrocarbon components, or containing oxygenated hydrocarbons of specific types and at specified maximum concentrations. The method does not apply outside these concentration levels, nor to any blends containing methanol or other oxygenated hydrocarbons not covered in note 1.

NOTE 1 The maximum concentration of ethers containing 5 or more carbon atoms is 15 % (*V/V*), and for ethanol is 10 % (*V/V*). For higher alcohols, the maximum concentration is 7 % (*V/V*).

NOTE 2 For the purposes of this International Standard, the term "%(*V/V*)" is used to represent the volume fraction of a material.

For petroleum products containing methanol, or other oxygenated hydrocarbons outside the scope of note 1, a dry vapour-pressure test method should be used. For liquefied petroleum gases, ISO 4256 should be used. The test method may be applied to volatile crude petroleum with a vapour pressure exceeding 10 kPa, although the precision has not been evaluated.

Four procedures are described in this International Standard. Procedures A and B are alternative apparatus configurations for products with a Reid vapour pressure up to 180 kPa, Procedure C is applied to liquid products with a Reid vapour pressure above 180 kPa, and Procedure D applies to aviation gasolines with a Reid vapour pressure of approximately 50 kPa.

Vapour pressure is an important physical property of volatile liquids, and has critical performance implications for automotive and aviation gasolines. Vapour pressure is also one of the properties affecting atmospheric evaporation, and is therefore increasingly used in regulations relating to emissions and air quality control. Vapour pressure is also a critical property limiting the performance and safety of operation of equipment during transfer operations.

NOTE Because the external atmospheric pressure is counteracted by the atmospheric pressure initially in the vapour chamber, the Reid vapour pressure is approximately the "absolute" vapour pressure at 37,8 °C. The Reid vapour pressure differs from the true vapour pressure of the sample owing to slight vaporization of the sample and the pressure of water vapour and air in the confined space.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, such publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3170:1988, *Petroleum liquids — Manual sampling*.

3 Term and definition

For the purposes of this International Standard, the following term and definition applies.

3.1
Reid vapour pressure
absolute vapour pressure exerted by a liquid under the specific conditions of test temperature, vapour:liquid ratio, and air and water saturation described in this International Standard

4 Principle

The liquid chamber of the Reid vapour-pressure apparatus is filled with the chilled sample and connected to the vapour chamber that has been preheated to 37,8 °C. The assembled apparatus is immersed in a bath at 37,8 °C until constant pressure is observed. The pressure reading, corrected if necessary, is the Reid vapour pressure.

5 Apparatus

The apparatus for Procedures A, C and D is described in annex A. The apparatus for Procedure B is described in annex B.

5.1 Cooling bath, to cool the samples to 0 °C to 1 °C and the liquid chamber to below 5 °C. An ice water bath or a refrigerator, with freezer compartment, are suitable.

NOTE Solid carbon dioxide is not a suitable cooling medium due to its solubility in gasolines, which may lead to erroneous results.

6 Samples and sampling

6.1 The extreme sensitivity of vapour-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 taking and handling of samples.

6.2 Unless otherwise specified, the samples shall be obtained by the procedures described in ISO 3170.

NOTE The taking of automatic in-line samples is not recommended for this International Standard, unless a variable-volume sample receiver is used. The use of a fixed-volume receiver, pressurized or not, may result in light-end loss from the product.

6.3 For procedures A, B and D, the sample containers shall be of 1 litre capacity, and shall be filled to 70 % to 80 % capacity with the sample. For Procedure C, the sample container shall be of a minimum of 0,5 litre capacity.

NOTE With agreement between all the parties concerned, smaller samples, down to 0,3 litre minimum, may be taken when sampling inerted vessels for vapour-pressure measurement exclusively. These samples should be placed in sample containers with the ullage requirements specified in 6.3. Precision on samples of less than that specified in 6.3 has not been determined.

6.4 Sample containers shall be leak-free. Discard containers found to have any visible leak, and obtain a new sample.

6.5 Official samples frequently require specific sampling arrangements, including a separate sample for the Reid vapour-pressure determination, and possibly the presence of a cooling bath or an insulated carrier at the sampling site (see also the note to 6.3). Regulations and/or specifications shall be consulted for any special instructions for sampling before samples are taken.

6.6 In all cases, protect the samples between the sampling point and the cooling bath (5.1) from excessive heat.

6.7 The Reid vapour-pressure determination shall be performed on the first test portion withdrawn from the sample container. The remaining sample in the container shall not be used for a second determination. If necessary, obtain a new sample.

6.8 The sample container and its contents shall be cooled to 0 °C to 1 °C before opening. Sufficient time to reach this temperature shall be ensured 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.

7 Sample preparation

7.1 With the sample at a temperature of 0 °C to 1 °C, remove the sample container from the cooling bath and wipe dry with absorbent material. Verify that the container is 70 % to 80 % full, either by visual examination if the container is transparent, or, if the container is not transparent, by the use of a suitable gauge.

7.2 If the container is less than 70 % full, discard the sample. If the container is more than 80 % full, pour out enough sample to bring the volume in the container to within the 70 % to 80 % range. Under no circumstances shall any sample poured out be returned to the container.

7.3 Reseal the container if necessary, and replace it in the cooling bath for a sufficient time for the temperature to equilibrate to 0 °C to 1 °C.

7.4 For Procedures A, B and D only, remove the sample container from the cooling bath at 0 °C to 1 °C, open it momentarily, reseal it, and shake it vigorously for 10 s to 20 s. Return it to the bath for a minimum of 2 min. Repeat this procedure twice more, and then return the sample to the cooling bath until ready for sample transfer.

7.5 For procedure C, do not disturb the sample in the cooling bath until it is removed for sample transfer.

8 Apparatus preparation

8.1 Liquid chamber

Completely immerse the open liquid chamber in an upright position in the cooling bath (5.1) for at least 10 min until it reaches a temperature below 5 °C. For Procedures A, B, and D, also immerse the sample transfer connection (A.5 and Figure 1) for the same cooling period.

NOTE The freezer compartment of the refrigerator may be used to minimize the time required.

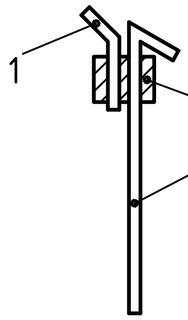
8.2 Vapour chamber

The purged (see 11.1 to 11.3) vapour chamber and pressure sensor shall be connected together and placed in a water bath (A.3) at 37,8 °C to a depth that ensures that at least 25 mm of water is above the highest level of the vapour chamber. Keep it in the water bath for a minimum of 10 min, and do not remove it until the liquid chamber has been filled with sample.

9 Sample transfer

9.1 For Procedures A, B and D, remove the chilled sample container from the cooling bath (5.1), uncap it, and insert the chilled transfer connection (see Figure 1). Remove the liquid chamber from the cooling bath or refrigerator, empty it, or confirm that it is empty by inversion, and place it rapidly over the sample delivery tube of the transfer connection. Invert the entire system rapidly, so that the liquid chamber is upright with the end of the delivery tube extending to approximately 6 mm of the bottom of the liquid chamber. Fill the liquid chamber to overflowing, ensuring that the sample is free of air bubbles by lightly tapping the liquid chamber against the work surface. Withdraw the delivery tube from the liquid chamber while allowing the sample to continue flowing up to complete withdrawal. Figure 2 illustrates the above operations.

CAUTION — Ensure that suitable containment of excess sample is provided, and that no potential ignition sources are adjacent. Make suitable provision for the safe disposal of excess sample.

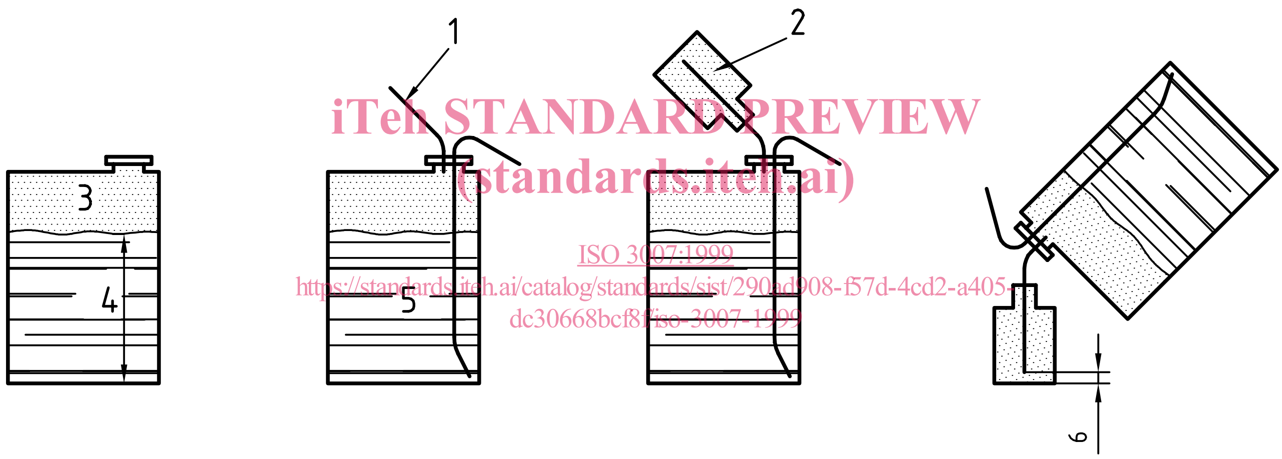


Key

1 Delivery tube
2 Stopper
3 Sampling tube

Figure 1 — Sample transfer connection

Dimensions in millimetres



a) Sample container prior to transfer of sample

b) Sealing closure replaced by sample transfer connection

c) Liquid chamber placed over liquid delivery tube

d) Position of system for sample transfer

Key

1 Chilled sample transfer connection
2 Chilled liquid chamber
3 Vapour
4 Liquid
5 Chilled sample

Figure 2 — Simplified outline of sample transfer for Procedures A, B and D

9.2 For Procedure C**,** use a safe method of displacement of the sample from the sample container to the liquid chamber which ensures that a chilled, unweathered sample is transferred. Self-induced pressure displacement by the procedure described in 9.2.1 to 9.2.3 is recommended.

9.2.1 Remove the sample container from the cooling bath and allow it to warm to a temperature that will maintain a pressure above atmospheric pressure. Warm slightly if necessary, but not to above 35 °C.

9.2.2 Connect an ice-cooled coil to the outlet valve of the sample container.

NOTE A suitable ice-cooled coil can be prepared by immersing a spiral of approximately 8 m of 6 mm diameter copper tubing in a 10 litre container of ice water.

9.2.3 Connect the lower valve of the liquid chamber, removed from the cooling bath and emptied by inversion, to the ice-cooled coil. With the upper valve of the liquid chamber closed, open the outlet valve of the sample container and the lower valve of the liquid chamber. Open the upper valve of the liquid chamber slightly and allow the liquid chamber to fill slowly until it has overflowed by at least 200 ml. Control this operation so that no appreciable drop in pressure occurs at the lower valve of the liquid chamber. In the order named, close the upper and lower valves of the liquid chamber and then close all other valves in the sample system. Disconnect the liquid chamber and cooling coil. Because of the liquid-full condition of the liquid chamber, immediate attachment to the vapour chamber and opening of the upper valve is essential (see 10.1). See also the Caution to 9.1.

10 Procedure

10.1 Apparatus assembly

Without delay, remove the vapour chamber from the water bath, shake it gently to remove free water droplets, and couple it to the filled liquid chamber as quickly as possible without spillage. Do not allow undue movement of the vapour chamber that could promote exchange of the ambient air with the air at 37,8 °C in the vapour chamber. The coupling shall be completed within 10 s of the vapour chamber being removed from the water bath. If a two-valve liquid chamber is used (Procedure C), open the upper valve immediately after coupling is completed.

10.2 Introduction of the apparatus into the bath

10.2.1 Procedures A and D

Turn the assembled apparatus upside down and allow all the sample in the liquid chamber to drain into the vapour chamber. With the apparatus still inverted, shake it vigorously up and down eight times. With the gauge end up, immerse the assembled apparatus in the bath at 37,8 °C in an inclined position, so that the connection of the liquid and vapour chambers is below the water level. Carefully examine for leaks. If no leaks are observed, further immerse the apparatus to a vertical position, with the water level a minimum of 25 mm above the top of the vapour chamber. Observe the apparatus for leaks throughout the test and discontinue the test at any time that a leak is detected.

NOTE Liquid leaks are more difficult to detect than vapour leaks, and because the coupling between the chambers is normally in the liquid section of the apparatus, it should be given particular attention.

10.2.2 Procedure B

While holding the apparatus vertically, immediately connect the spiral tubing at the quick-action disconnect. Tilt the apparatus to 20° to 30° downward for 4 s to 5 s to allow the sample to flow into the vapour chamber without entering the tube extending into the vapour chamber from the pressure sensor. Place the assembled apparatus in the water bath in such a way that the bottom of the liquid chamber engages in the drive coupling, and the other end of the apparatus rests on the support bearing. Turn on the switch to begin the rotation of the assembled liquid-vapour chambers (see B.1). Observe the apparatus for leaks throughout the test (see the note to 10.2.1). Discard the test at any time that a leak is detected.

10.2.3 Procedure C

With care, turn the assembled apparatus upside down and allow the sample in the liquid chamber to flow into the vapour chamber. Do not shake the apparatus. Re-invert the apparatus and immerse it in the bath at 37,8 °C in the manner described in 10.2.1. Continue to examine for leaks throughout the test as specified.

10.3 Vapour-pressure measurement

10.3.1 Procedures A and D

After the assembled apparatus has been in the water bath for at least 5 min, tap the pressure gauge (A.2) lightly and observe the reading. Withdraw the apparatus from the bath, invert it, and repeat the shaking action described in 10.2.1. Replace the apparatus vertically in the bath, and at further intervals of not less than 2 min, repeat this procedure at least four more times. Continue this procedure as necessary, until two consecutive gauge readings are the same. Read the final gauge pressure to the nearest 0,25 kPa and record this as the observed vapour pressure of the sample. Without delay, remove the apparatus from the bath, disconnect the pressure gauge (see the note below) and, without attempting to remove any trapped liquid in the gauge, check its reading against that of the verifying device (A.2.2) while both are subject to a common steady pressure that is within 1 kPa of the observed reading. If a difference is observed between the verifying device and gauge readings, this difference is applied to the observed vapour pressure to obtain the Reid vapour pressure of the sample.

NOTE Cooling the assembly, taking care not to cool the gauge, prior to disconnection will facilitate disassembly and reduce the escape of hydrocarbon vapours.

10.3.2 Procedure B

Carry out 10.3.1 without the removal of the apparatus and without the shaking procedure. For the pressure-gauge apparatus, the tapping and reading shall be as specified in 10.3.1, but for transducer apparatus, the tapping is not required. The checking and correction of the final pressure gauge or transducer readings shall be as specified in 10.3.1.

10.3.3 Procedure C

Carry out 10.3.1 without the removal of the apparatus and without the shaking procedure, as this could be hazardous. As an alternative to the manometer corrections to the observed vapour-pressure readings, a dead-weight tester is recommended for vapour pressures above 180 kPa. The corrections are applied in exactly the same manner as those described for manometer-reading corrections.

NOTE Because the assembled apparatus is not shaken to promote equilibrium, it is likely that the time taken to two consecutive identical observed vapour pressures will be significantly longer than that for Procedures A, B and D.

11 Preparation of apparatus for next test

11.1 Thoroughly purge the liquid and vapour chambers, and the sample transfer connection, of residual sample by filling them with warm water above 32 °C, and allowing them to drain. Repeat this purging at least five times. Rinse the components several times with a light aliphatic petroleum distillate, then several times with acetone. Dry in a current of dry air. Place the liquid chamber in the cooling bath or refrigerator in preparation for the next test.

NOTE Suitable distillates for washing the components include petroleum spirit, petroleum naphtha, heptane and 2,2,4-trimethylpentane.

11.2 If the purging of the vapour chamber is done in a bath, close the top and bottom openings of the chamber as they pass through the water surface to avoid small films of floating sample.

11.3 Disconnect the pressure gauge from the verifying device and remove trapped liquid in the Bourdon tube of the gauge by repeated centrifugal thrusts by hand. Hold the gauge between the palms of the hands, with the right hand on the face of the gauge and the threaded connection forward. Extend the arms forward and upward at an angle of 45°, and then swing the arms rapidly through an arc of approximately 135°. Repeat this operation at least three times, or until all liquid has been expelled from the gauge. In the correct operation of Procedure B, liquid shall not reach the pressure gauge or transducer. If liquid is observed or suspected to have reached the gauge, purge it as specified above. The transducer has no cavity to trap liquid, but ensure that there is no liquid in the T-handle fitting or spiral tubing by forcing a stream of dry air through the tubing. Connect the pressure gauge or transducer to the purged vapour chamber with the liquid connection closed, and place the chamber in the bath at 37,8 °C to condition for the next test.

NOTE The vapour chamber and attached gauge or transducer should not be left in the water bath for longer than is necessary for conditioning. Water vapour can condense in the Bourdon tube and cause erroneous results.

12 Expression of results

12.1 Report the corrected result obtained to the nearest 0,25 kPa for values of 100 kPa and below, and to the nearest 0,5 kPa for values above 100 kPa, as the Reid vapour pressure.

12.2 Report the Procedure (A, B, C or D) used.

13 Precision

13.1 General

The precision, as determined by statistical examination of interlaboratory test results, is given in Table 1.

13.2 Repeatability

The difference between two 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 values given in Table 1 in only one case in 20.

13.3 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 values given in Table 1 in only one case in 20.

Table 1 — Precision values

Values in kilopascals

Procedure	Range	Repeatability	Reproducibility
A	0 to 35	3,2	5,2
A (gasoline)	35 to 100	1,2	4,5
A	110 to 180	2,1	2,8
B (gasoline)[a]	35 to 100	1,2	4,5
C	Above 180	2,8	4,9
D (avgas)	50 ± 5	0,7	1,0

[a] A bias of 0,7 kPa to 1,4 kPa has been observed between pressure gauge and transducer results, with the transducer readings being higher.

14 Test report

The test report shall contain at least the following information:

a) a reference to this International Standard;

b) the type and complete identification of the product tested;