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An American National Standard

Designation: 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 D 1657; 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 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 may apply to other equipment designs.

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

1.4 *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:*

D 1250 Guide for Petroleum Measurement Tables[2]

D 1265 Practice for Sampling Liquefied Petroleum (LP) Gases (Manual Method)[2]

E 1 Specification for ASTM Thermometers[3]

E 100 Specification for ASTM Hydrometers[3]

2.2 *ASTM Adjuncts:*

Adjunct to D 1250 Guide for Petroleum Measurement Tables (API *MPMS* Chapter 11.1)

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. When the temperature has reached equilibrium, the hydrometer reading and the temperature of the sample are noted.

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.

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

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 14.03.

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 E 100.

6.1.1 *Thermohydrometers*, for field applications, thermohydrometers may be more convenient than hydrometers with separate thermometers. They shall conform to Specification E 100, 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.

6.2 *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 weaken plastics while aromatics also tend to attack the surface of plastics and should similarly not be used. A light aliphatic hydrocarbon is recommended for cleaning. (**Warning—**Extremely flammable. Harmful if inhaled. Vapors may cause flash fire.)

6.2.1 The liquid inlet valve and the liquid outlet valve shall be tightly connected to a base plate that shall be bored to give both valves a common inlet to the cylinder. The vapor vent valve shall be similarly connected to the top plate, which shall be bored to provide a vapor outlet from the pressure cylinder. All valves shall be 6 mm (¼ in.) or equivalent needle valves.

6.2.2 The cylinder shall not be operated at a gage pressure greater than 1.4 MPa (200 psi). A hydrostatic test at 2.8 MPa (400 psi) shall be carried out at intervals no greater than 12 months.

6.3 *Thermometers*, conforming to ASTM 12C or 12F in Specification E 1. The thermometer shall be held firmly inside the hydrometer cylinder by a clip in such a manner that it does not interfere with the free movement of the hydrometer.

6.4 *Constant-Temperature Bath*, of dimensions such that it can accommodate the hydrometer cylinder with the test portion fully immersed below the test portion liquid surface, and a temperature control system capable of maintaining the bath temperature within 0.25°C of the test temperature throughout the duration of the test.

7. Reference Liquids

7.1 The following reference liquids are required for standardization of the hydrometer:

7.1.1 *Propane*, pure grade, having a nominal density of 507.6 kg/m^3 at 15°C or a relative density 60/60°F of 0.50699. (**Warning—**Extremely flammable. Harmful if inhaled. Vapors may cause flash fire.) The density of the reference liquid used shall be known.

7.1.2 *Butane*, pure grade, having a nominal density of 584.1 kg/m^3 at 15°C or a relative density 60/60°F of 0.5840. (**Warning—**Extremely flammable. Harmful if inhaled. Vapors may cause flash fire.) The density of the reference liquid used shall be known.

8. Sampling

8.1 Unless otherwise specified, samples of liquid hydrocarbons shall be obtained by the procedures described in Practice D 1265. The procedure for sampling for verification of the apparatus and for subsequent testing is described as follows.

8.1.1 Connect the source of supply of the liquid to be tested to the inlet valve by suitable fittings so that a representative sample can be introduced into the cylinder. Ascertain that these connections are free of leaks. Open the outlet and vent valves and purge the sampling connections by opening the inlet valve slightly, permitting the product to flow through the outlet valve at the bottom of the cylinder and the vent valve at the top of the cylinder.

8.1.2 When the connections have been purged, close the outlet and vent valves and open the inlet valve, permitting the liquid to enter the cylinder until it is full. If necessary, the vent valve can be opened slightly to permit complete filling of the cylinder after which it shall be closed. At no time shall the pressure in the cylinder be allowed to rise above a gage pressure of 1.4 MPa (200 psi).

8.1.3 When the cylinder has been filled, close the inlet valve and open the outlet and vent valves, permitting the contents of the cylinder to be withdrawn completely and the pressure inside the cylinder to be returned to atmospheric pressure.

8.1.4 Close the outlet and vent valves and open the inlet valve, filling the cylinder to a level at which the enclosed hydrometer floats freely. If it is necessary to accomplish this filling by venting vapor through the vent valve, repeat the purging to cool the cylinder sufficiently to permit its being filled without venting.

8.1.5 With all valves closed, examine the apparatus for leaks. If leaks are detected, discard the sample, reduce the pressure to atmospheric and repair the leaks. Repeat the sampling procedure.

9. Verification of Apparatus

9.1 Carefully clean and dry the hydrometer and the inside wall of the pressure cylinder.

9.2 Insert the hydrometer in the pressure cylinder and attach the thermometer and cover plate. Connect the source of supply of the reference liquid to the inlet valve and ascertain that the connections are free of leaks. Fill the hydrometer with one of the reference fluids (see Section 7) by the procedure given in 8.1.2-8.1.5.