
Determination of flash point — Abel closed-cup method

Détermination du point d'éclair — Méthode Abel en vase clos

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 19, *Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 13736:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the [Subclause 7.5](#) has been further elaborated;
- under [13.2](#) and [13.3](#), the precision definitions have been updated in line with ISO 4259-1^[3];
- in [Annex C](#) the digital contact thermometers have been introduced and furthermore explanation on the generic liquid-in-glass thermometers has been introduced;
- [Annex D](#) has been revised (especially the evaluation subclause) and changed to normative status;
- a new [Annex E](#) on flash point values of chemicals has been introduced.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Flash point values are used in shipping, storage, handling and safety regulations, as a classification property to define “flammable” and “combustible” materials. Precise definition of the classes is given in each particular regulation.

A flash point value can indicate the presence of highly volatile material(s) in a relatively non-volatile or non-flammable material, and flash point testing can be a preliminary step to other investigations into the composition of unknown materials.

Flash point determinations are not appropriate for potentially unstable, decomposable, or explosive materials, unless previously established that heating the specified quantity of such materials in contact with the metallic components of the flash point apparatus, within the temperature range required for the method, does not induce decomposition, explosion or other adverse effects.

Flash point values are not a constant physical-chemical property of materials tested. They are a function of the apparatus design, the condition of the apparatus used, and the operational procedure carried out. Flash point can therefore be defined only in terms of a standard test method, and no general valid correlation can be guaranteed between results obtained by different test methods or with test apparatus different from that specified.

ISO/TR 29662^[Z] gives useful advice on carrying out flash point tests and interpreting results.

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Determination of flash point — Abel closed-cup method

WARNING — The use of this document can involve hazardous materials, operations and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of users of this document to take appropriate measures to ensure the safety and health of personnel prior to the application of the standard, and to determine the applicability of any other restrictions for this purpose.

1 Scope

This document specifies a method for the determination of the manual and automated closed cup flash point of combustible liquids having flash points between $-30,0\text{ }^{\circ}\text{C}$ to $75,0\text{ }^{\circ}\text{C}$. However, the precision given for this method is only valid for flash points in the range $-8,5\text{ }^{\circ}\text{C}$ to $75,0\text{ }^{\circ}\text{C}$.

This document is not applicable to water-borne paints.

NOTE 1 Water borne paints can be tested using ISO 3679^[1].

NOTE 2 See 9.1 for the importance of this test in avoiding loss of volatile materials.

NOTE 3 Liquids containing halogenated compounds can give anomalous results.

NOTE 4 The thermometer specified for the manual apparatus limits the upper test temperature to $70,0\text{ }^{\circ}\text{C}$.

NOTE 5 See 13.1 for more specific information related to precision.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3170, *Petroleum liquids — Manual sampling*

ISO 3171, *Petroleum liquids — Automatic pipeline sampling*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

flash point

lowest temperature of the test portion, adjusted to account for variations in atmospheric pressure from $101,3\text{ kPa}$, at which application of an ignition source causes the vapour of the test portion to ignite and the flame to propagate across the surface of the liquid under the specified conditions of test

4 Principle

The test portion is placed in the test cup of an Abel apparatus and heated to give a constant temperature increase with continuous stirring. An ignition source is directed through an opening in the test cup cover at regular temperature intervals with simultaneous interruption of stirring. The lowest temperature at which application of the ignition source causes the vapours of the test portion to ignite and propagate over the surface of the liquid is recorded as the flash point at the ambient barometric pressure. The temperature is adjusted to account for variation in atmospheric pressure from 101,3 kPa, using a formula.

5 Chemicals and materials

5.1 Cleaning solvent, for the removal of traces of sample from the test cup and cover.

The choice of solvent depends upon the previous material tested, and the tenacity of the residue. Low volatility aromatic (benzene-free) solvents may be used to remove traces of oil, and mixed solvents can be efficacious for the removal of gum-type deposits.

5.2 Coolant, mixture of equal volumes of 1,2-ethanediol (ethylene glycol) and water, or mixture of equal volumes of glycerol and water, or silicone oil (optional), for use in an external cooling bath (6.5) or in the Abel apparatus (6.1).

5.3 Lubricant (optional), to reduce the formation of ice crystals on the cover and shutter mechanism when carrying out tests at temperatures below 5,0 °C (7.4.3, Note 1).

5.4 Verification liquids, certified reference materials (CRM) and secondary working standards (SWS) as described in Annex D.

5.5 Ignitor and pilot light gas, which may be propane, butane or natural gas (not required if an electric ignitor is used).

6 Apparatus

6.1 Flash point apparatus, as specified in Annex A.

If automated equipment is used, ensure that the test cup and cover assembly conform to the key dimensions specified in A.2 and that the procedure described in Clause 10 is followed. The user shall ensure that all of the manufacturer's instructions for adjusting and operating the instrument are followed.

In cases of dispute, unless explicitly agreed otherwise, the manual determination of the flash point, using a flame ignition source, shall be considered the referee test.

6.2 Thermometers

6.2.1 Test cup thermometer, installed as in Annex B and conforming to the specification given in Annex C.

6.2.2 Heating vessel thermometer, installed as in Annex B and conforming to the specification given in Annex C.

Other types of temperature-measuring device may be used, provided that they meet the requirements for accuracy and have the same response as the thermometers specified in Annex C.

6.3 Timing device, stopwatch or electronic timer with an accuracy better than 5 %.

6.4 Barometer, absolute pressure reading, accurate to 0,5 kPa. Barometers pre-corrected to give sea-level readings, such as those used at weather stations and airports, shall not be used.

6.5 External cooling bath (optional), for assisting in the cooling of the Abel apparatus and test sample (7.4.1 and 7.4.2).

6.6 Test cup thermal insulating cap (optional), to reduce the formation of ice crystals on the cup and cover assembly during sub-ambient testing.

7 Apparatus preparation

7.1 Location of the apparatus

Support the Abel apparatus (6.1) on a level and steady surface in a draught-free position.

NOTE When draughts cannot be avoided, it is good practice to surround the apparatus with a shield.

When testing materials that produce toxic vapours, the apparatus should be located in a fume hood with an individual control of air flow, adjusted such that vapours can be withdrawn without causing air currents around the test cup during the test.

7.2 Cleaning the test cup

Wash the test cup with an appropriate solvent (5.1) to remove any traces of gum or residue remaining from a previous test. Dry using a stream of clean air or other proven procedure to ensure complete removal of the solvent used.

WARNING — Any remaining cleaning solvent can significantly affect the measured flash point of a sample.

7.3 Apparatus examination

Examine the test cup, the cover and other parts to ensure that they are free from signs of damage and deposits. If any damage is found, either rectify the problem or, if this is not possible, obtain a replacement. If deposits are found remove them.

7.4 Heating and cooling

7.4.1 Liquid baths

Use water or, for less than or near 0 °C bath temperatures, a coolant (5.2), to completely fill the heating vessel and to fill the inner air chamber that surrounds the test cup to a depth of at least 38 mm.

Adjust the temperature of the heating vessel using an external cooling bath (6.5) if required, to at least 9,0 °C below the expected flash or to -35,0 °C, whichever is the higher.

7.4.2 Solid metal baths

Follow the manufacturers' instructions to adjust the temperature of the bath to at least 9,0 °C below the expected flash point or to -35,0 °C, whichever is the higher.

7.4.3 Test cup and cover

Loosely assemble the cover and test cup. Adjust their temperature, using an external cooling bath (6.5) or refrigerator if required, to at least 17,0 °C below the expected flash point or to -35,0 °C, whichever is the higher.

Use the thermal insulating cap (6.6) at lower temperatures.

Ensure that neither cooling liquid nor vapour from the cooling bath, that could affect the flash point of the product under test, enters the test cup.

NOTE 1 Cooling a cover or test cup that is wet with water to below 0 °C can cause sticking due to ice (e.g. sticking of the slide). Wiping the apparatus dry with a duster or a piece of absorbent paper before cooling to below 0 °C is usually sufficient to prevent icing but, alternatively, icing can be minimized by the use of a thermal insulating cap (6.6) and by lubricating the outer face of the lip of the test cup and the slide with a lubricant (5.3).

NOTE 2 A low humidity laboratory environment helps minimize the formation of ice crystals at test temperatures of below 5 °C.

7.5 Apparatus verification

7.5.1 Check the temperature measuring devices and barometer at least once a year to ensure that they are in accordance with 6.2 and 6.4 requirements respectively.

7.5.2 Ensure the correct operation of ignition sources, in accordance with the manufacturers' instructions and this test method.

7.5.3 Verify the accuracy of the apparatus at least once a year by testing a certified reference material (CRM) (see 5.4 and Annex D). It is recommended that more frequent verification checks are made using CRM or SWS.

The result of a single test obtained for either CRM or SWS shall be equal to or less than $R/\sqrt{2}$ from the certified value of the CRM or from the accepted reference value (ARV) of the SWS, where R is the reproducibility of the test method.

NOTE These reference materials and in-house quality control samples can also be used to monitor stability and establish statistical control limits, in accordance with ASTM D6299^[13] or equivalent standard, if required.

7.5.4 Do not use the numerical values obtained during verification checks to correct subsequent flash point results or provide a bias statement.

7.5.5 When the flash point is not within the required limits, check the condition and operation of the apparatus to ensure conformity with the details listed in A.1 especially with regard to tightness of the lid, the action of the shutter, the position and operation of the ignition source, and the angle and position of the temperature measuring device. After any adjustment, repeat the test in Annex D using a fresh test portion, with special attention to the procedural details prescribed in this test method.

8 Sampling

8.1 Obtain samples in accordance with the procedures given in ISO 3170, ISO 3171, ISO 15528 or an equivalent national standard, unless otherwise agreed.

8.2 Place sufficient sample volume for testing in a tightly sealed container appropriate to the material being sampled and, for sample integrity and safety purposes, ensure that the sample container is filled to between 85 % and 95 % of its capacity.

8.3 Store the samples in conditions that minimize vapour loss and pressure build-up.

IMPORTANT — Erroneously high flash points can be obtained if precautions are not taken to avoid the loss of volatile material. Do not open containers unnecessarily, to prevent loss of volatile material or possible introduction of moisture. Avoid storage of samples at temperatures in excess of 30 °C.

8.4 For samples, for storage, ensure that the sample container is tightly closed and leak free. Do not make a transfer unless the sample temperature is at least 17 °C below the expected flash point or to –35,0 °C, whichever is the higher, before opening the container.

8.5 Do not store samples in gas-permeable containers, since volatile material can diffuse through the walls of the enclosure. Samples in leaky containers are suspect and not a source of valid results.

9 Sampling handling

9.1 General

Since the presence of small proportions of highly volatile materials needs to be detected, this test should be the first determination on a received sample to reduce the loss of these volatile materials.

9.2 Subsampling

9.2.1 Subsample at a sample temperature that is at least 17 °C below the expected flash point or to –35,0 °C, whichever is the higher, before opening the container.

Cool liquids that crystallize on cooling to just above their melting points.

9.2.2 Successive test portions may be taken from the same sample container when the second test portion is taken with the sample container at least 50 % filled.

NOTE Results of flash point determinations can be affected if the sample volume falls below 50 % of the container's capacity.

9.3 Samples containing undissolved water

Flash point results can be affected by the presence of water. If a sample contains water as a separate phase, decant an aliquot from the water prior to mixing.

For certain fuels, it is not always possible to decant the sample from the free water. In such cases, the water should be separated from the aliquot physically, prior to mixing, or, if this is not possible, the material should be tested in accordance with ISO 3679.

9.4 Sample mixing

Mix samples by gentle manual shaking prior to the removal of the test portion, taking care to minimize the loss of volatile components, and proceed in accordance with [Clause 10](#).

10 Procedure

10.1 Using a barometer ([6.4](#)), record the ambient pressure in the vicinity of the apparatus at the time of test.

NOTE It is not necessary to correct the barometric pressure for ambient temperature, although some barometers are designed to make this correction automatically.

10.2 Follow apparatus preparation (see [Clause 7](#)) and sample handling (see [Clause 9](#)) to adjust the temperature of the Abel bath, cup and cover respectively.

10.3 Place the test cup in position in the apparatus and insert the test cup thermometer (6.2.1). Remove the cover and pour in the test portion without undue agitation, avoiding as far as possible the formation of air bubbles, until the level just reaches the point of the index gauge on the wall of the test cup.

The sample may be poured into the test cup before it is placed in position in the apparatus. Place the cover on the test cup and push it down into position. Make any necessary mechanical or electrical connections to the cover and, if a gas ignition source is used, ignite the ignition source flame, adjust its size to conform to the size of the reference bead mounted on the cover of the test cup, and maintain it at that size throughout the test.

A pre-test dip of the ignition source is strongly recommended, before commencing heating of the test portion, as this could indicate the presence of low flash point components. If a flash is detected, discontinue the test, discard the test portion and proceed in accordance with 10.2, commencing the test with a lower expected flash point temperature.

10.4 At the start of the test, apply heat to the heating vessel in such a manner that the temperature of the test portion in the test cup rises at a rate of approximately 1 °C/min from the first application of the ignition source, as described in 10.6, to the end of the test. This rate of heating is not reached immediately at the start of the test. See A.2.5 for specific requirements for automated heating vessels.

10.5 Stir the test portion in a clockwise direction (i.e. to give a downward thrust) at 30 r/min $\pm$ 5 r/min. Continue stirring in a steady manner for the duration of the test but do not stir during the application of the ignition source.

10.6 When the temperature of the test portion reaches at least 9,0 °C below the expected flash point or -35,0 °C, whichever is the higher, apply the ignition source by slowly and uniformly opening the slide over a period of approximately 2 s and then closing it over a period of approximately 1 s.

10.7 If a flash is detected on this first application of the ignition source, discontinue the test, discard the test portion and proceed in accordance with 10.2, commencing the test at a lower expected flash point temperature. If no flash occurs, proceed in accordance with 10.8. If a flash occurs at a temperature below -30,0 °C, record and report this fact and discontinue the test.

10.8 Apply the ignition source in this manner at every 0,5 °C rise in temperature until a distinct flash is detected in the interior of the test cup.

10.9 Record, as the detected flash point, the temperature read by the test cup thermometer at the time when the ignition source application causes a distinct flash in the interior of the test cup.

10.10 Do not confuse the true flash point with the bluish halo that sometimes surrounds the ignition source flame at applications preceding the actual flash point.

11 Calculation

11.1 If the barometric pressure reading taken in accordance with 10.1 is in a unit other than kilopascals, convert to kilopascals using the following formulae as appropriate:

- reading in hPa $\times$ 0,1 = kPa;
- reading in mbar $\times$ 0,1 = kPa;
- reading in mmHg $\times$ 0,133 322 = kPa.

NOTE For the purposes of correcting flash point values to account for variations in atmospheric pressure from 101,3 kPa, it is not considered necessary to correct the barometer readings for ambient temperature. However, some barometers are designed to automatically correct the barometric pressure for ambient temperature.

11.2 Calculate the corrected flash point, T_c , using [Formula \(1\)](#):

$$T_c = T_d + 0,25 \times (101,3 - P) \quad (1)$$

where

- T_d is the detected flash point, expressed in degrees Celsius;
- P is the barometric pressure at 0 °C, expressed in kilopascals;
- 0,25 is a constant with dimensions degrees Celsius per kilopascal;
- 101,3 is used as the standard atmospheric pressure in kilopascals.

NOTE 1 [Formula \(1\)](#) is strictly correct only within the barometric pressure range from 98,0 kPa to 104,7 kPa.

NOTE 2 For practical purposes, 4 kPa is equivalent to a flash point temperature change of 1 °C.

12 Expression of results

Report the flash point, corrected to standard atmospheric pressure and rounded to the nearest 0,5 °C.

13 Precision

13.1 General

The precision, as determined by statistical examination of interlaboratory test results in accordance with ISO 4259^[2] for both manual and automated apparatus, is given in [13.2](#) and [13.3](#) and applies over the range –8,5 °C to 75,0 °C for automated apparatus and 20,0 °C to 70,0 °C for manual apparatus. The method and apparatus may be used over a wider temperature range; however, the precision could be affected.

A comparison of precision values between manual apparatus, automated apparatus with gas ignition, and automated apparatus with electric ignition indicated that there was no real difference between the reproducibility estimates. However, repeatability for automated apparatus with electric ignition was found to be slightly greater than in [Formula \(2\)](#). For practical purposes, this difference shall be ignored as it is significantly less than the repeatability of the method.

The evaluation of the degree of agreement between the different apparatus types was performed in accordance with ASTM D6708^[14]. No relative bias was found between automated apparatus using gas ignition sources and that using electric ignition sources. However, a small relative bias was evident between manual and automated. For practical purposes this relative bias shall be ignored as it is significantly less than the repeatability of the method.

The results of the interlaboratory test programme are reported in Reference [\[18\]](#) together with full details of the test programme and statistical evaluations.

13.2 Repeatability, r

The difference between two independent results obtained in the normal and correct operation of the test method by the same operator in a given laboratory applying the same method, for test material considered to be the same, within a short interval of time, with the same apparatus under constant operating test conditions, would exceed the following value with an approximate probability of 5 %:

$$r = 1,4 \text{ °C} \quad (2)$$

13.3 Reproducibility, R

The difference between two independent results obtained by different operators in the normal and correct operation of the same method, for test material considered to be the same, in different laboratories using different apparatus under different operating test conditions, would exceed the following value with an approximate probability of 5 %:

$$R = 3,2 \text{ }^{\circ}\text{C} \quad (3)$$

14 Test report

The test report shall contain at least the following information:

- a) a reference to this document (i.e. ISO 13736:2021);
- b) the type and complete identification of the sample tested;
- c) the ambient barometric pressure in the vicinity of the apparatus (see [10.1](#) and the Note therein);
- d) the result of the test (see [Clause 12](#));
- e) any deviation, by agreement or otherwise, from the procedure specified;
- f) the date of the test.

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Annex A (normative)

Abel flash point apparatus

A.1 Manual apparatus

A.1.1 General

The apparatus shall consist of a test cup, cover assembly and heating vessel as described below and detailed in [Figure A.1](#) and [Figure A.2](#).

A.1.2 Test cup

The test cup shall be made of brass and conform to the form and dimensions shown in [Figure A.1](#) a).

The wall thickness of the test cup shall be $1,4 \text{ mm} \pm 0,1 \text{ mm}$ except locally to the sample height gauge where the thickness can be greater.

A gauge, consisting of a rod bent upwards and terminating in a point, shall be fixed within the test cup through the wall.

A.1.3 Test cup cover assembly

The test cup shall be provided with a close-fitting cover made of brass and conforming to the form and dimensions shown in [Figure A.1](#) c). A downwardly projecting rim barely reaching the flange on the test cup shall either form part of the top or shall be silver soldered or brazed into place.

Upon the cover shall be mounted a thermometer socket, a bush for the stirrer, trunnions to support a test gas jet, a pair of guides in which a slide moves, and a bead or other reference mark to depict the required 3,6 mm to 4,1 mm size of the ignition source flame. The top of the cover shall include three rectangular holes symmetrically placed on a diameter, one in the centre and the other two as close as practicable to the inner sides of the rim and opposite each other.

These three holes shall be covered or uncovered by means of a slide moving in guides. The slide shall have two apertures, one corresponding to the centre hole in the cover and the other to one of the holes at the side. The movement of the slide shall be restricted by suitable stops, and its length and the disposition of the holes shall be such that, at the outer extremity of the movement of the slide, the holes in the cover are just completely opened and, at the inner extremity of the movement of the slide, they are completely closed.

The trunnions supporting the test gas jet shall be fixed to the top of the guides and the gas jet shall be mounted in the trunnions so that it is free to oscillate. The test gas jet shall be arranged so that, when the slide is moved to uncover the holes, the oscillating test gas jet is caught by a pin fixed in the slide and tilted over the central hole in such a way that the lower edge of the cover bisects the circle formed by the bore of the jet when in the lowest position. The flame shall then occupy a central position within the hole in both directions.

The thermometer shall be fitted at such an angle as to bring the bulb of the thermometer when in place, vertically below the centre of the cover and at the correct distance from it.

The stirrer shall be mounted on the cover in a position diametrically opposite the thermometer mounting. Its length and the angle at which it is set shall be such that the stirrer rod clears the level gauge and the blades operate below the level of the thermometer bulb and without fouling it.

A.1.4 Stirrer

This shall be made of brass and conform to the form and dimensions given in [Figure A.1](#) b).

It shall consist of a round stem having four blades at one end. The blades of the stirrer shall be set so that the liquid is thrust in a downward direction when the stirrer is rotated clockwise.

A.1.5 Heating vessel

This shall be made of copper and conform to the form and dimensions given in [Figure A.2](#). It shall consist of two flat-bottomed cylindrical copper vessels (heating vessel and inner air chamber) placed coaxially one inside the other and soldered at their tops to a flat copper ring that is greater in outside diameter than the smaller vessel. Thus, the space between the two vessels shall be totally enclosed and used as a water jacket.

An ebonite or fibre ring of right-angled section shall be fitted into the hole in the centre of the flat ring to form the top of the heating vessel. When the apparatus is in use, the test cup shall fit into, and its flange rest upon, the ebonite or fibre ring so that the test cup is centrally disposed within the heating vessel. The ebonite or fibre ring shall be secured to avoid metallic contact between the heating vessel and the test cup.

A fitting set vertically shall allow a thermometer to be inserted into the water space. A funnel and overflow pipe shall also be connected with the water space through the top plate and two loop handles provided thereon.

The heating vessel shall have a cylindrical copper jacket.

A.1.6 Heating device

Use any suitable device for heating the vessel, such as gas flame, electric heater or spirit lamp.

A.2 Automated apparatus

A.2.1 General

The apparatus shall consist of a test cup, cover assembly and heating vessel as described below. All items of the apparatus shown in [Figure A.1](#) are made of brass.

A.2.2 Test cup

The test cup shall be made of brass and conform to the key form and dimensions shown in [Figure A.1](#) a).

The wall thickness of the test cup shall be $1,4 \text{ mm} \pm 0,1 \text{ mm}$ except locally to the sample height gauge where the thickness can be greater.

A gauge, consisting of a rod bent upwards and terminating in a point, shall be fixed within the test cup through the wall, and silver soldered or brazed into place.

A.2.3 Test cup cover assembly

The test cup shall be provided with a close-fitting cover made of brass and conforming to the key form and dimensions shown in [Figure A.1](#) c). A downwardly projecting rim barely reaching the flange on the test cup shall either form part of the top or shall be silver soldered or brazed into place.

Upon the cover shall be mounted a thermometer socket, a stirrer, a flash detector, a pair of guides in which a slide moves and, if a flame ignition source is used, a bead or other reference mark to depict the required 3,6 mm to 4 mm size of the flame. The top of the cover shall include three rectangular holes symmetrically placed on a diameter, one in the centre and the other two as close as practicable to the inner sides of the rim and opposite each other.

These three holes shall be covered or uncovered by means of a slide moving in suitably disposed guides. The slide shall have two apertures, one corresponding to the centre hole in the cover and the other to one of the holes at the side. The movement of the slide shall be restricted by suitable stops, and its length and the disposition of the holes shall be such that, at the outer extremity of the movement of the slide, the holes in the cover are just completely opened and, at the inner extremity of the movement of the slide, they are completely closed.

The ignition source, either gas flame or hot wire, shall be arranged so that, when the slide is moved so as to uncover the holes, the oscillating ignition source is tilted over the central hole. For a flame ignition source, the lower edge of the cover shall bisect the circle formed by the bore of the jet when in the lowest position. For hot wire ignition sources, follow the manufacturers' instructions to set the lowest mechanical position. The ignition source shall then occupy a central position within the hole in both directions.

The thermometer shall be mounted on a diameter at right angles to the diameter through the centres of the holes, and fitted at such an angle as to bring the tip of the thermometer, when in place, vertically below the centre of the cover and at the correct distance from it.

The stirrer shall be mounted in a position diametrically opposite the thermometer mounting. Its length and the angle at which it is set shall be such that the stirrer rod clears the level gauge and the blades operate below the level of the thermometer bulb and without fouling it.

A.2.4 Stirrer

This shall be made of brass and conform to the form and dimensions given in [Figure A.1 b](#)).

It shall consist of a round stem having four blades at one end. The blades of the stirrer shall be set so that the liquid is thrust in a downward direction when the stirrer is rotated clockwise.

A.2.5 Heating vessel

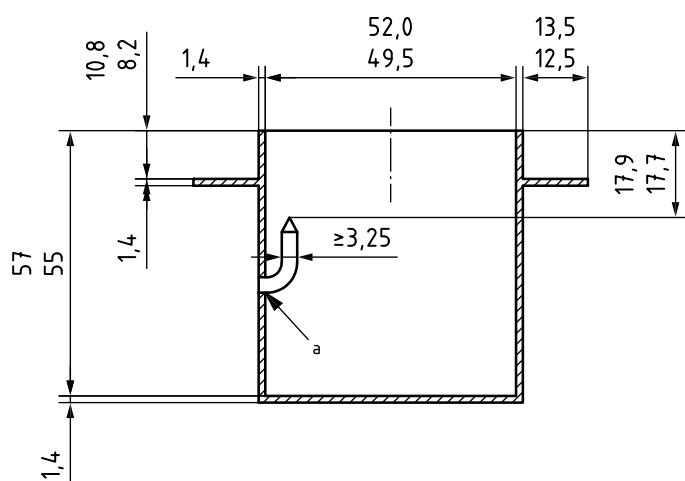
This shall be constructed and thermally controlled to ensure that the heating rate of the test portion is 0,75 °C/min to 1,25 °C/min during the test. This heating rate is not reached immediately at the start of the test. The vessel may be a replica of the manual configuration or a solid block made of aluminium, brass or a material with a similar thermal conductivity.

A.2.6 Heating device

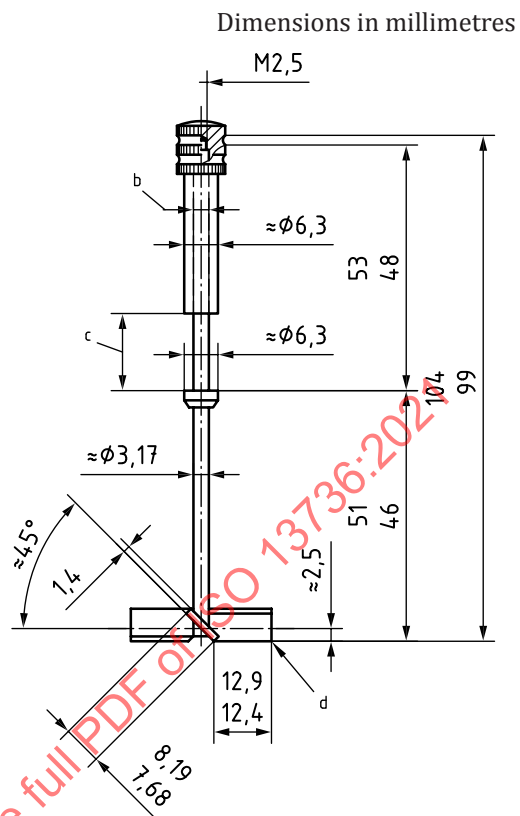
Use any suitable heating/cooling device type, such as electrical or thermoelectric. These can be used in conjunction with an external cooling bath.

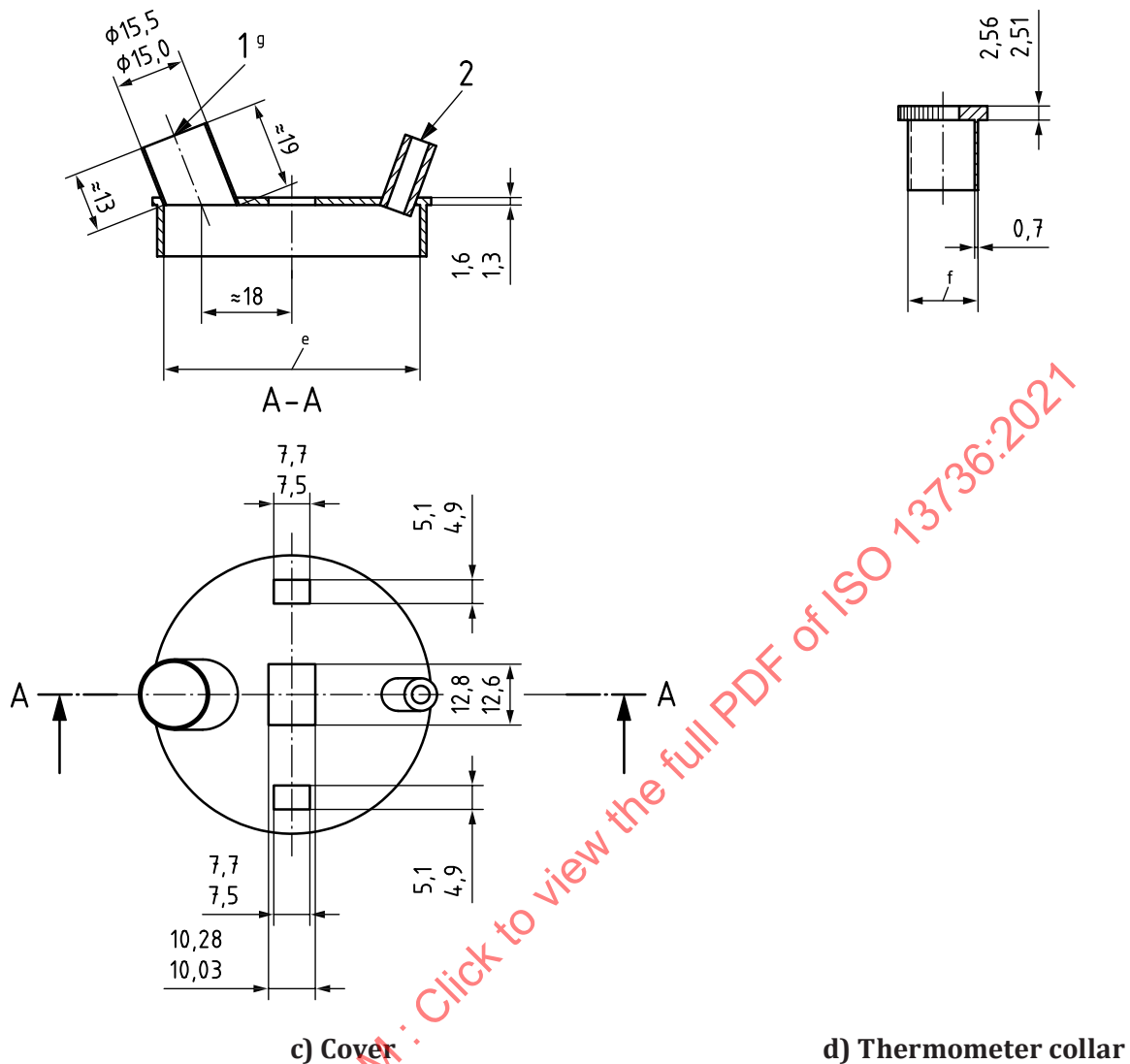
A.2.7 Flash detector

Automated apparatus shall be equipped with an electronic flash detector. Follow the manufacturer's instructions for proper positioning and adjustment of this device.



a) Test cup

**b) Stirrer**

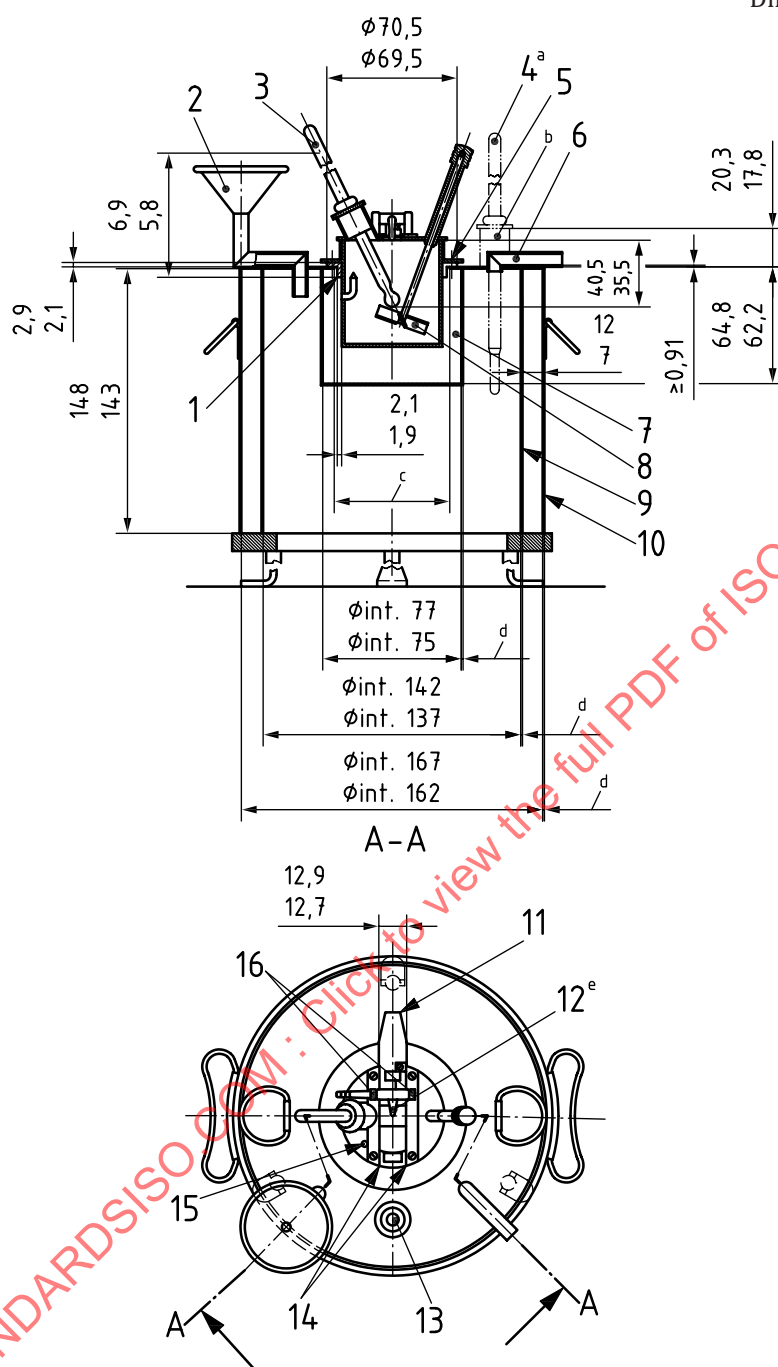


Key

- 1 thermometer socket
- 2 stirrer bush
- a Brazed or silver-soldered.
- b Inside diameter of sleeve is a sliding fit on stem.
- c This dimension is such that the stirrer rotates freely with no appreciable end play when assembled on cover.
- d All corners are rounded.
- e Close fit over test cup.
- f Push fit in thermometer socket on cover and heating vessel.
- g It is recommended that, in order to achieve interchangeability, the internal diameter of the thermometer socket be between 15,235 mm and 15,253 mm and the external diameter of the thermometer collar be between 15,222 mm and 15,232 mm.

Figure A.1 — Abel flash point apparatus — Test cup, stirrer, cover and thermometer collar

Dimensions in millimetres



Key

- | | | | |
|---|---|----|--|
| 1 | ebonite or fibre ring that fits easily on cup | 9 | heating vessel |
| 2 | funnel | 10 | outer jacket |
| 3 | test cup thermometer | 11 | slide SWG 0,91 brass |
| 4 | heating vessel thermometer | 12 | gas jet or pilot light |
| 5 | $\phi 2,2 \text{ mm} \times 3,8 \text{ mm}$ for long CSK screws | 13 | heating vessel thermometer |
| 6 | copper overflow pipe | 14 | guides |
| 7 | inner (air) chamber | 15 | white bread $\phi 3,6 \text{ mm}$ to $4,1 \text{ mm}$ of suitable material |
| 8 | stirrer | 16 | trunnions |
| a | For actual position, see plan view. | | |
| b | Inside diameter of thermometer socket is equal to 15 mm to 15,5 mm. | | |

- c 2,5 mm maximum clearance in top plate.
- d 0,6 copper.
- e Length of jet is approximately 15 mm; the bore at the end of the jet is 1,71 mm maximum and 1,46 mm minimum.

Figure A.2 — Abel flash point apparatus — Assembly plus heating vessel

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Annex B (normative)

Positioning and fixing of test cup and heating vessel thermometers into thermometer collar

B.1 Thermometer

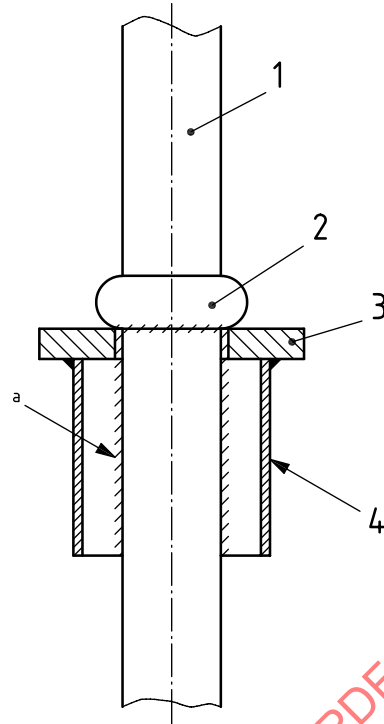
The collar shall be made of brass and shall be of the following dimensions:

- outside diameter: push fit in socket;
- thickness of tube: 0,69 mm to 0,73 mm;
- thickness of flange: 2,515 mm to 2,565 mm.

B.2 Position

Secure the thermometer in the collar in accordance with [Figure B.1](#), by means of either a mixture of plaster-of Paris (calcium sulfate hemihydrate/gypsum) and glycerine, or an epoxy-resin-based commercial adhesive.

NOTE Automated equipment can use alternative thermometer collars to enhance removal and fitting of the thermometers.



Key

- | | | | |
|---|------------------------------------|---|---|
| 1 | thermometer stem | 3 | brass collar |
| 2 | glass swelling | 4 | 0,69 mm to 0,73 mm wall tube push fit in socket |
| a | Areas for application of adhesive. | | |

Figure B.1 — Position of thermometer stem in collar

Annex C (normative)

Temperature measuring device specifications

C.1 Digital contact thermometer

C.1.1 Temperature range, at least $-35\text{ }^{\circ}\text{C}$ to $80\text{ }^{\circ}\text{C}$.

C.1.2 Display resolution, $0,1\text{ }^{\circ}\text{C}$ or better.

C.1.3 Accuracy (after calibration), $0,5\text{ }^{\circ}\text{C}$ for temperatures up to $0\text{ }^{\circ}\text{C}$ and $0,2\text{ }^{\circ}\text{C}$ for temperatures over $0\text{ }^{\circ}\text{C}$.

C.1.4 Immersion depth, less than 61 mm.

NOTE Guidelines for digital temperature measuring devices are given in ASTM E1137^[15], IEC 60751^[10] and ASTM E2877^[17].

C.2 Liquid in-glass thermometers

C.2.1 Liquid-in-glass thermometers using low hazard precision liquids may be used providing they conform to the principles and requirements stated in specification ASTM E2251,^[16] and meet the scale error, immersion depth, graduations and diameter criteria given in [Table C.1](#).

WARNING — Stem correction requirements are particularly important with liquid-in-glass thermometers using low hazard precision liquids as these liquids can have significantly higher coefficients of expansion.

WARNING — Liquid-in-glass thermometers using low hazard precision liquids can experience a separation of the liquid column during transport or rough treatment. If this separation occurs, follow the manufacturer's instructions to restore the column.

C.2.2 Test cup thermometer. See [Table C.1](#) for thermometer specifications as indicated in [Figure C.1](#).

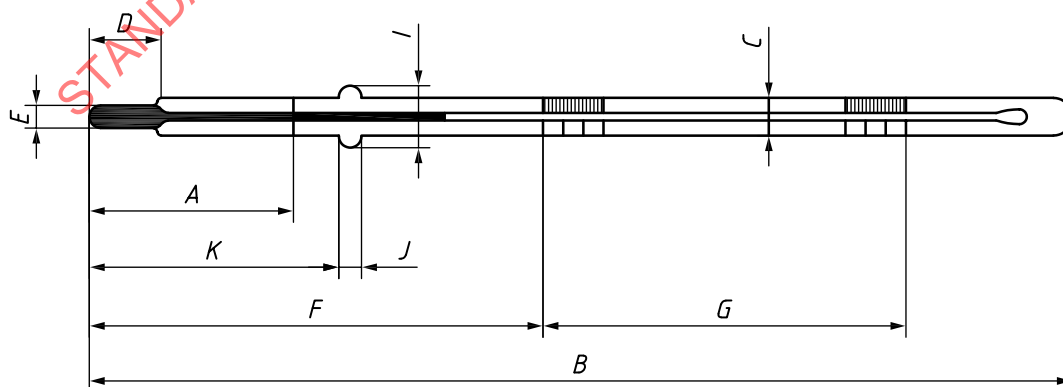


Figure C.1 — Test cup and heating vessel thermometers

NOTE Previously available Thermometer IP 74C conforms to these requirements.

C.2.3 Heating vessel thermometer. See [Table C.1](#) for thermometer specifications as indicated in [Figure C.2](#).

NOTE Previously available Thermometer IP 75C conforms to these requirements.

Table C.1 — Thermometer specifications

Type		Abel test cup wide range	Abel heating vessel wide range	Key
Temperature range, °C		–35 to 70	–30 to 80	—
Immersion, mm		61	89	A
Scale marks, °C	Subdivisions	0,5	0,5	—
	Long lines at each	1 and 5	1 and 5	—
	Numbers at each	5	5	—
	Maximum line width, mm	0,15	0,15	—
Scale error, °C, max.		0,5 below 0 0,2 at and above 0	0,5	—
Expansion chamber		Required	Required	—
Total length, mm		300 to 320	300 to 320	B
Stem OD, mm		6 to 7	6 to 7	C
Bulb length, mm		7,5 to 10,5	7,5 to 10,5	D
Bulb OD, mm		4 to 6	4 to 6	E
Scale location	Bottom of bulb to line at, °C	–35	–30	—
	Distance, mm	70 to 80	100 to 110	F
	Length of scale range, mm	195 min.	164 min.	G
	Swelling diameter, mm	9,5 to 10,5	9,5 to 10,5	I
	Swelling depth, mm	3 to 5	3 to 5	J
	Distance from base of swelling to bottom of bulb, mm	59,6 to 62,5	86,5 to 91,5	K

NOTE The average temperature of the emergent stem is 21 °C over the entire range.

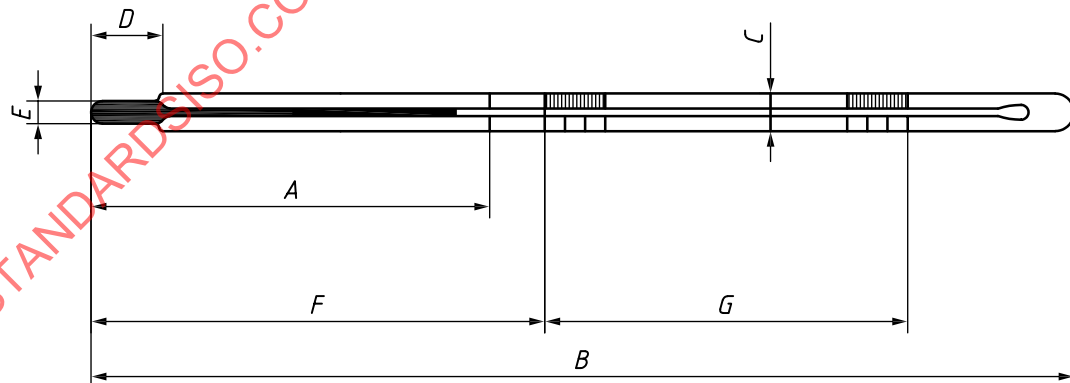


Figure C.2 — Low-temperature thermometer