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Manual of Petroleum Measurement Standards (MPMS), Chapter 9.3

Standard Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method¹

This standard is issued under the fixed designation D6822; 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 determination, using a glass thermohydrometer and/or a separate (alternative) temperature measuring device in conjunction with a series of calculations, of the density, relative density, or API gravity of crude petroleum, petroleum products, or mixtures of petroleum and nonpetroleum products normally handled as liquids and having Reid vapor pressures (Test Method **D323**) of 101.325 kPa (14.696 psia) or less. Values are determined at existing temperatures and corrected to 15 °C (or 60 °F) by means of a series of calculations and international standard tables. Alternative temperature measuring devices shall be either the appropriate liquid-in-glass ASTM thermometers meeting either Specifications **E1** or **E2251** or digital contact thermometers (Guides **E2877** and **D8164**).

1.2 The initial thermohydrometer readings obtained are uncorrected hydrometer readings and not density measurements. Readings are measured on a thermohydrometer 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 Use of the Petroleum Measurement Tables (API *MPMS* Chapter 11.1). Values measured (determined) at other than the reference temperature being hydrometer/thermohydrometer readings and not density measurements

1.3 Readings determined as density, relative density, or API gravity can be converted to equivalent values in the other units

or alternate reference temperatures by means of Interconversion Procedures (API *MPMS* Chapter 11.5) or Adjunct to **D1250** Guide for Use of the Petroleum Measurement Tables (API *MPMS* Chapter 11.1), or both, or tables as applicable.

1.4 The initial thermohydrometer reading (including temperature) shall be recorded before performing any calculations. The calculations required in **9.1.5** and Section **10** shall be applied to the initial thermohydrometer 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).

1.5 **Annex A1 – Annex A3** contain procedures for determining fit-for-service, verifying, or certifying the equipment for this test method.

1.6 The values stated in SI units are to be regarded as standard.

1.6.1 *Exception*—The values given in parentheses (inch-pound) are for information only.

1.7 *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.*

1.8 *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

¹ This test method is under the jurisdiction of ASTM Committee **D02** on Petroleum Products, Liquid Fuels, 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). This test method has been approved by the sponsoring committees and accepted by the Cooperating Societies in accordance with established procedures.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. 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

- D287** Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer/Method)
 - D323** Test Method for Vapor Pressure of Petroleum Products (Reid Method)
 - D1250** Guide for the Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
 - D1298** Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
 - D4057** Practice for Manual Sampling of Petroleum and Petroleum Products
 - D4175** Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- NOTE 1—Terminology defined in this standard takes precedence over any different definition for the term defined and found in any other document of the ASTM D02 Standards Library.
- D4177** Practice for Automatic Sampling of Petroleum and Petroleum Products
 - D5854** Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
 - D6300** Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products, Liquid Fuels, and Lubricants
 - D7962** Practice for Determination of Minimum Immersion Depth and Assessment of Temperature Sensor Measurement Drift
 - D8009** Practice for Manual Piston Cylinder Sampling for Volatile Crude Oils, Condensates, and Liquid Petroleum Products
 - D8164** Guide for Digital Contact Thermometers for Petroleum Products, Liquid Fuels, and Lubricant Testing
 - E1** Specification for ASTM Liquid-in-Glass Thermometers
 - E77** Test Method for Inspection and Verification of Thermometers
 - E100** Specification for ASTM Hydrometers
 - E126** Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers
 - E344** Terminology Relating to Thermometry and Hydrometry
 - E2251** Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids
 - E2877** Guide for Digital Contact Thermometers
 - E2995** Specification for ASTM Thermohydrometers with Integral Low-Hazard Thermometers

2.2 API Standards:³

MPMS Chapter 1 Terms and Definitions Database

NOTE 2—Terminology defined in this standard takes precedence over any different definition for the term defined and found in any other document of the MPMS.

MPMS Chapter 8.1 Practice for Manual Sampling of Petroleum and Petroleum Products (ASTM Practice **D4057**)
MPMS Chapter 8.2 Practice for Automatic Sampling of

Petroleum and Petroleum Products (ASTM Practice **D4177**)

MPMS Chapter 8.3 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products (ASTM Practice **D5854**)

MPMS Chapter 8.5 Practice for Manual Piston Cylinder for Sampling for Volatile Crude Oils, Condensate and Liquid Petroleum Products (ASTM Practice **D8009**)

MPMS Chapter 9.1 Hydrometer Test Method for Density, Relative Density or API Gravity of Crude Petroleum and Liquid Petroleum Products (ASTM Test Method **D1298**) (Note 3)

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 11.5 Density/Weight/Volume Interconversion

NOTE 3—These density test methods are ASTM Test Methods, and are developed in accordance with ASTM Policy and Procedures using the ASTM format and voting policies. As joint standards with API, API adds their cover to the ASTM Document for API publication; otherwise, they are identical to the ASTM Test Method.

2.3 Energy Institute Standards:⁴

IP Standard Methods Book, Appendix A Specifications – IP Standard Thermometers

2.4 ASTM Adjuncts:

Adjunct to **D1250** Standard Guide for the Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricant Oils: API MPMS Chapter 11.1, Addenda 1 and 2⁵

3. Terminology

3.1 Definitions:

3.1.1 For terms used but not defined in this test method, please refer to Terminology **D4175** and/or API MPMS Ch 1 Terms and Definitions Database.

3.2 Definitions of Terms:

3.2.1 *API gravity* ($^{\circ}\text{API}$), n —a special calculated function of relative density 60/60 °F (equivalent to 15.56/15.56 °C), represented by:

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

3.2.1.1 *Discussion*—No statement of reference temperature is required, as 60 °F is included in the definition.

NOTE 4—Please note that in the definition for API Gravity that 15.56 is used to provide the user the mathematical equivalent of 60 °F, as an information courtesy of the SI value for this parameter (60 °F). API Gravity is only expressed in customary (inch-pound) units.

3.2.2 *calibration, n —for this test method*, calibration refers to the determination of the interval values of the thermohydrometer and their compliance with the required uncertainty as defined in Test Method **E126**.

⁴ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

⁵ Available from ASTM International Headquarters. Order Adjunct No. **ADJD1250-A1A2-E-PDF**. Original adjunct produced in 1983.

³ Available from American Petroleum Institute (API), 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, www.api.org.