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AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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Standard Test Method for Specific Gravity of Drying Oils, Varnishes, Resins, and Related Materials at 25/25°C[1]

This standard is issued under the fixed designation D 1963; 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 specific gravity of drying oils, varnishes, alkyd resins, fatty acids, and related materials.

1.2 This test method is recommended where precision is required in the determination of specific gravity, such as establishing specifications or referee work.

1.2.1 For materials with a kinematic viscosity of 40 stokes or less, use the Leach type pycnometer.

1.2.2 For materials with a viscosity in excess of 40 stokes, use the Hubbard-type pycnometer.

1.2.3 For materials that are solid or semisolid at 25°C but liquid at slightly higher temperatures, use the Hubbard-type pycnometer.

NOTE 1—The weight per gallon cup method is satisfactory for most routine laboratory work although the precision does not equal that of the pycnometer method. The test method described herein for use with the Hubbard-type pycnometer is applicable to the weight per gallon cup method, or Test Method D 1475 may be used.

NOTE 2—Hydrometers also provide a rapid method for checking specific gravity and are generally satisfactory for routine control work. However, the precision of the hydrometer method is not adequate where accurate results are required. Test Method D 1298 covers the use of the hydrometer in the determination of specific gravity.

Most ASTM Hydrometers (See Specification E 100) are calibrated to read specific gravity at 15.5/15.5°C (60/60°F). Information on sources of hydrometers calibrated at 25/25°C is available at ASTM Headquarters.

1.3 *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.* For specific hazard statements, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1298 Test Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method[2]

D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[3]

E 100 Specification for ASTM Hydrometers[4]

3. Terminology

3.1 Definition:

3.1.1 *specific gravity, of drying oils and varnishes*—the ratio of the mass of a given volume of material at 25°C to that of an equal volume of water at 25°C, expressed as follows: Specific gravity at 25/25°C___ .

4. Significance and Use

4.1 Specific gravity is a useful measure, since conversion from volume to weight, or vice versa, is often required. For this reason it should be determined with care.

4.2 Specific gravity is very sensitive to temperature, and the temperature of measurement must be controlled, or at least known, with high precision. If the specific gravity at some temperature other than the standard is required, temperature correction factors for this purpose are provided. These factors may also be used to correct the specific gravity from some other temperature to the standard 25/25°C.

4.3 In addition, various procedures are outlined in this test method so that specific gravities of materials with widely varying viscosities can be accurately measured.

4.4 Specific gravity is not a measure of the quality of the oil, and an oil that deviates slightly from the specified limits, but otherwise conforms, is usually completely satisfactory. Specific gravity increases with polymerization or oxidation in a regular manner, and for every bodied or blown oil of a given viscosity there is an appropriate specific gravity.

4.5 Determine the specific gravity in accordance with this test method, which is capable of high precision and is the referee method. If less accurate results (3 significant figures) are adequate, "weight-per-gallon" cups as described in Test Method D 1475 may be used.

5. Apparatus

5.1 *Leach-Type Pycnometer*—A glass pycnometer, conical in shape and vented by a side arm that has a cap with a

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications, and is the direct responsibility of Subcommittee D01.32 on Drying Oils.

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

[3] *Annual Book of ASTM Standards*, Vol 06.01.

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

standard-taper No. 5/12 joint. A thermometer shall be sealed in the neck by a standard-taper No. 10/18 interchangeable joint. The thermometer shall have a range from 12 to 38°C in 0.2°C divisions. Either 25 or 50-mL capacity is satisfactory. Weld pycnometers have also been found suitable.

5.2 *Hubbard-Type Pycnometer*—A glass pycnometer, conical or cylindrical in shape, and fitted with a ground glass stopper 22 to 26 mm in diameter. The stopper shall have a 1.0 to 2.0-mm vertical hole in the center. The top of the stopper shall be a plane, smooth surface. The under surface of the stopper shall be concave (approximately 5 mm at the center) to let the air escape when it is inserted. The capacity shall be about 25 to 30 mL and the weight not more than 40 g.

5.3 *Water Bath*, capable of being maintained at 25 ± 0.1°C.

6. Hazards

6.1 *Chromic Acid Cleaning Solution* is based on concentrated sulfuric acid that is corrosive to skin, eyes and mucous membranes in the form of liquid, mist, or fumes. It causes severe burns. Take care to prevent contact of the acid with eyes, skin, or clothing. In making dilute solutions, always add the acid to water with care. In case of contact, immediately flush eyes with copious amounts of water for 15 min; flush skin with water (use shower if available); wash contaminated clothing before reuse. Immediately call a physician. Like sulfuric acid, chromic acid cleaning solution is a strong oxidizer and should not be brought into contact with organic or reducing agents as a fire or explosion can result. Consult supplier's Material Safety Data Sheets.

7. Calibration of Leach-Type Pycnometer

7.1 Carefully clean the pycnometer by first soaking all parts in potassium dichromate ($K_2Cr_2O_7$) dissolved in concentrated sulfuric acid (H_2SO_4) (**Precaution**—see 6.1) and then washing thoroughly with water. Dry the pycnometer thoroughly and place it with all its parts in a desiccator for at least 1 h before weighing. Weigh the pycnometer with all its parts to 0.1 mg. Record this weight as *A*.

7.2 Fill the pycnometer to overflowing (by holding on its side in such a manner as to prevent the entrapment of air bubbles) with cooled, just previously boiled, distilled water at a temperature of 20°C. Insert the thermometer by holding the bottle 45° from the horizontal, being careful no air bubbles are included.

7.3 Transfer the pycnometer to a 25°C bath so that the water in the bath will be 1⁄16 in. (1.5 mm) lower than the top of the capillary vent tube and hold it in the bath for approximately 1 h or until the pycnometer-thermometer has reached 25°C.

7.4 Carefully remove excess water from the capillary with absorbent materials, and cap immediately. Remove the pycnometer from the bath. Dry the outside of the pycnometer by wiping dry with an absorbent material. Take care not to handle the pycnometer so as to raise the temperature markedly or leave fingerprints. Immediately weigh to 0.1 mg and record the weight as *B*.

8. Calibration of Hubbard-Type Pycnometer

8.1 Clean and weigh the pycnometer as described in 7.1.

8.2 Fill the pycnometer with freshly boiled, distilled water at a temperature of approximately 20°C. Insert the stopper, taking care that no air bubbles are entrapped.

8.3 Immerse in the water bath at 25 ± 0.1°C to a level of 1⁄16 to 1⁄8 in. (1.5 to 3.2 mm) above the water until constant temperature is reached (approximately 1 h).

8.4 Seat the stopper firmly in the pycnometer and blot the water from the surface so that the level in the bore is flush with the surface. Remove the pycnometer from the bath, wipe dry with a clean cloth, and weigh immediately, recording the mass as *B*. (The pycnometer may be cooled slightly before weighing to prevent loss of water through the capillary.) Calibrate until consistent results are obtained.

9. Procedure Using Leach-Type Pycnometer

9.1 Fill a clean, dry pycnometer with the material to be tested at a temperature of approximately 20°C, in the same manner as described in 7.2. If necessary, centrifuge the material to remove air bubbles either before or after filling the pycnometer.

9.2 Bring the material to a temperature of 25°C, dry with absorbent material moistened with toluene, and weigh as described in 7.3 and 7.4. Record the weight as *C*.

NOTE 3—When using the Leach-type pycnometer for routine work it is not necessary to bring the flask and contents to exactly 25°C. The thermometer temperature can be read when the vent cap is put in place and a temperature correction applied to the calculated specific gravity.

10. Procedure Using Hubbard-Type Pycnometer

10.1 When determining specific gravity on materials that are very viscous, semisolid, or solid at 25°C, use the following procedure:

10.1.1 Fill a clean, dry pycnometer one half full of the material to be tested.

NOTE 4—Precautions must be taken to keep the material from touching the sides of the flask above the final level and to prevent the inclusion of air bubbles. It is advisable to warm the bottle before filling.

10.1.2 Permit the bottle with its contents to cool to room temperature and then weigh with the stopper. Record the weight as *C*.

10.1.3 Remove the pycnometer from the balance and fill it with freshly boiled distilled water of approximately 20°C. Insert the stopper and place the pycnometer in the constant temperature bath for at least 30 min. At the end of this time firmly seat the stopper and then carefully blot the top of the stopper, being careful not to draw water from the stopper opening.

NOTE 5—When difficulty with bubble release is encountered in making the determination, refer to a procedure in which water is replaced with odorless mineral spirits.[5]

10.1.4 Remove the pycnometer from the bath and partially immerse it in cold distilled water until the contents recede from the stopper opening. Wipe dry and weigh at once to 0.1 mg. Record this weight as *D*.

[5] Ashton, H. E., "Measuring Specific Gravity of Viscous Materials," *Materials, Research and Standards*, Vol 1, No. 7, July 1961.

11. Calculation

11.1 Calculate the specific gravity, *S*, determined as described in Sections 7-9, where the pycnometer is completely filled with the material to be tested as follows:

$$S = (C - A)/(B - A) \quad (1)$$

where:
A = weight of pycnometer, g,
B = weight of pycnometer plus water, g,
C = weight of pycnometer plus material, g.

11.2 When the Leach pycnometer is used and the temperature of the pycnometer plus material, *C*, is not exactly 25°C, a correction must be made using the thermal coefficient of the material tested. For most vegetable oils this is approximately 0.00068/°C:

$$S_C = X + 0.00068\ Y \quad (2)$$

where:
S_C = corrected specific gravity,
X = uncorrected specific gravity, and
Y = temperature difference, plus or minus, °C.

11.3 Calculate the specific gravity, *S*, determined as described in 11.1, where the pycnometer is only partially filled with the material to be tested, as follows:

$$S = (C - A)/[(B - A) - (D - C)] \quad (3)$$

where:
A = weight of empty pycnometer, g,
B = weight of pycnometer plus water, g, and
C = weight of pycnometer plus material plus water, g.

11.4 Using 0.00068 as the thermal coefficient of drying oils approximate corrections to other temperatures can be made as follows:

To correct from 25/25°C to 25/15.5°C, subtract 0.0018.

To correct from 25/25°C to 15.5/15.5°C, add 0.0047.

12. Precision and Bias

12.1 *Precision*—Fourteen laboratories participating in the AOCS Smalley check series reported single results on six oils for a total of 84 results and a calculated standard deviation of 0.0049.

12.2 *Repeatability*—(95 % confidence level) Duplicate results by the same operator should be considered suspect if they differ by more than 0.0011.

12.3 *Reproducibility*—Single determinations made in two different laboratories should not differ by more than 0.0013.

12.4 *Bias*—Bias has not been determined.

13. Keywords

13.1 drying oils; resins; specific gravity; varnishes