



Designation: D287 – 22

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 U.S. Department of Defense.

1. Scope*

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 14.696 psi (101.325 kPa) or less. Values are determined at existing temperatures and corrected to values at 60 °F (15.56 °C), or converted to values at 60 °F, by means of 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 Lubricating Oils (API MPMS Chapter 11.1). These tables are not applicable to nonhydrocarbons or essentially pure hydrocarbons such as the aromatics.

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 are corrected for the meniscus effect, the thermal glass expansion effect, alternate calibration temperature effects and to the reference temperature by means of the petroleum measurement tables; values obtained at other than the reference temperature being hydrometer readings and not density measurements.

1.3 The initial 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific warning statement, see [8.5](#).*

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

- [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
- [D6822](#) Test Method for Density, Relative Density, and API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method
- [D7962](#) Practice for Determination of Minimum Immersion Depth and Assessment of Temperature Sensor Measurement Drift
- [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

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).

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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

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

2.2 API Standards:³

MPMS Chapter 9.1 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method (ASTM Test Method **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 Test Method **D6822**)

MPMS Chapter 11.1 Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils (Adjunct to ASTM **D1250**)

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 Lubricating Oils: API **MPMS Chapter 11.1**)⁴

3. Terminology

3.1 Definitions:

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

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

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

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

3.1.2.1 *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).

3.1.3 *observed values*, *n*—values observed at temperatures other than the specified reference temperature; these values are only hydrometer readings and not density, relative density, or API gravity at those other temperatures.

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

3.2 Acronyms:

3.2.1 *PRT*—platinum resistance temperature device

3.2.1.1 *Discussion*—While there may be other types of RTDs available, for Custody Transfer operations in conjunction with other standards organizations Platinum RTDs have been standardized on for their accuracy and discrimination.

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 test method, is called an API hydrometer.

4.2 The API gravity is read by observing the freely floating ASTM hydrometer (calibrated for API gravity) 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 shall be read from a separate accurate ASTM thermometer placed in the sample, which meets either Specifications **E1** or **E2251** requirements or ASTM Digital Contact Thermometers, which meet Guide **E2877** requirements. The temperature determination device, be it the bulb of a ASTM Thermometer (Specifications **E1** or **E2251**) or a sensor of a Digital Contact Thermometer (Guide **E2877**) shall be placed at the same elevation (within the stated tolerances) as the hydrometer bulb.

NOTE 1—Through various testings that Subcommittee D02.02 (Joint ASTM/API Subcommittee) measurement committee and others have conducted, it has been determined that temperature stratifications do exist vertically from top to bottom of a hydrocarbon container as well as across the diameter of the container. Therefore, as temperature affects the viscosity as well as the fluid density, the buoyancy of the hydrometer floating in the liquid is therefore affected, clarifying procedures have been added to the Procedure section.

4.3 The observed hydrometer reading is corrected for the meniscus effect, the thermal glass expansion effect on the hydrometer, alternate calibration temperature effects and reduced to the reference temperature by means of the petroleum measurement 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 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

³ Available from American Petroleum Institute (API), 200 Massachusetts Ave. NW, Suite 1100, Washington, DC 20001, <http://www.api.org>.

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