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Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)¹

This standard is issued under the fixed designation D287; 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. This test method has been adopted for use by government agencies to replace Method 401 of Federal Test Method Standard No. 791b.

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1. Scope

1.1 This test method covers the determination by means of a glass hydrometer of the API gravity of crude petroleum and petroleum products normally handled as liquids and having a Reid vapor pressure (Test Method ~~*~~

1.1 This test method covers the determination by means of a glass hydrometer in conjunction with a series of calculations of the API gravity of crude petroleum and petroleum products normally handled as liquids and having a Reid vapor pressure (Test Method D323) of 26 psi (180 kPa) or less. Gravities are determined at 60°F (15.56°C), or converted to values at 60°F, by means of standard tables. These tables are not applicable to nonhydrocarbons or essentially pure hydrocarbons such as the aromatics.) of 101.325 kPa (14.696 psi) or less. Gravities are determined at 60°F (15.56°C), or converted to values at 60°F, by means of Adjunct to D1250 Guide for Petroleum Measurement Tables (API MPMS Chapter 11.1). These tables are not applicable to nonhydrocarbons or essentially pure hydrocarbons such as the aromatics.

NOTE 1—The international version of this test method is described in Test Method D1298.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3

1.2 The initial values obtained are uncorrected hydrometer readings and not density measurements. Values are measured on a hydrometer at either the reference temperature or at another convenient temperature, and readings corrected for the meniscus effect, the thermal glass expansion effect, alternate calibration temperature effects and to the reference temperature by means of volume correction tables.

1.3 The hydrometer readings determined shall be recorded before performing any calculations. Then the calculations required in Section 9 shall be performed and documented before using the final result in a subsequent calculation procedure (measurement ticket calculation, meter factor calculation, or base prover volume determination).

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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 and health practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see For specific warning statement, see 8.3.

2. Referenced Documents

2.1 ASTM Standards:²

D323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)

D1250 Guide for Use of the Petroleum Measurement Tables Guide for Use of the Petroleum Measurement Tables (API MPMS Chapter 11.1)

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.02 on Hydrocarbon Measurement for Custody Transfer (Joint ASTM-API).

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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.

D1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method—Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method (API *MPMS* Chapter 9.1)

D6822 Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method (API *MPMS* Chapter 9.3)

E1 Specification for ASTM Liquid-in-Glass Thermometers

E100 Specification for ASTM Hydrometers

2.2 ~~*IP Standards*~~—*EI Standards*:³

Specifications for IP Standard Thermometers ~~IP Specifications for Petroleum Hydrometers~~

IP Specifications for Petroleum Hydrometers

2.3 *API Standards*:⁴

MPMS Chapter 9.1 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method (ASTM D1298)

MPMS Chapter 9.3 Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method (ASTM D6822)

MPMS Chapter 11.1-2004, including Addendum 1–2007 Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils

2.4 *ASTM Adjuncts*:

Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1)⁵

3. Terminology

3.1 *Definitions*:

3.1.1 *API gravity, n*—a special function of relative density (~~specific gravity~~) 60/60°F (15.56/15.56°C), represented by:

$$\text{API} = \frac{141.5}{(\text{relative density } 60/60^\circ\text{F})} - 131.5 \quad (1)$$

$$\text{API} = \frac{141.5}{(\text{relative density } 60/60^\circ\text{F})} - 131.5 \quad (1)$$

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No statement of reference temperature is required, since 60°F is included in the definition.

3.1.2 *specific gravity, n*—historical term, no longer used, which has been replaced by *relative density*.

4. Summary of Test Method

4.1 This test method is based on the principle that the gravity of a liquid varies directly with the depth of immersion of a body floating in it. The floating body, which is graduated by API gravity units in this method, is called an API hydrometer.

4.2 The API gravity is read by observing the freely floating API hydrometer and noting the graduation nearest to the apparent intersection of the horizontal plane surface of the liquid with the vertical scale of the hydrometer, after temperature equilibrium has been reached. The temperature of the sample is read from a separate accurate ASTM thermometer in the sample or from the thermometer which is an integral part of the hydrometer (thermohydrometer):

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4.2 The API gravity is read by observing the freely floating API hydrometer and noting the graduation nearest to the apparent intersection of the horizontal plane surface of the liquid with the vertical scale of the hydrometer, after temperature equilibrium has been reached. The temperature of the sample is read from a separate accurate ASTM thermometer in the sample.

4.3 The observed hydrometer reading is corrected for the meniscus effect, the thermal glass expansion effect, alternate calibration temperature effects and reduced to the reference temperature by means of the volume correction tables. If necessary, the hydrometer cylinder and its contents are placed in a constant temperature bath to avoid excessive temperature variation during the test.

5. Significance and Use

5.1 Accurate determination of the gravity of petroleum and its products is necessary for the conversion of measured volumes to volumes at the standard temperature of 60°F (15.56°C).

5.2 Gravity is a factor governing the quality of crude oils. However, the gravity of a petroleum product is an uncertain indication of its quality. Correlated with other properties, gravity can be used to give approximate hydrocarbon composition and heat of combustion.

³ Available from the Institute of Petroleum, 61 New Cavendish St., London W1M, 8AR, England.

³ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

⁴ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, <http://www.api.org>.

⁵ Available from ASTM International Headquarters. Order Adjunct No. **ADJD1250**. Original adjunct produced in 1983.

5.2 This procedure is most suitable for determining the API gravity of low viscosity transparent liquids. This test method can also be used for viscous liquids by allowing sufficient time for the hydrometer to reach temperature equilibrium, and for opaque liquids by employing a suitable meniscus correction. Additionally for both transparent and opaque fluids the readings shall be corrected for the thermal glass expansion effect before correcting to the reference temperature.

5.3 When used in connection with bulk oil measurements, volume correction errors are minimized by observing the hydrometer reading at a temperature as close to reference temperature as feasible.

5.4 Gravity is a factor governing the quality of crude oils. However, the gravity of a petroleum product is an uncertain indication of its quality. Correlated with other properties, gravity can be used to give approximate hydrocarbon composition and heat of combustion.

5.5 Gravity is an important quality indicator for automotive, aviation and marine fuels, where it affects storage, handling and combustion.

6. Apparatus

6.1 *Hydrometers*, of glass, graduated in degrees API as listed in Table 1 and conforming to Specification E100, or the IP Specifications for Petroleum Hydrometers.

6.1.1 The user should ascertain that the instruments used for this method conform to the requirements set out above with respect to materials, dimensions, and scale errors. In cases where the instrument is provided with a calibration certificate issued by a recognized standardizing body, the instrument is classed as certified and the appropriate corrections for the meniscus effect, the thermal glass expansion effect, and alternative calibration temperature effects shall be applied to the observed readings prior to corrections. Instruments that satisfy the requirements of this test method, but are not provided with a recognized calibration certificate, are classed as uncertified.

6.2 *Thermometers*, having a range from -5 to $+215^{\circ}\text{F}$ and conforming to the requirements for Thermometer 12F as prescribed in Specification E1 or Thermometer 64F of the Specifications for IP Standard Thermometers. A thermometer is not required if a thermohydrometer is employed, or Thermometer 64F of the Specification for IP Standard Thermometers.

6.2.1 Alternate measuring devices or systems may be used, provided that the total uncertainty of the calibrated system is no greater than when using liquid-in-glass thermometers. The stated repeatability and reproducibility values are not applicable if alternate fluids are used in the liquid-in-glass thermometers.

NOTE 2—The ASTM Gravity Thermometer 12F has 0.5°F subdivisions and allowable $\pm 0.25^{\circ}\text{F}$ scale error. The thermometers incorporated in thermohydrometers have 2°F subdivisions and allowable $\pm 1^{\circ}\text{F}$ scale error. 2—The ASTM Gravity Thermometer 12F has 0.5°F subdivisions and allowable $\pm 0.25^{\circ}\text{F}$ scale error.

6.3 *Hydrometer Cylinders*, of metal, clear glass, or plastic. For convenience in pouring, the cylinder may have a lip on the rim. The inside diameter of the cylinder shall be at least 25 mm greater than the outside diameter of the hydrometer used in it. The height of the cylinder shall be such that the length of the column of sample it contains is greater by at least 25 mm than the portion of the hydrometer which is immersed beneath the surface of the sample. For field testing, a sampling thief of suitable dimensions may be used. Hydrometer Cylinder, clear glass, plastic, or metal (see 6.3.1). The inside diameter of the cylinder shall be at least 25 mm greater than the outside diameter of the hydrometer and the height shall be such that the appropriate hydrometer floats in the test portion with at least 25 mm clearance between the bottom of the hydrometer and the bottom of the cylinder.

6.3.1 Hydrometer cylinders constructed of plastic materials shall be resistant to discoloration or attack by oil samples and shall not affect the material being tested. They shall not become opaque under prolonged exposure to sunlight.

7. Temperature of Test

7.1 The gravity determined by the hydrometer method is most accurate at or near the standard temperature of 60°F (15.56°C). Use this or any other temperature between 0 and 195°F (-18 and $+90^{\circ}\text{C}$) (-18 and $+90^{\circ}\text{C}$) for the test, so far as it is consistent with the type of sample and necessary limiting conditions shown in Table 2.

8. Procedure

8.1 For referee testing, use the long plain form of hydrometer (1H to 10H). For field testing, use the thermohydrometer. Procedure 8.1 For referee testing, use the long plain form of hydrometer (1H to 10H). For field testing, use the thermohydrometer method in Test Method D6822/API MPMS Chapter 9.3.

TABLE 1 Available Hydrometers Scaled, Degrees API

Designation	Type	API Range, deg		Scale	
		Series Total	Each Unit	Division	Error
1H to 10H	long plain	-1 to 101	12	0.1	0.1
21H to 40H	short plain	0 to 101	6	0.1	0.2
51H to 60H	thermo	-1 to 101	12	0.1	0.1
71H to 74H	thermo	-1 to 41	12	0.1	0.1
^A	thermo	15 to 51	8		

^A Eight-degree range thermohydrometers are available.