



Standard Test Method for Density and Relative Density (Specific Gravity) of Viscous Materials by Bingham Pycnometer¹

This standard is issued under the fixed designation D1480; 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 two procedures for the measurement of the density of materials which are fluid at the desired test temperature. Its application is restricted to liquids of vapor pressures below 80 kPa (600 mm Hg) and viscosities below 40 000 mm²/s (cSt) at the test temperature. The method is designed for use at any temperature between 20 °C and 100 °C. It can be used at higher temperatures; however, in this case the precision section does not apply.

NOTE 1—For the determination of density of materials which are fluid at normal temperatures, see Test Method [D1217](#).

1.2 This test method provides a calculation procedure for converting density to specific gravity.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous material that can cause central nervous system, kidney and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website—<http://www.epa.gov/mercury/faq.htm>—for additional information. Users should be aware that selling mercury and/or mercury containing products in your state or country may be prohibited by law.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This test method is under the jurisdiction of ASTM Committee [D02](#) on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee [D02.04.0D](#) on Physical and Chemical Methods.

Current edition approved Dec. 1, 2015. Published February 2016. Originally approved in 1957. Last previous edition approved in 2012 as D1480–12. DOI: 10.1520/D1480-15.

2. Referenced Documents

2.1 *ASTM Standards*:²

[D1217](#) Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer

[D4052](#) Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

[E1](#) Specification for ASTM Liquid-in-Glass Thermometers

3. Terminology

3.1 *Definitions*:

3.1.1 *density, n*—mass per unit volume at a specified temperature. **D4052**

3.1.2 *relative density, n*—the ratio of the density of a material at a stated temperature to the density of water at a stated temperature. **D4052**

4. Summary of Test Method

4.1 The liquid sample is introduced into the pycnometer, equilibrated to the desired temperature, and weighed. The density or specific gravity is then calculated from this weight and the previously determined calibration factor, and a correction is applied for the buoyancy of air.

5. Significance and Use

5.1 Density is a fundamental physical property that can be used in conjunction with other properties to characterize both the light and heavy fractions of petroleum and to assess the quality of crude oils.

5.2 Determination of the density or relative density of petroleum and its products is necessary for the conversion of measured volumes to volumes at the standard temperatures of 15 °C.

5.3 The determination of densities at the elevated temperatures of 40 °C and 100 °C is particularly useful in providing the data needed for the conversion of kinematic viscosities in

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

mm²/s (centistokes) to the corresponding dynamic viscosities in mPa·s (centipoises).

6. Apparatus

6.1 *Pycnometer*,³Bingham-type of 10 mL capacity (as shown in Fig. 1), constructed of heat-resistant⁴ glass.

NOTE 2—Pycnometers having capacities of 2 mL to 25 mL are available but have not been cooperatively evaluated.

6.2 *Constant-Temperature Bath*, provided with suitable pycnometer holders and means for maintaining temperatures constant to ± 0.01 °C in the desired range. Water-glycerin mixtures can be used for temperatures up to 100 °C.

6.3 *Bath Thermometer*, graduated in 0.1 °C subdivisions and standardized for the range of use to the nearest 0.01 °C (ASTM Saybolt Viscosity Thermometers 17 °C to 22 °C, conforming to the requirements in Specification E1, are recommended). For most hydrocarbons the density coefficient is about 0.0008 units/°C, and therefore an error of ± 0.013 °C would cause an error of ± 0.00001 g/mL in density. A standardized platinum resistance thermometer may also be used, and it offers the best means for observing temperature changes in the bath.

6.4 *Thermal Shields*, as shown in Fig. 2, to hold the pycnometer and syringe during the filling procedure, constructed of two aluminum shells with suitably spaced viewing ports, the upper bored to hold a 30 mL hypodermic syringe and the lower bored to hold a 25 mL Bingham pycnometer. A winding of No. 26 Chromel “A” wire, insulated from the

³ There is more than one supplier. If you cannot find a supplier, then contact Subcommittee D02.04.0D on Physical and Chemical Methods for possible suppliers.

⁴ Borosilicate glass has been found satisfactory for this purpose.

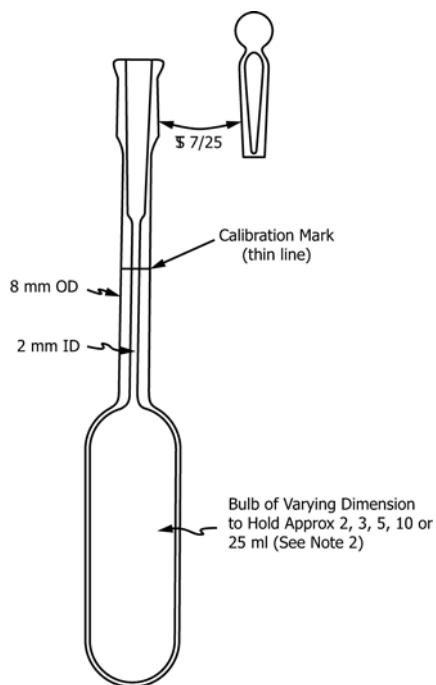
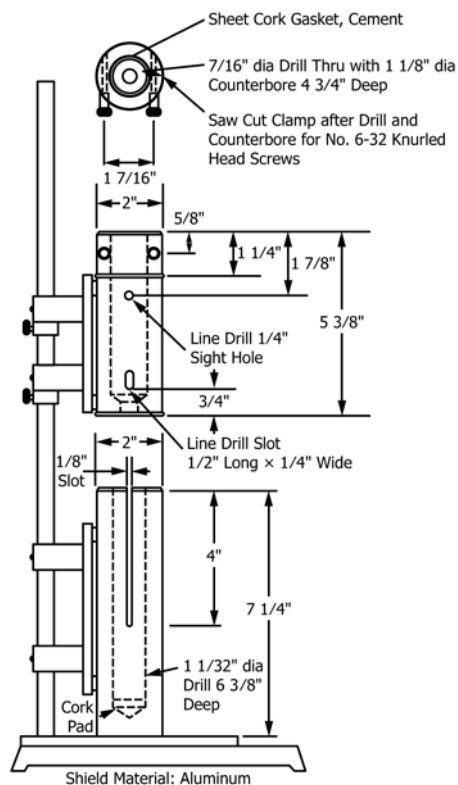


FIG. 1 Bingham-Type Pycnometer



Metric Equivalents

in.	mm	in.	mm	in.	mm	in.	mm
1/8	3.2	5/8	15.9	1 1/4	31.8	4	102
1/4	6.4	3/4	19.1	1 7/16	36.5	4 3/4	121
7/16	11.1	1 1/32	26.2	1 7/8	47.6	5 5/8	136
1/2	12.7	1 1/8	28.6	2	50.8	6 3/8	162
						7 1/4	184

NOTE 1—Cover shields with mica or insulating cement. Wind with No. 26 gauge Chromel “A” wire: Upper block 1.52 m (60 in.) (25.4 Ω), lower block 2.16 m (85 in.) (35.0 Ω) wound vertically. Cover with insulating tape or insulating cement and connect heaters in series. Insulate shields from stand with 1/4 in. Transite.

FIG. 2 Details of Thermal Shields for 30 mL Syringe and 25 mL Pycnometer

shields with mica, covered with insulating tape, and having resistances connected in series of 25 Ω on the upper shield and 35 Ω on the lower produces controlled heat to the shields by means of a variable transformer. A stand is necessary to support the shields in such a manner that the center of the wells may be aligned, and the upper shield raised 180 mm to 200 mm and swung through 45°.

6.5 *Hypodermic Syringes*, 2 mL to 30 mL capacity, of chemically resistant glass, equipped with a 170 mm, 16 gauge (0.065 in.) filling needle made from stainless-steel tubing, as shown in Fig. 3.

6.6 *Draw-off Needle*, made of stainless-steel tubing, as shown in Fig. 3.

6.7 *Solvent Cleaning Assembly*, as shown in Fig. 4.

6.8 *Chromic Acid Cleaning Apparatus*, similar to that shown in Fig. 5.

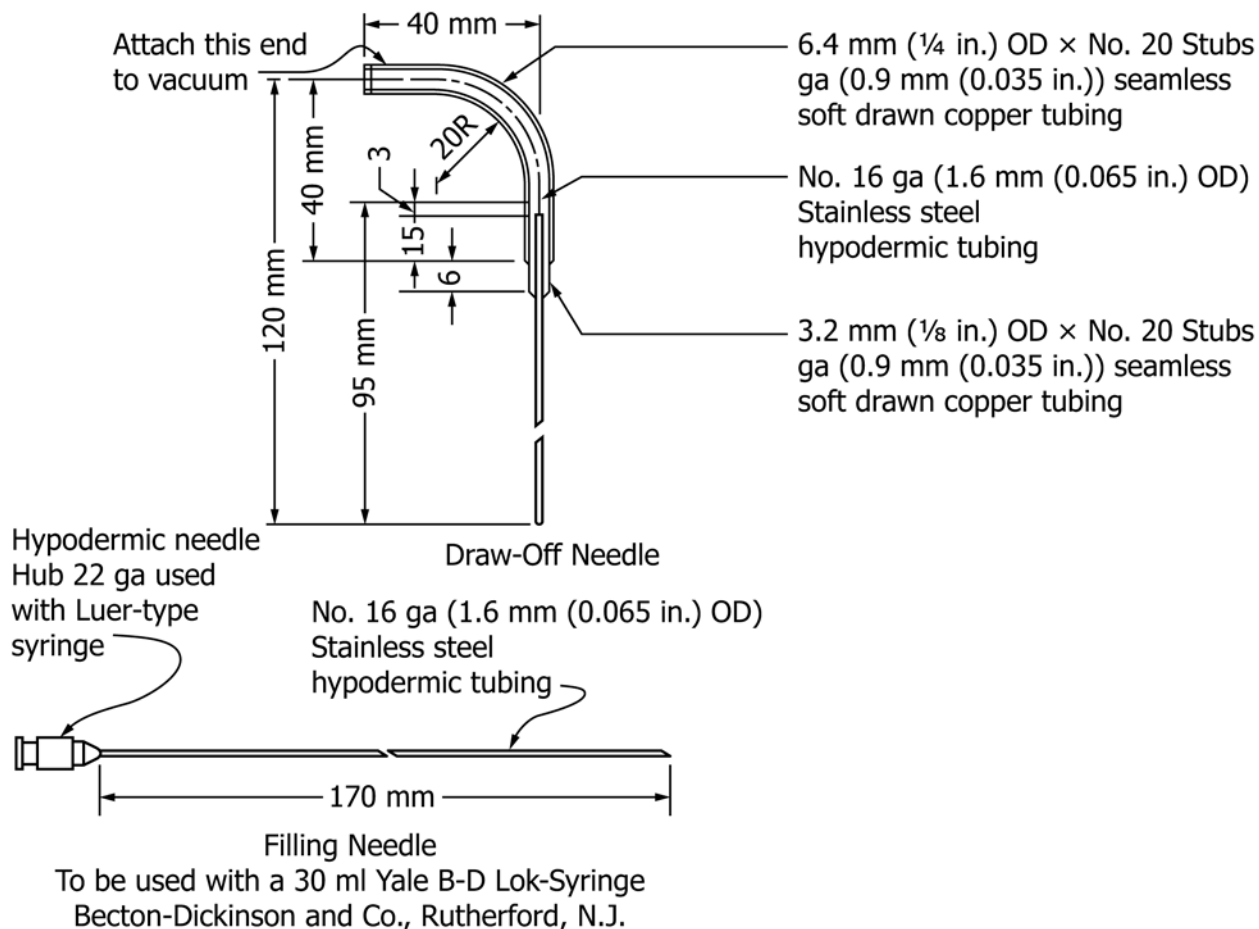


FIG. 3 Accessories for Bingham-Type Pycnometer

6.9 *Balance*, capable of reproducing weighings within 0.1 mg when carrying a load of 30 g. The balance shall be located in a room shielded from drafts and fumes and in which the temperature changes between related weighings (empty and filled pycnometer) do not cause a significant change in the ratio of the balance arms. The same balance shall be used for all related weighings.

6.10 *Weights*, whose relative values are known to the nearest 0.05 mg or better. Use the same set of weights for the calibration of the pycnometer and the determination of densities.

7. Reagents and Materials

7.1 *Acetone*—(Warning—Extremely flammable. Use adequate ventilation.)

7.2 *Isopentane*—(Warning—Extremely flammable. Avoid build up of vapors and remove all sources of ignition, especially non-explosion proof electrical apparatus.)

7.3 *Chromic Acid (Potassium Dichromate/Conc. Sulfuric Acid)*—(Warning—Causes severe burns. A recognized carcinogen. Do not get in eyes, on skin, or on clothing.)

8. Preparation of Apparatus

8.1 Clean the pycnometer thoroughly with hot chromic acid cleaning solution by means of the assembly shown in Fig. 5 (Warning—See 7.3.) Chromic acid solution is the most effective cleansing agent. However, surfactant cleansing fluids have also been used successfully. Mount the apparatus firmly and connect the trap to the vacuum. Warm the necessary amount of cleaning acid in the beaker, place the pycnometer on the ground joint, and evacuate by opening the stopcock to vacuum. Fill the pycnometer with acid by turning the stopcock, and either repeat several times, or remove the filled pycnometer and allow it to stand for several hours at 50 °C to 60 °C. Remove the acid from the pycnometer by evacuation, empty the acid from the trap, and flush the pycnometer with distilled water. Clean in this manner whenever the pycnometer is to be calibrated or whenever liquid fails to drain cleanly from the walls of the pycnometer or its capillary. Ordinarily, the pycnometer may be cleaned between determinations by washing with a suitable solvent, rinsing with pure, dry acetone, followed by isopentane, and vacuum drying. (Warning—See 7.1 and 7.2.)