Designation: D1840 – 22

Standard Test Method for Naphthalene Hydrocarbons in Aviation Turbine Fuels by Ultraviolet Spectrophotometry[1]

This standard is issued under the fixed designation D1840; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination, by ultraviolet spectrophotometry, of the total concentration of naphthalene, acenaphthene, and alkylated derivatives of these hydrocarbons in jet fuels. This test method is designed to analyze fuels containing not more than 5 % of such components and having end points below 315 °C (600 °F). The range of concentrations used in the interlaboratory test programs which established the precision statements for this test method was 0.08 % to 5.6 % by volume. This test method determines the maximum amount of naphthalenes that could be present.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see 8.1 and 8.2.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E131 Terminology Relating to Molecular Spectroscopy

E169 Practices for General Techniques of Ultraviolet-Visible Quantitative Analysis

E275 Practice for Describing and Measuring Performance of Ultraviolet and Visible Spectrophotometers

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms and symbols relating to absorption spectroscopy in this test method shall conform to Terminology E131. Terms of particular significance are the following:

3.1.2 *radiant energy, n*—energy transmitted as electromagnetic waves.

3.1.3 *radiant power, P, n*—rate at which energy is transported in a beam of radiant energy.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *absorbance, A, n*—the molecular property of a substance that determines its ability to take up radiant power, expressed by

$$A = \log_{10}(1/T) = -\log_{10}T \tag{1}$$

where:

T = transmittance as defined in 3.2.5.

3.2.1.1 *Discussion*—It may be necessary to correct the observed transmittance (indicated by the spectrophotometer) by compensating for reflectance losses, solvent absorption losses, or refraction effects.

3.2.2 *absorptivity, a, n*—the specific property of a substance to absorb radiant power per unit sample concentration and path length, expressed by

$$a = A/bc \tag{2}$$

where:

A = absorbance defined in 3.2.1,
b = sample cell path length, and
c = quantity of absorbing substance contained in a unit volume of solvent.

3.2.2.1 *Discussion*—Quantitative ultraviolet analyses are based upon the absorption law, known as Beer's law. The law

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.04.0F on Absorption Spectroscopic Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

states that the absorbance of a homogeneous sample containing an absorbing substance is directly proportional to the concentration of the absorbing substance at a single wavelength, expressed by

$$A = abc \tag{3}$$

where:

A = absorbance as defined in 3.2.1,
a = absorptivity as defined in 3.2.2,
b = sample cell path length, and
c = quantity of absorbing substance contained in a unit volume of solvent.

3.2.3 *concentration, c, n*—the quantity of naphthalene hydrocarbons in grams per litre of *iso*octane.

3.2.4 *sample cell path length, b, n*—the distance, in centimetres, measured in the direction of propagation of the beam of radiant energy, between the surfaces of the specimen on which the radiant energy is incident and the surface of the specimen from which it is emergent.

3.2.4.1 *Discussion*—This distance does not include the thickness of the cell in which the specimen is contained.

3.2.5 *transmittance, T, n*—the molecular property of a substance that determines its transportability of radiant power expressed by

$$T = P/P_o \tag{4}$$

where:

P = radiant power passing through the sample, and
P_o = radiant power incident upon the sample.

4. Summary of Test Method

4.1 The total concentration of naphthalenes in jet fuels is determined by measurement of the absorbance at 285 nm of a solution of the fuel at known concentration.

5. Significance and Use

5.1 This test method for naphthalene hydrocarbons is one of a group of tests used to assess the combustion characteristics of aviation turbine fuels of the kerosene boiling range. The naphthalene hydrocarbon content is determined because naphthalenes, when burned, tend to have a relatively larger contribution to a sooty flame, smoke, and thermal radiation than single ring aromatics.

6. Interferences

6.1 Interferences add to the apparent naphthalene content. Phenanthrenes, dibenzothiophenes, biphenyls, benzothiophenes, and anthracenes interfere if present. The end point limitation of 315 °C will minimize this interference except for benzothiophenes and biphenyls. The contribution to measured naphthalene content by the presence of 1 % of such interfering compounds can be estimated from Table 1.

6.2 Saturated hydrocarbons, olefins, thiophenes, and alkyl or cycloalkyl derivatives of benzene will not interfere.

7. Apparatus

7.1 *Spectrophotometer,* equipped to measure the absorbance of solutions in the spectral region 240 nm to 300 nm with a spectral slit width of 1 nm or less. Wavelength measurements shall be repeatable and known to be accurate within 0.1 nm or less as measured by mercury emission line at 253.65 nm or the absorption spectrum of either holmium oxide glass at 287.5 nm or holmium oxide solution at 287.1 nm. At the 0.4 absorbance level in the spectral region between 240 nm and 300 nm, absorbance measurements shall be repeatable within ±0.5 % or better. In the absorbance range encompassing 0.2 to 0.8, the photometric accuracy shall not differ by more than ±0.5 % of samples whose absorbance has been established by a standardizing laboratory.

TABLE 1 Interfering Compounds

Type of Interfering Compound	Error in Percentage of Naphthalenes Caused by 1 % Interfering Compound
Phenanthrenes	2
Dibenzothiophenes	2
Biphenyls	1
Benzothiophenes	0.6
Anthracenes	0.1

7.1.1 *Discussion*—Many manufacturers provide secondary standards, traceable to NIST primary standards, for checking the wavelength accuracy and photometric accuracy of spectrophotometers. These materials may be used to verify spectrophotometer performance provided that they have been recalibrated periodically as recommended by the manufacturer.

7.2 It shall be initially and thereafter periodically demonstrated that an instrument can be operated in a manner to give test results equivalent to those described in 7.1.

NOTE 1—For recommended methods of testing spectrophotometers to be used in this test method, refer to Practice E275. Other preferred alternatives to those in 7.1 are potassium dichromate in perchloric acid (NIST SRM 935 series as described in Practice E275) for photometric accuracy and a 20 mg ⁄L high (>99 %) purity naphthalene in spectroscopic grade *iso*octane for wavelength accuracy. The latter has a minor maximum at 285.7 nm. The naphthalene solution shall not be used for photometric accuracy.

7.3 *Vitreous Silica Cells,* two, having path lengths of 1.00 cm ± 0.005 cm.

7.4 *Pipets,* Class *A*.

7.5 *Lens Paper.*

7.6 *Balance,* capable of taring or weighing 100 g to the nearest 0.0001 g. The balance shall be accurate to ±0.0002 g at a 100 g load.

8. Solvents

8.1 *Spectroscopic 2,2,4 Trimethylpentane (Isooctane).* (**Warning**—*Iso*octane is extremely flammable, harmful if inhaled.)

NOTE 2—Spectroscopic-grade *iso*octane is available commercially. Technical-grade *iso*octane is a satisfactory base stock for the preparation of spectroscopic solvent. Allow about 4 L or 5 L of this material to percolate through a column of activated silica gel (74 µm) 50.8 mm to 76.2 mm in diameter and 0.6 m to 0.9 m in depth. Collect only the portion of the solvent that has a transmission compared to distilled water greater than 90 % over the entire spectral range from 240 nm to 300 nm. Store in scrupulously clean glass-stoppered bottles and always keep covered. In general it will be best to use a fresh portion of silica gel in preparing a new