INTERNATIONAL

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).

Current edition approved Dec. 1, 2022. Published February 2023. Originally approved in 1928. Last previous edition approved in 2019 as D287–12b (2019). DOI: 10.1520/D0287-22.

[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:

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

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.

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 as listed in Table 2 and conforming to Specification E2251.

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 traceable to a NMI (National Metrology Institute), 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 *Temperature Determination:*

6.2.1 *Thermometers (Glass),* having a range from −5 °F to +215 °F and conforming to the requirements for Thermometer 12F as prescribed in Specification E1.

NOTE 2—The ASTM Gravity Thermometer 12F has 0.5 °F subdivisions and allowable ±0.25 °F scale error and is suitable for use in determining temperature of bulk crude oil volumes, such as lease production tanks. Additional thermometers conform to Specification E1 standard or Specification E2251 standard having a narrower range than the 12F or S12F Thermometers may also be used, if they have similar performance characteristics.

6.2.2 Alternate liquid measuring device (Thermometer S12F) conforming to the requirements prescribed in Specification E2251 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.

6.2.3 *Digital Temperature Sensors*—Digital Contact Thermometers of the PRT style shall meet the requirements of Guide E2877 and may be used instead of glass thermometers with the following exceptions:

6.2.3.1 Thermocouples shall not be used.

6.2.3.2 Thermistors shall not be used.

6.3 *Hydrometer Cylinder,* transparent material (see 6.3.2). The inside diameter of the cylinder shall be at least 0.25 in. (6.35 mm) greater (see A in Fig. 1) than the outside diameter of the hydrometer body and the temperature measuring device plus the separation interval specified in Fig. 1 and the height shall be such that the appropriate hydrometer floats in the test portion with at least 1 in. (25 mm) clearance between the bottom of the hydrometer and the bottom of the cylinder, under all densities and temperatures. Ensure that the hydrometer cylinder is cleaned after each use to ensure that no contaminants remain.

6.3.1 When using separate hydrometer (or thermohydrometer) and temperature measuring devices, care shall be exercised to ensure that neither interfere with each other and that they are not affected by external temperature effects. The minimum separation distances as shown in Fig. 1 shall be required. These separation distances are a function of the diameters of the measuring devices and the minimum distance from the sides of the measuring chamber to minimize external thermal effects.

where:

A = minimum separation interval specified in 6.3 between the inside diameter of hydrometer cylinder and the sum of the OD of the hydrometer body plus the OD of temperature measuring device plus the minimum separation interval between devices of 0.25 in. (6.35 mm), see Fig. 1, and

B = minimum separation interval between measuring devices of 0.5 in. (12.7 mm).

6.3.2 Hydrometer cylinders constructed of transparent materials shall be resistant to discoloration or attack by the petroleum or petroleum product samples and shall not affect the material being tested. They shall not become opaque under prolonged exposure to sunlight. If the opacity prevents the

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
41H to 45 H	thermo	15 to 51	8	0.1	0.1
51H to 60H	thermo	−1 to 101	12	0.1	0.1
71H to 74H	thermo	−1 to 41	12	0.1	0.1

TABLE 2 Available Hydrometers Scaled, Degrees API (Low Hazardous Liquid Type)

ASTM Hydrometer Designation	Type	API Range, deg	Each Unit	Scale	
				Division	Error
52HL	thermo	−1 to 11	12	0.1	0.1
52HL	thermo	9 to 21	12	0.1	0.1
53HL	thermo	19 to 31	12	0.1	0.1
54HL	thermo	29 to 41	12	0.1	0.1
55HL	thermo	39 to 51	12	0.1	0.1
56HL	thermo	49 to 61	12	0.1	0.1
57HL	thermo	59 to 71	12	0.1	0.1
58HL	thermo	69 to 81	12	0.1	0.1
59HL	thermo	79 to 91	12	0.1	0.1
60HL	thermo	89 to 101	12	0.1	0.1

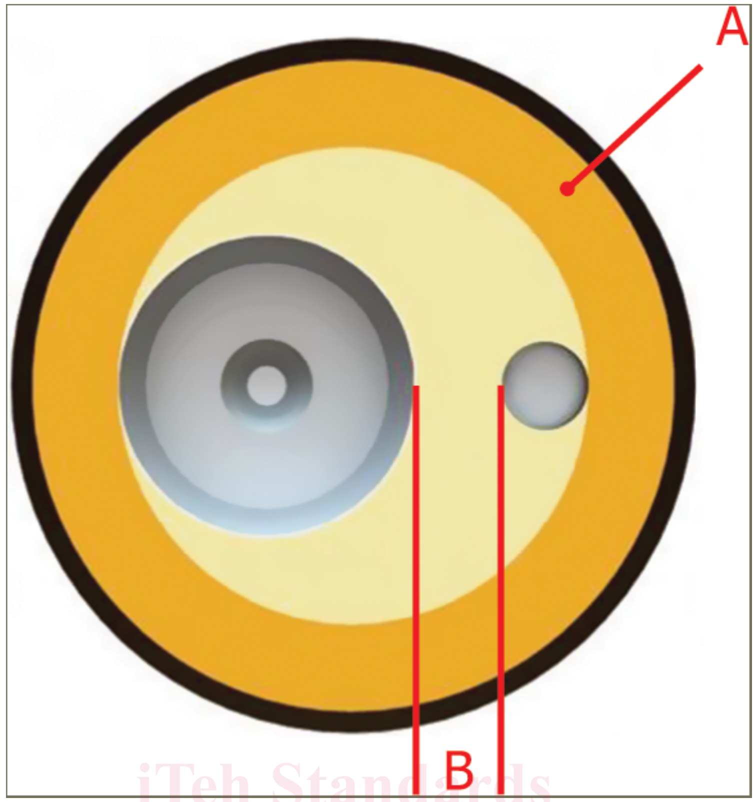


FIG. 1 Separation Intervals (minimum requirements) between Devices and Hydrometer Cylinder

observation of both devices then the hydrometer cylinder shall be replaced before continuing with the test.

6.3.3 The minimum separation intervals specified is to prevent any capillary action between devices and to ensure that external temperature effects are minimized on the values determined for density and temperature.

7. Temperature of Test (Limiting Conditions 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 °F and 195 °F (–18 °C and + 90 °C) for the test, so far as it is consistent with the type of sample and necessary limiting conditions shown in Table 3.

7.2 The purpose of Table 3 is to clarify what actions are required to ensure that the sample does not change its physical makeup during the testing period or modifications to the sample physical properties to ensure that the devices can function properly. For example, with highly volatile samples being measured in an open container the light ends may evaporate while the devices are reaching temperature equilibrium. This is a function of ambient temperature as well as fluid temperature and composition. Conversely, if the fluid is too viscous (thick) the hydrometer may not float freely, which is a requirement for a buoyance device.

8. Procedure

8.1 For referee testing, use the long plain form of hydrometer (1H to 10H). For field testing, the thermohydrometer method in Test Method D6822 (API *MPMS* Chapter 9.3) is the preferred method. However, if the user desires to use a liquid-in-glass thermometer with low-hazard glass precision fluid as specified in Specification E2251 or a Digital Contact Thermometer as specified in Guide E2877 and 6.2.3, the user

TABLE 3 Limiting Conditions and Testing Temperatures

Sample Type	Gravity Limits	Initial Boiling Point Limits	Other Limits	Test Temperature
Highly volatile	lighter than 70° API			Cool to 35 °F (2 °C) or lower in original closed container.
Moderately volatile	heavier than 70° API	below 250 °F (120 °C)		Cool to 65 °F (18 °C) or lower in original closed container.
Moderately volatile and viscous	heavier than 70° API	below 250 °F (120 °C)	Viscosity too high at 65 °F (18 °C)	Heat to minimum temperature for sufficient fluidity.
Nonvolatile	heavier than 70° API	above 250 °F (120 °C)		Any temperature between 0 °F and 195 °F (–18 °C and 90 °C) as convenient.
Mixtures of nonpetroleum products or essentially pure hydrocarbons				60 °F ± 0.25 °F (15.56 °C ± 0.1 °C)

can use Test Method D6822 (API *MPMS* Chapter 9.3) with a modified procedure as detailed in 8.11 of this test method.

8.1.1 As shown in Table 1 and Table 2, the user has access to hydrometers covering various ranges of API gravity. The user should select a hydrometer which results in the liquid interface cutting the hydrometer stem in the center third of the range. The hydrometer should not be used when the liquid interface cuts the scale in the bottom two API gravity values or at the top two API gravity values.

8.1.2 When using digital temperature devices the user shall utilize only intrinsically rated temperature devices that conform to the appropriate standard.

NOTE 3—In practice whether in a lab or field environment this test method is used in a potentially hazardous environment (that is, explosive) and as these devices are electrically powered which could possibly produce a spark, potentially resulting in an explosion/fire. All companies generally have Engineering and Operating standards that refer to NFPA (National Fire Protection Association) and NEC (National Electrical Code) codes that detail the requirements for the use of electrical devices in classified areas. These company requirements should take precedence.

8.2 Prior to lowering the selected hydrometer and/or temperature determination instrument into the sample perform the Equipment Validation enumerated in Annex A1.

8.3 Verify that the selected density and/or temperature determination instruments conform to the requirements of Annex A2.

8.4 Adjust the temperature of the sample in accordance with Table 3. For field testing, test temperatures other than those listed in Table 3 may be used. The hydrometer cylinder shall be approximately the same temperature as the sample to be tested.

8.5 Transfer the sample into the clean hydrometer cylinder without splashing, so as to avoid the formation of air bubbles and to reduce to a minimum the evaporation of the lower boiling constituents of the more volatile samples. (**Warning—** Samples may be extremely flammable. Vapors may cause flash fire.) For the more volatile samples, transfer to the hydrometer cylinder by siphoning. (Do not start the siphon by mouth.) Remove any air bubbles formed, after they have collected on the surface of the sample, by touching them with a piece of clean filter paper or other suitable means before inserting the hydrometer. For field testing, the gravity measurement is directly made in the sampling core thief or hydrometer cylinder. Place the cylinder containing the sample in a vertical position in a location free from air currents. Take precautions to prevent the temperature of the sample from changing appreciably during the time necessary to complete the test. During this period, the temperature of the surrounding medium should not change more than 5 °F (3 °C).

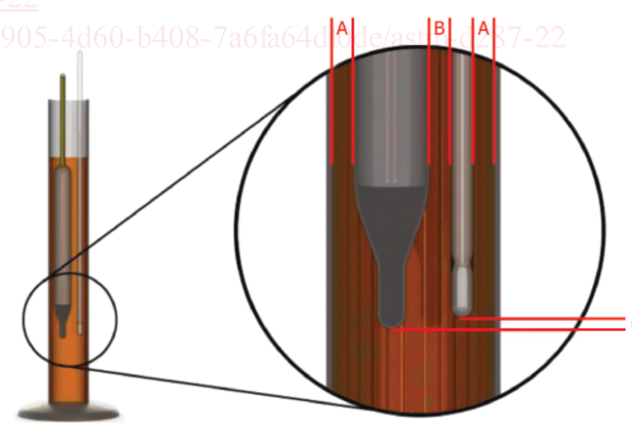
8.6 Lower the hydrometer gently into the sample and, when it has settled, depress it about two scale divisions into the liquid and then release it; keep the rest of the stem dry, as unnecessary liquid on the stem changes the effective weight of the instrument, and so affects the reading obtained. With samples of low viscosity, a slight spin imparted to the instrument on releasing assists in bringing it to rest, floating freely away from the walls of the hydrometer cylinder. Allow sufficient time for the hydrometer to become completely stationary and for all air bubbles to come to the surface. This is particularly necessary in the case of the more viscous samples.

8.7 Lower the temperature measuring device slowly into the sample, in close proximity to the hydrometer installed in 8.6 making sure that neither touch, nor come in contact with the side walls of the sample cylinder. Refer to Fig. 2a and Fig. 2b and Fig. 3a and Fig. 3b. The temperature measuring device may also be used to cautiously and slowly stir the sample instead of the hydrometer, to minimize stratification.

8.7.1 The hydrometer is a buoyancy device, its performance or where it floats is dependent on the temperature of the fluid around the point of buoyancy. Therefore, it is essential that the sample temperature be taken as close to this point of buoyancy. In practice with opaque samples this point can be difficult to determine. However, it can be estimated from knowing the lengths of the various instruments and then estimating their relative positions.

8.8 When the hydrometer has come to rest, floating freely, and the temperature of the sample is constant to within 0.2 °F (0.1 °C), read and record the hydrometer reading to the nearest scale division. The correct reading is that point on the hydrometer scale at which the surface of the liquid cuts the scale. Determine this point by placing the eye slightly below the level of the liquid and slowly raising it until the surface, first seen as a distorted ellipse, appears to become a straight line cutting the hydrometer scale. See Fig. 4.

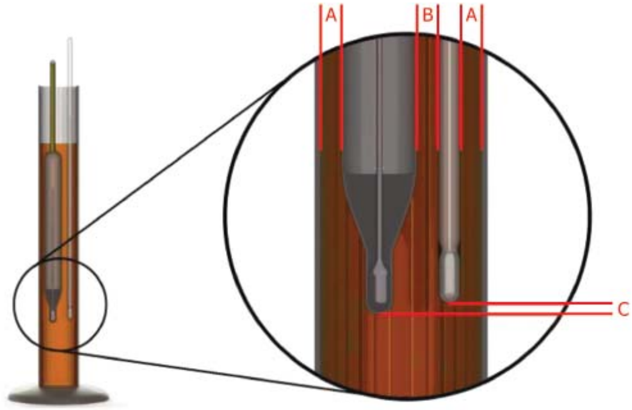
8.9 To make a reading with nontransparent liquids, observe the point on the hydrometer scale to which the sample rises above its main surface, placing the eye slightly above the plane surface of the liquid. This reading requires a correction. Determine this correction (meniscus correction) for the particular hydrometer in use by observing the height above the



where:

A = separation interval specified in 6.3 and Fig. 1,
B = separation interval specified in 6.3 and Fig. 1, and
C = relative vertical alignment between the density and temperature measuring devices (the bottom of the sensing portion of the temperature measuring device should be within ±0.5 in. (±12.5 mm) and not more than ±1.0 in. (±25 mm) of the bottom of the density sensor).

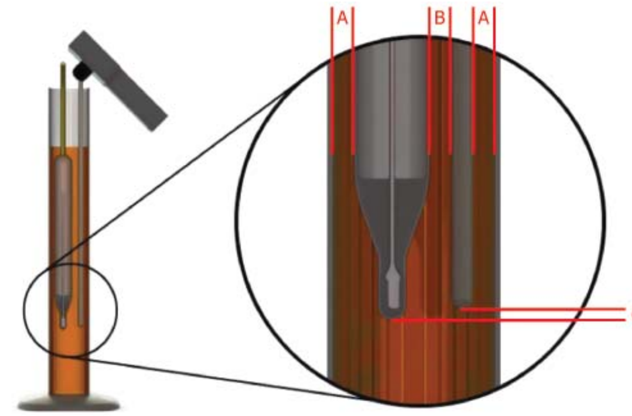
FIG. 2 a Hydrometer and Liquid-in-Glass Thermometer Placement (Typical)



where:

A = separation interval specified in 6.3 and Fig. 1,
B = separation interval specified in 6.3 and Fig. 1, and
C = relative vertical alignment between the density and temperature measuring devices (the bottom of the sensing portion of the temperature measuring device should be within ±0.5 in. (±12.5 mm) and not more than ±1.0 in. (±25 mm) of the bottom of the density sensor).

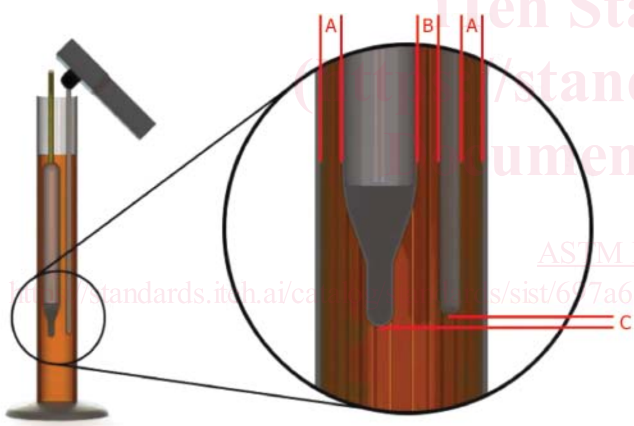
FIG. 2 b Thermohydrometer and Liquid-in-Glass Thermometer Placement (Typical) *(continued)*



where:

A = separation interval specified in 6.3 and Fig. 1,
B = separation interval specified in 6.3 and Fig. 1, and
C = relative vertical alignment between the density and temperature measuring devices (the bottom of the sensing portion of the temperature measuring device should be within ±0.5 in. (±12.5 mm) and not more than ±1.0 in. (±25 mm) of the bottom of the density sensor).

FIG. 3 b Thermohydrometer and Digital Contact Thermometer Placement (Typical) *(continued)*



where:

A = separation interval specified in 6.3 and Fig. 1,
B = separation interval specified in 6.3 and Fig. 1, and
C = relative vertical alignment between the density and temperature measuring devices (the bottom of the sensing portion of the temperature measuring device should be within ±0.5 in. (±12.5 mm) and not more than ±1.0 in. (±25 mm) of the bottom of the density sensor).

FIG. 3 a Hydrometer and Digital Contact Thermometer (Typical)

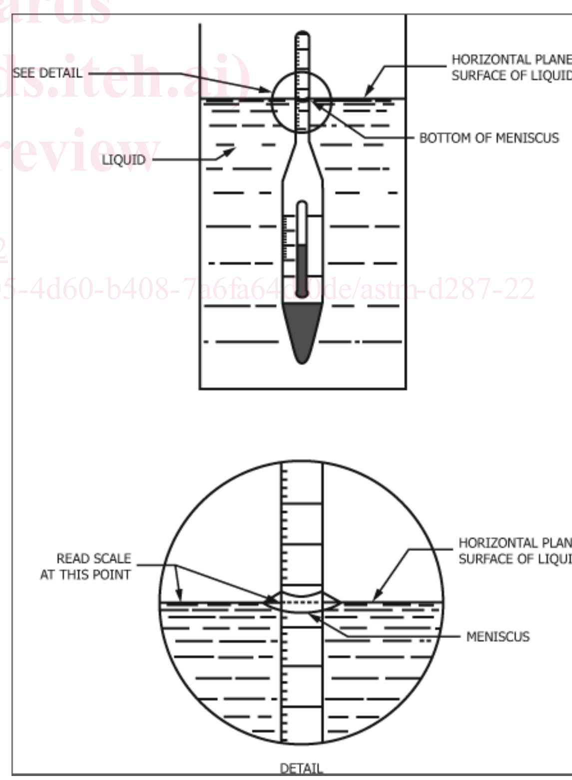


FIG. 4 Hydrometer Scale Reading for Transparent Liquids (Typical)

main surface of the liquid to which the sample rises on the hydrometer scale when the hydrometer in question is immersed in a transparent liquid having a surface tension similar to that of a sample under test. See Fig. 5.

8.9.1 Record the observed hydrometer scale readings to the nearest 0.1° API for transparent liquids.

8.9.2 When gravity readings have been observed on opaque liquids using the procedure given in 8.9, subtract the meniscus correction from the hydrometer reading observed and record the meniscus corrected hydrometer scale reading to the nearest 0.1° API.

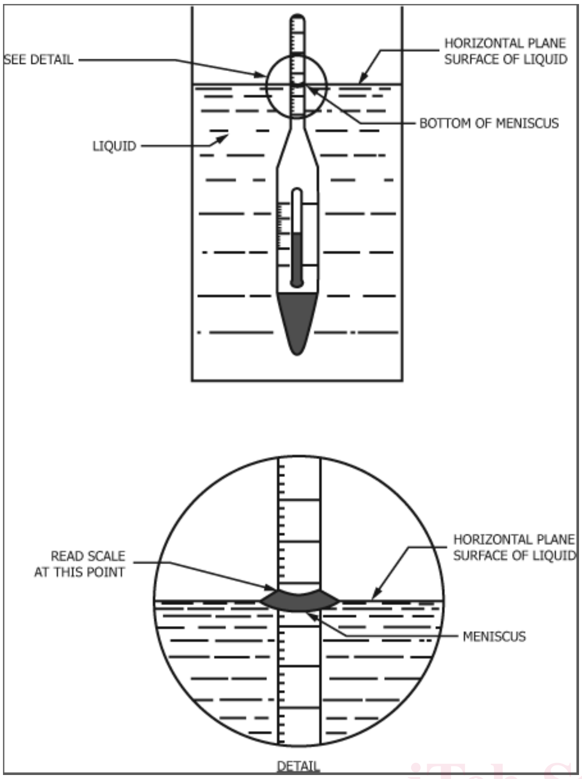


FIG. 5 Hydrometer Scale Reading for Opaque Fluids (Typical)

NOTE 4—The meniscus correction for a particular hydrometer in use is determined by observing the maximum height above the principal surface of the liquid to which liquid rises on the hydrometer scale when the hydrometer in question is immersed in a transparent liquid having a surface tension similar to that of the sample under test.

8.10 Observe the temperature of the sample immediately before and after the observation of the gravity, the liquid in the cylinder being thoroughly but cautiously stirred with the thermometer (Note 5), and the whole of the temperature thread being immersed. Should these temperature readings differ by more than 1 °F (0.5 °C), repeat the temperature and gravity observations when the temperature of the sample has become more stable. Record the mean of the thermometer reading before and after the final hydrometer reading, to the nearest 1 °F, as the temperature of the test.

8.11 When using a separate temperature measuring device such as a liquid-in-glass thermometer; a liquid-in-glass thermometer with low-hazard precision liquid or a digital contact thermometer they shall be placed in the sample measurement cylinder as shown in Fig. 2a and Fig. 2b as well as Fig. 3a and Fig. 3b.

NOTE 5—When only thermohydrometers are used, stir the sample by carefully moving the thermohydrometer in a side to side motion, without immersing the thermohydrometer any lower into sample. It is satisfactory in this case to read the thermometer scale of the thermohydrometer after the hydrometer reading has been observed. Read the thermometer to the nearest 1 °F (0.5 °C). If using a separate device to measure temperature, use the temperature measuring device to stir the sample and read according to 8.10.

9. Calculation

9.1 Apply any relevant thermometer corrections to the temperature reading observed in 8.10 and record the average of those two temperatures to the nearest 1 °F.

9.2 Application of the glass thermal expansion correction depends upon what edition 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) will be used to calculate the base density.

9.2.1 The 1980 version of the Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1) has the hydrometer glass thermal expansion correction included. Input into the 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) software (see API *MPMS* Ch. 11.1.1.3 paragraphs 5 and 6) requires the Hydrometer Reading – Observed or Hydrometer Reading – Observed, Meniscus Corrected in API units from 8.9.1 or 8.9.2, observed temperature of the sample, and the built-in hydrometer glass thermal correction switch set to "on" (0) or "off" (1). It will return API @ 60 °F.

9.2.2 The 2004 version of the Adjunct to D1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1) does not include the hydrometer glass thermal expansion correction, so that correction must be made before entering the 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) software. Depending on the specific end use of the calculation results, the final value may be left rounded or unrounded. See 9.3.

9.3 The following steps are required to implement 9.2.2:

Step 1. Convert the meniscus corrected hydrometer scale reading to density in kg/m^3 using Eq 2.

Hydrometer Scale Reading Units	Conversion to Density
For API gravity:	

$$density\ (kg\ /\ m^3) = (141.5*999.016)/(131.5+API) \quad (2)$$

Leave the result unrounded.

Step 2. Calculate the hydrometer thermal glass expansion correction factor (HYC) using the appropriate equation below (*t* is observed temperature).

Correction for a Base Temperature (T_b) of 60 °F:

$$HYC = 1.0 - [0.00001278\ (\tau - 60)] - [0.0000000062\ (\tau - 60)^2] \quad (3)$$

Leave the result unrounded.

Step 3. Multiply the hydrometer reading in kg/m^3 from Step 1 by HYC from Step 2 to obtain the glass expansion corrected hydrometer reading.

$$kg/m^3_{\ HYC} = kg/m^3 * HYC \quad (4)$$