

British Standard Methods of test for

Petroleum and its products**Part 34. Flash point by Pensky–Martens closed tester**

(Identical with IP 34/88)

Méthodes d'essai du pétrole et des produits pétroliers

Partie 34. Point d'éclair par la méthode Pensky-Martens en vase clos

Verfahren zur Prüfung von Erdöl und Erdölprodukten

Teil 34. Flammpunkt im geschlossenen Pensky-Martens-Gerät

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, provides general information on safety precautions, sampling and other matters, and lists the methods scheduled for publication as Parts of BS 2000. When BS 2000 : Part 0 was first published in 1982, it included a list of more than 60 methods intended for publication in the first group of Parts of BS 2000; it is envisaged that Part 0 will be revised from time to time to take account of the publication of additional methods.

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', which in 1987 has been retitled by the IP as 'Standard methods for analysis and testing of petroleum and related products'. BS 2000 : Part 34 is thus identical with IP 34/88. In the present revision the principle changes include the following:

- (a) thermometers for tests in which the indicated reading falls in either the range 60 °C to 140 °C, or 60 °C to 110 °C are detailed;
- (b) mention of the determination of the flash point of drying oils and solvent-type liquid waxes, is omitted from 1.1;
- (c) the procedure in 10.1 concerning the filling of the air space with water is omitted;
- (d) a note concerning the source of the precision data is added to 12.2.3.

NOTE 1. In relation to paints and varnishes, however, the main British Standard methods for determination of flash point are given in BS 3900 : Parts A9 and A14, which are also applicable to petroleum as BS 6664 : Parts 2 and 4.

It is intended to issue further revisions when necessary in line with changes that may be made in subsequent editions of this IP method.

This Part of BS 2000 supersedes BS 2000 : Part 34 : 1983 which is withdrawn.

The corresponding international standard is ISO 2719-1973 'Petroleum products — Determination of flash point — Pensky-Martens closed cup method' which is scheduled for revision. The principal differences between this standard and ISO 2719 are as follows.

Scope. With reference to clauses 1 and 10 this standard provides for the testing of suspensions of solids that are not referred to in ISO 2719.

Thermometers. This standard provides for the determination of flash points down to -7 °C compared with +12 °C specified in ISO 2719 and there are further minor differences regarding the temperature ranges specified for testing and the thermometers to be used. Moreover this standard provides for the use of a number of alternative thermometers in addition to the two thermometers specified in ISO 2719.

Calculation. With reference to 11.1 the correction for barometric pressure in ISO 2719 is given as $\frac{1.013 - p}{0.0033} \times 0.9$

where

p is the barometric pressure in bars.

This correction is equivalent to using a factor of 0.027 in the third equation in 11.1.

Caution. Attention is drawn to the safety precautions mentioned in Part 0 of this British Standard.

NOTE 2. The titles of the publications referred to in this Part of this British Standard are listed on the inside back cover.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

British Standards Institution

Method (identical with IP 34/88)

1. SCOPE

1.1. This method covers the determination of the flash point by Pensky–Martens closed tester of fuel oils, lubricating oils, suspensions of solids, liquids that tend to form a surface film under test conditions, and other liquids.

NOTE 1: This method may be employed for the detection of contamination of lubricating oils by minor amounts of volatile material.

NOTE 2: The US Department of Transportation (OHMO)² and US Department of Labor (OSHA) have established that liquids with a flash point under 37.8°C (100°F) are flammable as determined by this method for those liquids which have a viscosity of 5.8 cSt or more at 37.8°C (100°F) or 9.5 cSt or more at 25°C (77°F), or that contain suspended solids, or have a tendency to form a surface film while under test. Other classification flash points have been established by these departments for liquids using this test.

1.2. Liquids which have viscosities less than 5.5 cSt at 40°C (104°F), do not contain suspended solids or do not have a tendency to form a surface film while under test may be tested in accordance with Method D56.

1.3. This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

1.4. The values stated in inch-pound units shall be regarded as the standard.

NOTE to note 2. 1 cSt = 1 mm²/s.

NOTE to 1.2. There is no British Standard or IP equivalent to ASTM method D 56 'Test for flash point by Tag closed tester'.

NOTE to 1.4. For the purposes of this British Standard precedence should be given to SI or metric units as reflected in Figs. 1, 2, 3, 4, 5 and 6.

2. APPLICABLE DOCUMENTS

2.1. *ASTM Standards*:

D56 Test for Flash Point by Tag Closed Tester³

E1 Specification for ASTM Thermometers⁴

E134 Specification for Pensky–Martens Closed Flash Tester⁵

2.2. *IP Standards*:

Specifications for IP Standard Thermometers.

NOTE to 2.2. The detailed specifications for IP thermometers are given in BS 2000 : Part 0 : Addendum 1.

3. SUMMARY OF METHOD

3.1. The sample is heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame causes the vapour above the sample to ignite.

4. SIGNIFICANCE

4.1. Flash point measures the response of the sample to heat and flame under controlled laboratory conditions. It is only one of a number of properties which must be considered in assessing the overall flammability hazard of a material.

4.2. Flash point is used in shipping and safety regulations to define 'flammable' and 'combustible' materials. One should consult the particular regulation involved for precise definitions of these classes.

4.3. Flash point can indicate the possible presence of highly volatile and flammable materials in a relatively non-volatile or non-flammable material. For example, an abnormally low flash point on a sample of kerosine may indicate gasoline contamination.

5. DEFINITION

5.1. *Flash point* – the lowest temperature of the sample, corrected to a barometric pressure of 101.3 kPa (760 mm Hg), at which application of a test flame causes the vapour of the sample to ignite under specified conditions of test.

5.1.1. The sample is deemed to have flashed when a large flame appears and instantaneously propagates itself over the surface of the sample.

¹ These methods are under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants. In the IP, these methods are under the jurisdiction of the Standardization Committee.

² For information concerning regulations of US Department of Transportation see Codes of US Regulations 49 CFR Chapter I and of US Department of Labor see 29 CFR Chapter XVII. Each of these items is revised annually and may be procured from Superintendent of Documents, Government Printing Office, Washington, DC 20402.

³ *Annual Book of ASTM Standards*, Vols 05.01 and 06.03.

⁴ *Annual Book of ASTM Standards*, Vols 05.03 and 14.01.

⁵ *Annual Book of ASTM Standards*, Vols 05.03 and 14.02.

5.1.2. Occasionally, particularly near the actual flash point, the application of the test flame will cause a halo or an enlarged flame; this is not a flash and should be ignored.

6. APPARATUS

6.1. *Pensky–Martens Closed Flash Tester* – as described in Appendix I.

NOTE 3: There are automatic flash point testers available and in use which may be advantageous in the saving of testing time, permit the use of smaller samples, and other factors which may merit their use. If automatic testers are used, the user must be sure that all of the manufacturer's instructions for calibrating, adjusting, and operating the instrument are followed. In any cases of dispute, the flash point as determined manually shall be considered the referee test.

6.2. *Thermometers* – two standard thermometers shall be used with the ASTM Pensky–Martens tester, as follows:

6.2.1. For tests in which the indicated reading falls within the limits 50° to 230°F (10° to 110°C), inclusive, an ASTM Pensky–Martens Low Range or Tag Closed Tester Thermometer having a range from 20° to 230°F (–7° to +110°C) and conforming to the requirements for thermometers 9F (9C) and as prescribed in ASTM Specifications E1, or IP thermometer 15F (15C) shall be used. Specifications for these thermometers are given in Appendix III.

6.2.2. For tests in which the indicated reading falls within the limits 140 to 284°F (60 to 140°C) inclusive an ASTM 88F (88C) Vegetable Oil Flash Thermometer having a range of 50 to 392°F (10 to 200°C) and conforming to the requirements of Specification E1 shall be used. Alternatively an IP Thermometer 101C (20 to 150°C) shall be used. The specification for this thermometer is given in Appendix III.

6.2.3. For the range 140 to 230°F (60 to 110°C) either low or medium range thermometers may be used.

6.2.4. For tests in which the indicated reading falls within the limits 230° to 700°F (110° to 370°C), an ASTM Pensky–Martens High Range Thermometer having a range from 200° to 700°F (90° to 370°C) and conforming to the requirements for thermometers 10F (10C) as prescribed in ASTM Specifications E1, or IP thermometer 16F (16C) shall be used. Specifications for these thermometers are given in Appendix III.

7. PREPARATION OF APPARATUS

7.1. Support the tester on a level, steady table. Unless tests are made in a draught-free room or compartment, it is good practice, but not required, to surround the tester on three sides with a shield, each section of which is about 18 in (46 cm) wide and 24 in (61 cm) high.

NOTE to 7.1. Precedence should be given to dimensions in centimetres.

8. PREPARATION OF SAMPLE

8.1. Samples of asphalts or very viscous materials may be warmed until they are reasonably fluid before they are tested. However, no sample should be heated more than is absolutely necessary. It shall never be heated above a temperature of 30°F (17°C) below its expected flash point.

8.2. Samples containing dissolved or free water may be dehydrated with calcium chloride or by filtering through a qualitative filter paper or a loose plug of dry absorbent cotton. Warming the sample is permitted, but it shall not be heated for prolonged periods or above a temperature of 30°F (17°C) below its expected flash point.

8.3. Samples should not be stored in plastic (polyethylene, polypropylene, etc.) bottles, since volatile material may diffuse through the walls of the bottle.

NOTE 4: If the sample is suspected of containing volatile contaminants, the treatment described in Sections 8.1 and 8.2 should be omitted.

NOTE to clause 8. See note 2 to 6.2.

METHOD A — BASIC PROCEDURE

9. PROCEDURE

9.1. Thoroughly clean and dry all parts of the cup and its accessories before starting the test, being sure to remove any solvent which had been used to clean the apparatus. Fill the cup with the sample to be tested to the level indicated by the filling mark. Place the lid on the cup and set the latter in the stove. Be sure to have the locating or locking device properly engaged. Insert the thermometer. Light the test flame and adjust it to $\frac{5}{32}$ in (4 mm) in diameter. Supply the heat at such a rate that the temperature as indicated by the thermometer increases 9° to 11°F (5° to 6°C)/min. Turn the stirrer 90–120 rpm, stirring in a downward direction.

NOTE to clause 9. See note 2 to 6.2.

9.2. If the sample is known to have a flash point of 230°F (110°C) or below, apply the test flame when the temperature of the sample is 30°F (17°C) to 50°F (28°C) below the expected flash point and thereafter at a temperature reading that is a multiple of 2°F (1°C). Apply the test flame by operating the mechanism on the cover which controls the shutter and test flame burner so that the flame is lowered into the vapour space of the cup in 0.5 s, left in its lowered position for 1 s, and quickly raised to its high position. Do not stir the sample while applying the test flame.

9.3. If the sample is known to have a flash point above 230°F (110°C) apply the test flame in the manner just described at each temperature that is a multiple of 5°F (2°C) beginning at a temperature of 30°F (18°C) to 50°F (28°C) below the expected flash point.

NOTE 5: When testing materials to determine if volatile contaminants are present it is not necessary to adhere to the temperature limits for initial flame application as stated in Sections 9.2 and 9.3.

9.4. Record as the flash point the temperature read on the thermometer at the time the test flame application causes a distinct flash in the interior of the cup. Do not confuse the true flash point with the bluish halo that sometimes surrounds the test flame at applications preceding the one that causes the actual flash.

METHOD B — DETERMINATION OF FLASH POINT OF SUSPENSIONS OF SOLIDS AND HIGHLY VISCOUS MATERIALS

10. PROCEDURE

10.1. Bring the material to be tested and the tester to a temperature of 60 ± 10°F (15 ± 5°C) or 20°F (11°C) lower than the estimated flash point, whichever is lower. Turn the stirrer 250 ± 10 rev/min, stirring in a downward direction. Raise the temperature throughout the duration of the test at a rate of not less than 2° nor more than 3°F (1° to 1.5°C)/min. With the exception of these requirements for rates of stirring and heating, proceed as prescribed in Section 9.

NOTE 6: Solid carbon dioxide (CO₂) (dry ice) shall in no case be used to obtain the proper rate of temperature rise, since CO₂ has a blanketing effect which leads to a false flash point.

11. CALCULATION AND REPORT

11.1 Observe and record the barometric pressure (Note 8) at the time of test. When the pressure differs from 760 mm Hg or 1013 mbar, correct the observed flash point by means of one of the following expressions:

corrected flash point (°F) = F + 0.06 (760 - p)
or corrected flash point (°C) = C + 0.033 (760 - p)
or corrected flash point (°C) = C + 0.025 (1013 - P)
where F is the observed flash point, °F
C is the observed flash point, °C
p is the barometric pressure, mm Hg.
P is the barometric pressure, mbar.

NOTE 7: The barometric pressure used in this calculation must be the ambient pressure of the laboratory at the time of test. Many aneroid barometers, such as those used at weather stations and airports, are precorrected to give sea level readings. These must not be used.

11.2. Record the corrected flash point to the nearest 1°F or 0.5°C.

11.3. Report the recorded flash point as the Pensky–Martens Closed Cup Flash Point ASTM D 93–IP 34, of the sample tested.

12. PRECISION

12.1. Method A – The following criteria should be used for judging the acceptability of results (95% confidence):

12.1.1. Repeatability – Duplicate results by the same operator should be considered suspect if they differ by more than the following amount:

Material	Flash point range		Repeatability	
	°F	°C	°F	°C
Suspension of solids	95 to 110	35 to 43.5	4	2
All others	220 and under	104 and under	4	2
	above 220	above 104	10	5.5

NOTE to 10.1. See note 2 to 6.2.

NOTE to 11.1. The SI unit of pressure is the newton per square metre (N/m²) also known as the pascal (Pa). For measurements of pressure the IP uses the bar, the ASTM uses the kilopascal. 1 bar = 10⁵ N/m² = 10⁵ Pa = 10² kPa.

NOTE to 11.2. See note 2 to 6.2.

NOTE to 11.3. Test results should additionally be reported as having been obtained in accordance with BS 2000 : Part 34.

12.1.2. *Reproducibility* – The results submitted by each of two laboratories should not be considered suspect unless the two results differ by more than the following amounts:

Material	Flash point range		Repeatability	
	°F	°C	°F	°C
Suspension of solids	95 to 110	35 to 43.5	6	3.5
All others	220 and under above 220	104 and under above 104	6 15	3.5 8.5

12.2. *Method B* – The following criteria should be used for judging the acceptability of results (95% confidence) obtained on viscous or heavily pigmented (paint or varnish) materials which tend to form a surface film:

12.2.1. *Repeatability* – The average of two tests by the same operator on the same day compared with the average of two tests on another day should be considered suspect if they differ by more than 9°F (5°C).

12.2.2. *Reproducibility* – The average of two tests by an operator on the same day compared with the average of two tests by another operator (or another laboratory) on any one day should be considered suspect if they differ by more than 18°F (10°C).

12.2.3. The definition of repeatability and reproducibility given here represents different parameters of the variance of the method; those given in 12.1 are derived from standards of ASTM Committee D-2 and the Institute of Petroleum, while those in 12.2 are from ASTM Committee D-1.

NOTE 8: The above precision is based on data which did not include a representative sample of residual fuels.

NOTE to 12.2. See foreword for other British Standards on determination of flash point of paints and varnishes.

APPENDIX I

APPARATUS SPECIFICATIONS

A1. A typical assembly of the apparatus, gas heated, is shown in Fig. 1. The apparatus shall consist of a test cup, cover, and stove conforming to the following requirements:

A1.1. *Cup* – The cup shall be of brass, or other non-rusting metal of equivalent heat conductivity, and shall conform to the dimensional requirements in Fig. 2. The flange shall be equipped with devices for locating the position of the cup in the stove. A handle attached to the flange of the cup is a desirable accessory. The handle shall not be so heavy as to tip over the empty cup.

A1.2. *Cover*:

A1.2.1. *Cover Proper* – The cover shown in Fig. 3 shall be of brass (A1.1), and shall have a rim projecting downward almost to the flange of the cup. The rim shall fit the outside of the cup with a clearance not exceeding 0.014 in (0.36 mm) on the diameter. There shall be a locating or locking device, or both, engaging with a corresponding device on the cup. The four openings in the cover, *A*, *B*, *C*, and *D*, are shown in Fig. 3. The upper edge of the cup shall be in close contact with the inner face of the cover throughout its circumference.

A1.2.2. *Shutter* – The cover shall be equipped with a brass shutter (Fig. 4), approximately $\frac{3}{32}$ in (2.4 mm) thick, operating on the plane of the upper surface of the cover. The shutter shall be so shaped and mounted that it rotates on the axis of the horizontal centre of the cover between two stops, so placed that, when in one extreme position, the openings *A*, *B*, and *C* in the cover are completely closed, and when in the other extreme position, these openings are completely opened.

The mechanism operating the shutter shall be of the spring type and constructed so that when at rest the shutter shall exactly close the three openings. When operated to the other extreme, the three cover openings shall be exactly open and the tip of the exposure tube shall be fully depressed.

A1.2.3. *Flame-exposure Device* – The flame-exposure device (Fig. 4) shall have a tip with an opening 0.027 to 0.031 in (0.69 to 0.79 mm) in diameter. This tip shall be made preferably of stainless steel, although it may be fabricated of other suitable metals. The flame-exposure device shall be equipped with an operating mechanism which, when the shutter is in the 'open' position, depresses the tip so that the centre of the orifice is between the planes of the under and upper surfaces of the cover proper at a point on a radius passing through the centre of the larger opening *A* (Fig. 3).

NOTE to appendix I. Precedence should be given to dimensions in millimetres.