



Designation: D6822 – 23



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 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 a Reid vapor pressures of 101.325 kPa (14.696 psi) 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.

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).

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 shall be recorded before performing any calculations. The calculations required in Section 9 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** contains a procedure for verifying or certifying the equipment of 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 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

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

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.

Current edition approved Dec. 1, 2023. Published January 2024. Originally approved in 2002. Last previous edition approved in 2017 as D6822 – 12b (2017) ^{ϵ 1}. DOI: 10.1520/D6822-23.

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

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

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

E100 Specification for ASTM Hydrometers

2.2 *API Standards*.³

MPMS Chapter 1 Terms and Definitions Database

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

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 Intraconversion

2.3 *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 2⁴

3. Terminology

3.1 Definitions:

3.1.1 For terms and definitions used in this test method, refer to Terminology **D4175** and API **MPMS Ch 1** Terms and Definitions Database.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *API gravity* ($^{\circ}\text{API}$), n —a special function of relative density 60/60 $^{\circ}\text{F}$, 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 $^{\circ}\text{F}$ is included in the definition.

3.2.2 *density*, n —the mass of liquid per unit volume at 15 $^{\circ}\text{C}$ and 101.325 kPa with the standard unit of measurement being kilograms per cubic metre (kg/m^3).

3.2.2.1 *Discussion*—Other reference temperatures, such as 20 $^{\circ}\text{C}$, 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.

3.2.3 *hydrometer reading*, n —the point on the hydrometer scale at which the surface of the liquid cuts the scale.

3.2.3.1 *Discussion*—In practice for transparent fluids this can be readily determined by aligning the surface of the liquid on both sides of the hydrometer and reading the Hydrometer scale where these surface readings cut the scale (Hydrometer Reading – Observed). For nontransparent fluids the point at which the liquid surface cuts the Hydrometer scale cannot be determined directly and requires a correction (Meniscus Correction). The value represented by the point (Meniscus Reading) at which the liquid sample rises above the main surface of the liquid subtracted from the value represented by where the main surface of the liquid cuts the Hydrometer scale is the amount of the correction or Meniscus correction. This meniscus correction is documented and then subtracted from the value represented by the Meniscus Reading to yield the Hydrometer Reading corrected for the Meniscus (Hydrometer Reading – Observed, Meniscus Corrected).

3.2.4 *observed values*, n —hydrometer readings observed at a temperature other than the defined reference temperature.

3.2.4.1 *Discussion*—These values are only hydrometer readings and not density, relative density, or API gravity at the temperature.

3.2.5 *relative density*, 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.

3.2.5.1 *Discussion*—Common reference temperatures include 15/15 $^{\circ}\text{C}$, 60/60 $^{\circ}\text{F}$, 20/20 $^{\circ}\text{C}$, and 20/4 $^{\circ}\text{C}$. The historic term specific gravity may still be found.

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

4. Summary of Test Method

4.1 The density or API gravity, after temperature equilibrium has been reached, is read by observing the freely floating thermohydrometer 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 observed thermohydrometer reading is reduced to the reference temperature value by means of the Petroleum Measurement Tables (the appropriate adjunct to Adjunct to **D1250** Guide for Petroleum Measurement Tables (API **MPMS Chapter 11.1**) and observed temperature from the enclosed thermometer.

5. Significance and Use

5.1 Density and API gravity are used in custody transfer quantity calculations and to satisfy transportation, storage, and regulatory requirements. Accurate determination of density or API gravity of crude petroleum and liquid petroleum products is necessary for the conversion of measured volumes to volumes at the standard temperatures of 15 $^{\circ}\text{C}$ or 60 $^{\circ}\text{F}$.

5.2 Density and API gravity are also factors that indicate the quality of crude petroleum. Crude petroleum prices are frequently posted against values in kg/m^3 or in degrees API.

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

⁴ Available from ASTM International Headquarters. Order Adjunct No. **ADJD1250-A1A2-E-PDF**. Original adjunct produced in 1983.