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An American National Standard

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Standard Test Method for Smoke Point of Kerosine and Aviation Turbine Fuel[1]

This standard is issued under the fixed designation D 1322; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers a procedure for determination of the smoke point of kerosine and aviation turbine fuel.

NOTE 1—There is good correlation between Luminometer number (Test Method D 1740) and smoke point which is represented in Appendix X1.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1740 Test Method for Luminometer Number of Aviation Turbine Fuels[2]

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products[3]

2.2 *IP Standard:*

IP 57/95 Smoke Point[4]

NOTE 2—Only IP 57/95 published in 1995[4] is equivalent to D1322; earlier versions of IP 57 were not equivalent.

2.3 *ISO Standard:*[5]

ISO 3014:1993(E) Petroleum Products—Determination of the Smoke Point of Kerosine

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *aviation turbine fuel*—refined petroleum distillate, generally used as a fuel for aviation gas turbines.

3.1.1.1 *Discussion*—Different grades are characterized by volatility ranges, freeze point, and by flash point.

3.1.2 *kerosine*—refined petroleum distillate, boiling between 140 and 300°C, generally used in lighting and heating applications.

3.1.3 *smoke point*—the maximum height, in millimetres, of a smokeless flame of fuel burned in a wick-fed lamp of specified design.

4. Summary of Test Method

4.1 The sample is burned in an enclosed wick-fed lamp that is calibrated daily against pure hydrocarbon blends of known smoke point. The maximum height of flame that can be achieved with the test fuel without smoking is determined to the nearest 0.5 mm.

5. Significance and Use

5.1 This test method provides an indication of the relative smoke producing properties of kerosines and aviation turbine fuels in a diffusion flame. The smoke point is related to the hydrocarbon type composition of such fuels. Generally the more aromatic the fuel the smokier the flame. A high smoke point indicates a fuel of low smoke producing tendency.

5.2 The smoke point (and Luminometer number with which it can be correlated) is quantitatively related to the potential radiant heat transfer from the combustion products of the fuel. Because radiant heat transfer exerts a strong influence on the metal temperature of combustor liners and other hot section parts of gas turbines, the smoke point provides a basis for correlation of fuel characteristics with the life of these components.

6. Apparatus

6.1 *Smoke Point Lamp*, as shown in Fig. 1 and described in detail in Annex A1.

6.2 *Wick*, of woven solid circular cotton of ordinary quality, having the following characteristics:

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricantsand is the direct responsibility of Subcommittee D02.J0.07on Combustion Characteristics.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 05.02.

[4] Standard Methods for Analysis and Testing of Petroleum and Related Products, 1995, Institute of Petroleum, 61 New Cavendish St., London W1M 8AR, England.

[5] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

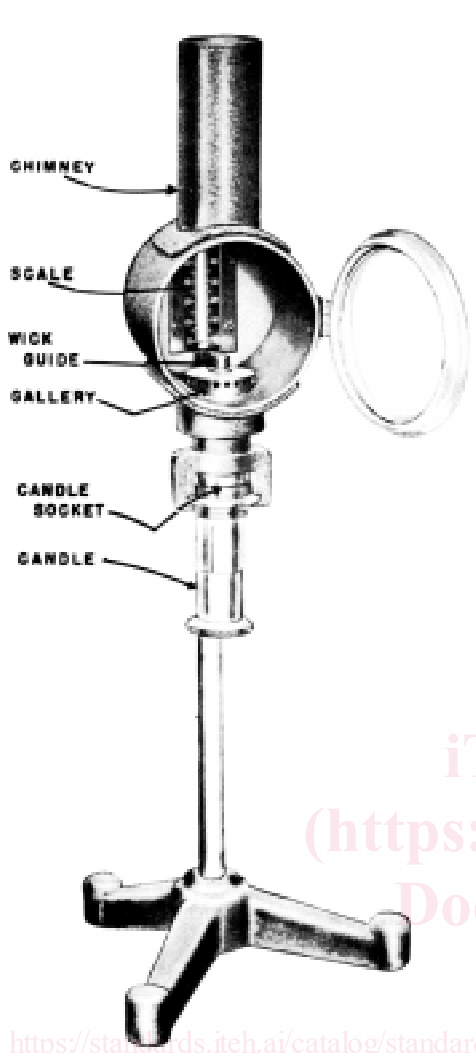

FIG. 1 Smoke Point Lamp

Casing	17 ends, 66 tex by 3
Filling	9 ends, 100 tex by 4
Weft	40 tex by 2
Picks	6 per centimetre

6.3 *Pipettes or Burettes*, Class A.

7. Reagents and Materials

7.1 *Toluene*, ASTM Reference Fuel grade.

NOTE 3—**Warning:** Flammable, vapor harmful. (See Annex A2.1.)

7.2 *2,2,4-trimethylpentane (isooctane)*, minimum purity 99.75 % (m/m).

NOTE 4—**Warning:** Flammable, vapor harmful. (See Annex A2.2.)

7.3 *Methanol (methyl alcohol)*, anhydrous.

NOTE 5—**Warning:** Flammable, vapor harmful. (See Annex A2.3.)

7.4 *Reference Fuel Blends*, appropriate to the fuels under test, made up accurately from toluene and 2,2,4-trimethylpentane, in accordance with the compositions given in Table 1, by means of calibrated burettes or pipettes.

7.5 *Heptane*, minimum purity 99.75 % (m/m).

TABLE 1 Reference Fuel Blends

Standard Smoke Point at 101.3 kPa	Toluene	2,2,4-trimethylpentane
mm	%(v/v)	% (v/v)
14.7	40	60
20.2	25	75
22.7	20	80
25.8	15	85
30.2	10	90
35.4	5	95
42.8	0	100

NOTE 6—**Warning:** Extremely flammable, vapor harmful if inhaled. (See Annex A2.4.)

8. Sampling and Preparation of Samples

8.1 It is recommended samples shall be taken by the procedures described in Practice D 4057. Use the sample as received. Allow all samples to come to ambient temperature (20 ± 5°C), without artificial heating. If the sample is hazy or appears to contain foreign material, filter through qualitative filter paper.

9. Preparation of Apparatus

9.1 Place the lamp in a vertical position in a room where it can be completely protected from drafts. Carefully inspect each new lamp to ensure that the air holes in the gallery and the air inlets to the candle holder are all clean, unrestricted and of proper size. The gallery shall be so located that the air holes are completely unobstructed.

NOTE 7—Slight variations in these items all have a marked effect on the precision of the result obtained.

9.1.1 If the room is not completely draft-free, place the lamp in a vertical position in a box constructed of heat-resistant material (not containing asbestos), open at the front. The top of the box shall be at least 150 mm above the top of the chimney and the inside of the box painted dull black.

9.2 Extract all wicks, either new or from a previous determination, for at least 25 cycles in an extractor, using a mixture of equal volumes of toluene and anhydrous methanol. Allow the wicks to dry partially in a hood before placing in the oven, or use a forced-draft and explosion-proof oven for drying wicks, or both. Dry for 30 min at 100 to 110°C and store in a dessicator until used.

10. Calibration of Apparatus

10.1 Calibrate the apparatus in accordance with 10.2. Recalibrate at regular intervals of not more than seven days or when there has been a change in the apparatus or operator, or when a change of more than 0.7 kPa occurs in the barometric pressure reading.

10.2 Calibrate the apparatus by testing two of the reference fuel blends specified in 7.4, using the procedure specified in Section 11 and, if possible, bracketing the smoke point of the sample. If this is not possible, use the two test blends having their smoke points nearest to the smoke point of the sample.

10.2.1 Determine the correction factor *f* for the apparatus from the equation;

$$f = \frac{(A_s / A_d) + (B_s / B_d)}{2} \quad (1)$$

where:

A_s = the standard smoke point of the first reference fuel blend;
A_d = the smoke point determined for the first reference fuel blend;
B_s = the standard smoke point of the second reference fuel blend;
B_d = the smoke point determined for the second reference fuel blend.

If the smoke point determined for the test fuel exactly matches the smoke point determined for a reference fuel blend, use as the second bracketing reference fuel the reference fuel blend with the next higher smoke point, if there is one. Otherwise, use the one with the next closest smoke point.

10.3 An alternative approach to confirm calibration of the apparatus is for each operator to run a control sample each day the apparatus is in use. Record the results and compare the average from the data base of the control sample using control charts or equivalent statistical techniques. If the difference exceeds the control limits or when new apparatus is used, then the apparatus must be recalibrated.

11. Procedure

11.1 Soak a piece of extracted and dried wick, not less than 125 mm long, in the sample and place it in the wick tube of the candle. Carefully ease out any twists arising from this operation. In cases of dispute, or of referee tests, always use a new wick, prepared in the manner specified in 9.2.

NOTE 8—It is advisable to resoak the burning-end of the wick in the sample after the wick is inserted in the wick tube.

11.2 Introduce as near to 20 mL of the prepared sample as available, but not less than 10 mL, at room temperature, into the clean, dry candle.

11.3 Place the wick tube in the candle and screw home. Take care that the candle air vent is free from fuel. If a wick-trimmer assembly is not being used, cut the wick horizontally and trim it free of frayed ends so that 6 mm projects from the end of the candle. Use a clean razor blade or other sharp instrument. (Some razor blades have a protective coating; in such cases, remove the coating with a solvent before using the blade). Insert the candle into the lamp.

11.3.1 An alternative method of preparing a wick free of twists and frayed ends utilizes a wick-trimmer assembly. The wick-trimmer holder is inserted over the top of the wick tube and the long-nosed triceps are inserted through the tube and holder. The wick is grasped and carefully pulled through the tube without twisting. A new, clean, sharp razor is used to cut the wick at the face of the holder and remove wisps and frayed ends. When the holder is removed, the wick will be at the correct height in the tube. The tube is then inserted into the candle and screwed home. The candle is inserted into the lamp.

11.4 Light the candle and adjust the wick so that the flame is approximately 10 mm high and allow the lamp to burn for 5 min. Raise the candle until a smoky tail appears, then lower the candle slowly through the following stages of flame appearance:

11.4.1 A long tip; smoke slightly visible; erratic and jumpy flame.

11.4.2 An elongated, pointed tip with the sides of the tip appearing concave upward as shown in Fig. 2 (Flame A).

11.4.3 The pointed tip just disappears, leaving a very slightly blunted flame as shown in Fig. 2 (Flame B). Jagged, erratic, luminous flames are sometimes observed near the true flame tip; these shall be disregarded.

11.4.4 A well rounded tip as shown in Fig. 2 (Flame C). Determine the height of Flame B to the nearest 0.5 mm. Record the height observed.

11.4.4.1 To eliminate errors due to parallax, the eye of the observer shall be slightly to one side of the centreline, so that a reflected image of the flame is seen on the scale on one side of the central vertical white line, and the flame itself is seen against the other side of the scale. The reading for both observations shall be identical.

11.5 Make three separate observations of the flame height at the smoke point by repeating the flame-appearance sequence specified in 11.4. If these values vary over a range greater than 1.0 mm, repeat the test with a fresh sample and another wick.

11.6 Remove the candle from the lamp, rinse with heptane, and purge with air to make ready for re-use.

12. Calculation

12.1 Calculate the smoke point, to the nearest 0.1 mm, from the equation:

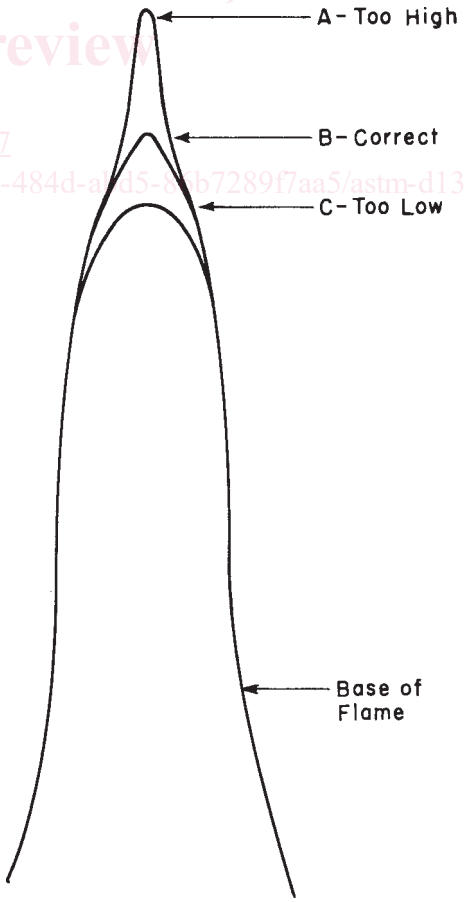

FIG. 2 Typical Flame Appearances