Designation: D1657 – 12$^{\varepsilon 1}$

Manual of Petroleum Measurement Standards (MPMS), Chapter 9.2

Standard Test Method for Density or Relative Density of Light Hydrocarbons by Pressure Hydrometer[1]

This standard is issued under the fixed designation D1657; 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.

ε[1] NOTE—Corrected API *MPMS* naming convention throughout editorially in October 2012.

1. Scope*

1.1 This test method covers the determination of the density or relative density of light hydrocarbons including liquefied petroleum gases (LPG) having Reid vapor pressures exceeding 101.325 kPa (14.696 psi).

1.2 The prescribed apparatus should not be used for materials having vapor pressures higher than 1.4 MPa (200 psi) at the test temperature. This pressure limit is dictated by the type of equipment. Higher pressures can apply to other equipment designs.

1.3 The initial pressure hydrometer readings obtained are uncorrected hydrometer readings and not density measurements. Readings are measured on a hydrometer at either the reference temperature or at another convenient temperature, and readings are corrected for the meniscus effect, the thermal glass expansion effect, alternate calibration temperature effects and to the reference temperature by means of calculations and Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1) or API *MPMS* Chapter 11.2.4 (GPA TP-27), as applicable.

1.4 Values determined as density or relative density can be converted to equivalent values in the other units or alternative reference temperatures by means of Interconversion Procedures API *MPMS* Chapter 11.5, or Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1) or API *MPMS* Chapter 11.2.4 (GPA TP-27), as applicable.

1.5 The calculations required in Section 11 shall be applied to the initial pressure hydrometer reading with observations and results reported as required by Section 11 prior to use in a subsequent calculation procedure (measurement ticket calculation, meter factor calculation, or base prover volume determination).

1.6 Annex A1 contains a procedure for verifying or certifying the equipment for this test method.

1.7 The values in SI units are to be regarded as the standard. US Customary values shown in adjacent parentheses are for information only and may not be exactly equivalent. Both SI and customary units have been rounded so that they may not be exactly equivalent.

1.8 *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:*[2]

D1250 Guide for Use of the Petroleum Measurement Tables

D1265 Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method

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

E1 Specification for ASTM Liquid-in-Glass Thermometers

E100 Specification for ASTM Hydrometers

2.2 *API Standards:*[3]

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

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and the API Committee on Petroleum Measurement, and is the direct responsibility of Subcommittee D02.02 /COMQ, the joint ASTM-API Committee 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.

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

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

MPMS Chapter 11.1 Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products and Lubricating Oils (Adjunct to ASTM D1250)
MPMS Chapter 11.2.2 Compressibility Factors for Hydrocarbons: 0.350-0.0637 Relative Density (60°F/60°F) and -50°F to 140°F Metering Temperature
MPMS Chapter 11.2.2M Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density 15°C and -46°C to 60°C Metering Temperatures
MPMS Chapter 11.2.4 Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E and 60E (joint standard with GPA TP-27)
MPMS Chapter 11.5 Density/Weight/Volume Intraconversion

2.3 *GPA Standards:*[4]

GPA Technical Publication TP-27 Temperature Correction for the Volume of NGL and LPG, Tables 23E, 24E, 53E, 54E, 59E and 60E (joint standard with API *MPMS* Chapter 11.2.4)

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 *density, n*—the mass of liquid per unit volume at 15°C and its saturation pressure with the standard unit of measurement being kilograms per cubic metre.

3.1.1.1 *Discussion*—Other reference temperatures, such as 20°C may be used for some products or in some locations. Less preferred units of measurement; for example, kg/L or g/mL, are still in use.

3.1.2 *relative density (specific gravity), n*—the ratio of the mass of a given volume of liquid at a specific temperature to the mass of an equal volume of pure water at the same or different temperature. Both reference temperatures shall be explicitly stated.

3.1.2.1 *Discussion*—Common reference temperatures include 60/60°F, 20/20°C, 20/4°C. The historic deprecated term "specific gravity" may still be found.

3.1.3 *thermohydrometer, n*—a glass hydrometer with a self-contained mercury thermometer.

4. Summary of Test Method

4.1 The apparatus is purged with a portion of the sample before filling with the portion to be used for testing. The pressure cylinder is filled to a level at which the enclosed hydrometer floats freely, and the cylinder is then placed in a constant-temperature bath (if needed). When the temperature has reached equilibrium, the hydrometer reading and the temperature of the sample are read. The observed hydrometer reading is corrected for the meniscus effect, alternate calibration temperature effects and reduced to the reference temperature by means of the volume correction factors or tables as applicable by use of the appropriate Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1) or API *MPMS* Chapter 11.2.4 (GPA TP-27), as applicable, and observed temperature from the thermometer.

5. Significance and Use

5.1 The density or relative density of light hydrocarbons and liquefied petroleum gases is used in custody transfer quantity calculations or to satisfy transportation, storage, and regulatory requirements.

6. Apparatus

6.1 *Hydrometers,* graduated in density with a range from 500 to 650 kg/m^3, or in relative density with a range from 0.500 to 0.650, and conforming to the dimensions in Specification E100.

6.1.1 *Thermohydrometers,* for field applications, thermohydrometers may be more convenient than hydrometers with separate thermometers. They shall conform to Specification E100, Thermohydrometer Nos. 101H or 310H.

6.1.1.1 Thermohydrometers shall be of suitable range and have dimensions to float freely within the pressure hydrometer cylinder with clearances of 5 mm at the wall and 25 mm at the top and bottom.

6.1.1.2 The test report shall state that a thermohydrometer was used.

6.1.1.3 The user should ascertain that the instruments used for this procedure 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 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.

6.2 *Hydrometer Cylinder,* constructed of transparent plastic; for example, poly(methyl methacrylate) or equivalent material, conforming to the design and recommended dimensions given in Fig. 1. The cylinder shall be of such dimensions that the hydrometer shall float freely within it. The ends shall be tightly sealed with neoprene gaskets and metal end plates as shown in Fig. 1. (**Warning—**A protective shield shall be placed around the cylinder. Replace any cylinders that show signs of fogging, crazing, cracking, or etching.)

NOTE 1—Certain compounds attack plastics and cloud the inner surface of the cylinder, making it difficult or impossible to read the hydrometer. Tests showed no attack by ethane, ethene (ethylene), propane, propylene, butane, methylpropane (isobutane), butenes (normal butylenes), methylpropene (isobutylene), pentane, and methylbutane (isopentane), and no attack is expected from butadiene and acetaldehyde. Users are cautioned, however, to clean the cylinder thoroughly after each determination. Ketones and alcohols should not be used for cleaning as they attack and

[4] Available from Gas Processors Association (GPA), 6526 E. 60th St., Tulsa, OK 74145, http://www.gpaglobal.org.

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