Designation: D2008 – 23

Standard Test Method for Ultraviolet Absorbance and Absorptivity of Petroleum Products[1]

This standard is issued under the fixed designation D2008; 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.

1. Scope*

1.1 This test method covers the measurement of the ultraviolet absorption of a variety of petroleum products. It covers the absorbance of liquids or the absorptivity of liquids and solids, or both, at wavelengths in the region from 220 nm to 400 nm of the spectrum.

1.2 The use of this test method implies that the conditions of measurement—wavelength, solvent (if any), sample path length, and sample concentration—are specified by reference to one of the examples of the application of this test method in the annexes or by a statement of other conditions of measurement.

1.3 Examples of the application of this test method are the absorptivity of refined petroleum wax, and the absorptivity of USP petrolatum.

1.4 The values stated in SI units are to be regarded as the standard. The values stated in Fahrenheit, feet, and inches, indicated in parentheses, are for information only.

1.5 *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 7.3.1, 7.3.3, and 13.4.

1.6 *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]

D1193 Specification for Reagent Water

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

3.2 *Definitions:*

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

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

where T is the transmittance as defined in 3.2.6.

3.2.1.1 *Discussion*—Absorbance expresses the excess absorption over that of a specified reference or standard. It is implied that compensation has been affected for reflectance losses, solvent absorption losses, and refractive effects, if present, and that attenuation by scattering is small compared with attenuation by absorption.

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:

$$a = Af/bc \quad (2)$$

where:

A = the absorbance defined in 3.2.1,

[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

f = the dilution factor defined in 3.2.3,
b = sample cell path length, and
c = the quantity of absorbing substance contained in a volume of solvent.

3.2.3 *dilution factor, f, n*—the proportion of solvent increase made to reduce the concentration and thus the absorbance of a solute, expressed by the ratio of the volume of the diluted solution to the volume of original solution containing the same quantity of solute as the diluted solution.

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

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

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

$$T = \frac{P}{P_o} \tag{3}$$

where:

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

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *concentration, c, n*—the quantity of absorbing substance in grams per litre.

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

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

4. Summary of Test Method

4.1 The ultraviolet absorbance of a liquid is determined by measuring the absorption spectrum of the undiluted liquid in a cell of known path length under specified conditions.

4.2 The ultraviolet absorptivity of a solid or a liquid is determined by measuring the absorbance, at specified wavelengths, of a solution of the liquid or solid at known concentration in a cell of known path length.

5. Significance and Use

5.1 The absorbance of liquids and the absorptivity of liquid and solids at specified wavelengths in the ultraviolet are useful in characterizing petroleum products.

6. Apparatus

6.1 *Spectrophotometer,* equipped to handle liquid samples in cells having sample path lengths up to 10 cm and capable of measuring absorbance in the spectral region from 220 nm to 400 nm with a spectral slit width of 2 nm or less. Wavelength measurement shall be repeatable and known to be accurate within ±0.2 nm or less as measured by 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 220 nm and 400 nm, absorbance measurements shall be repeatable within ±1.0 %.

6.2 For recommended methods of testing spectrophotometers to be used in this test method, refer to Practice E275.

6.3 An instrument is considered suitable when it can be operated in a manner to give test results equivalent to those described in 6.1.

6.4 Measurements requiring the use of cells having sample path lengths less than 10 cm can be made on instruments equipped to handle only these cells. It is desirable, but not essential, that the instrument be automatic recording when an extended range of the spectrum must be examined. Manually operated spectrometers are suitable for obtaining absorbance readings at specified analytical wavelengths. If measurements are to be made at temperatures higher than room temperature, the spectrophotometer must be provided with a means for maintaining cells at the selected test temperature.

6.5 One or more pairs of fused silica cells having sample path lengths in the range from 0.1000 cm to 10.00 cm are required. Sample path lengths must be known to within ±0.5 % of nominal sample path length or better. Unless otherwise specified, 1 cm sample path length cells are recommended. Suitable procedures for testing and cleaning cells are described in Practice E275.

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D1193, Type III.

7.3 *Solvents:*

7.3.1 *Isooctane*—(**Warning—**Extremely flammable, harmful if inhaled.), for use as the preferred spectroscopic solvent.

7.3.2 Technical *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 50 mm to 75 mm (2 in. to 3 in.) in diameter and 0.6 m to 0.9 m (2 ft to 3 ft) in depth. Collect only the portion of the solvent that has an absorbance less than 0.05 over the entire spectral range from 240 nm to 300 nm in a 1 cm cell when compared to water in a 1 cm cell.

[3] *ACS Reagent Chemicals, Specifications and Procedures for Reagents and Standard-Grade Reference Materials*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.