Designation: D3142/D3142M – 11

Standard Test Method for Specific Gravity, API Gravity, or Density of Cutback Asphalts by Hydrometer Method[1]

This standard is issued under the fixed designation D3142/D3142M; 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 laboratory determination, using a glass hydrometer, of the density, specific gravity, or API gravity of cutback asphalts as defined in Specifications D2026, D2027, and D2028 (Note 1). Values are measured on a hydrometer at convenient temperatures, readings of density, specific gravity, and API gravity being reduced to 15°C or 60°F by means of international standard tables. By means of these same tables, values determined in one of the three systems of measurement are convertible to equivalent values in either system so that measurements may be made in the units of local convenience.

NOTE 1—This test method is applicable to cutback asphalts and in general follows, but provides more explicit routines than, the procedure outlined in Test Method D1298.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

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.* Specific precautionary statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

D140 Practice for Sampling Bituminous Materials

D1250 Guide for Use of the Petroleum Measurement Tables

D1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D2026 Specification for Cutback Asphalt (Slow-Curing Type)

D2027 Specification for Cutback Asphalt (Medium-Curing Type)

D2028 Specification for Cutback Asphalt (Rapid-Curing Type)

E1 Specification for ASTM Liquid-in-Glass Thermometers

E100 Specification for ASTM Hydrometers

E220 Test Method for Calibration of Thermocouples By Comparison Techniques

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *API gravity*—a function of specific gravity 15/15°C [60/60°F], represented by the equation:

$$°\text{API} = [141.5/\text{SG } 15/15°\text{C}] - 131.5 \text{ or}$$
$$°\text{API} = [141.5/\text{SG } 60/60°\text{F}] - 131.5$$

No statement of reference temperature is required since 15°C [60°F] is included in the definition.

3.1.2 *density*—The mass of material per unit volume. When reporting results, explicitly state the density in units of mass (kilograms) and volume (litres), together with the standard reference temperature.

3.1.3 *observed values*—values observed at temperatures other than the standard reference temperature. Values observed at other temperatures are only hydrometer readings, and not density, relative density (specific gravity), or API gravity.

3.1.4 *specific gravity*—The ratio of mass of a given volume of a material at a specified temperature to the mass of an equal volume of pure water measured at the reference temperature. When reporting results, the standard reference temperature must be stated.

4. Summary of Test Method

4.1 The sample is brought to the testing temperature and transferred to a hydrometer cylinder at approximately the same temperature. The cylinder and its contents are placed in a

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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.

constant-temperature bath to avoid excessive temperature variation during the test. The appropriate hydrometer is lowered into the sample and allowed to settle. After temperature equilibrium, the hydrometer is read and the temperature of the sample is noted.

4.2 The hydrometer reading is corrected to either 15°C or 60°F by referring to standard tables.

5. Significance and Use

5.1 Accurate determination of the density, specific gravity, or API gravity of cutback asphalts is necessary for the conversion of measured volumes to volumes at the standard temperature of 15°C or 60°F.

5.2 Similarly, accurate determination is necessary for converting volumes to mass as required in other ASTM tests on cutback asphalts.

5.3 Values corrected to 15°C and 60°F will be different because the two temperatures are not equal.

6. Apparatus

6.1 *Hydrometers,* glass, graduated in units of specific gravity, API gravity, or density as required, as listed in Table 1 and in accordance with Specification E100.

6.2 *Thermometers*—A calibrated ASTM Gravity Thermometer, having a range of –20 to 102°C or –5 to 215°F and conforming to the requirements for Thermometer 12°C or 12°F, respectively, as prescribed in Specification E1, or an equivalent thermometric device that has been calibrated in accordance with Test Method E220. If a thermohydrometer is used, the temperature scale shall have a range from 20 to 65°C or 60 to 220°F (Designation H).

6.3 *Hydrometer Cylinder,* clear glass, plastic (Note 2), or metal. For convenience in pouring, the cylinder may have a lip on the rim. The inside diameter of the cylinder shall be at least 20 mm [¾ in.] greater than the outside diameter of the hydrometer used in it. The height of the cylinder shall be such that the hydrometer floats in the sample with at least 25 mm [1 in.] clearance between the bottom of the hydrometer and the bottom of the cylinder.

NOTE 2—Hydrometer cylinders constructed of plastic materials should be resistant to discoloration or attack by oil samples and must not become opaque by prolonged exposure to sunlight and oil samples.

TABLE 1 Recommended Hydrometers

Hydrometer Designation	Measurement	Range	Total Length, mm	Body Diameter, mm
1H to 4H	API Gravity	–1 to 41°API	325-335	23-27
21H to 28H	API Gravity	0 to 41°API	158-168	12-15
85H to 90H	Relative Density (SG) 15.6/15.6°C	0.8 to 1.1	325-335	23-27
105H to 108H	Relative Density (SG) 15.6/15.6°C	0.8 to 1.0	250-270	20-24
315H to 320H	Density at 15°C	800-1100 kg/m^3	325-335	21-27

6.4 *Constant-Temperature Bath,* capable of maintaining the testing temperature to ±0.5°C [1.0°F] and of such dimensions that the level of the liquid is approximately the same as that of the sample in the hydrometer cylinder.

6.5 *Oven,* for preheating the sample, and capable of maintaining the selected testing temperature to within ±3°C [5°F].

7. Hazards

7.1 Materials tested using this procedure may contain volatile and flammable hydrocarbons. Heat the sample in a covered container to minimize loss of volatile components. Carry out the test in a well ventilated area, and avoid breathing any vapors which may be generated. Keep sources of ignition away from materials being tested.

7.2 **Warning:** Mercury has been designated by the United States Environmental Protection Agency (EPA) and many state 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—www.epa.gov/mercury/faq.htm—for additional information. Users should be aware that selling mercury, mercury containing products, or both, into your state may be prohibited by state law.

8. Sampling

8.1 Take samples in accordance with Practice D140. The sample shall be free of foreign substances.

8.2 Thoroughly mix the sample before removing a representative portion for testing.

9. Temperature of Test

9.1 Because of differences in viscosity between various grades of cutback asphalts, the temperature of the test must be adjusted so that it will provide sufficient fluidity to conduct the test over a reasonable period of time. The recommended testing temperatures for the various grades shown in Table 2 are based on a viscosity of approximately 200 to 500 mm^2/s (cSt).

9.2 When the hydrometer value is to be used to select multipliers for correcting volumes to standard temperatures, the hydrometer reading should be made preferably at a temperature within ±3°C [5°F] of the temperature at which the bulk volume of the oil was measured (Note 3). However, in cases when appreciable amounts of light fractions may be lost during determination at the bulk asphalt temperature, the temperatures given in Table 2 should not be exceeded.

TABLE 2 Recommended Testing Temperatures for Various Grades of Cutback Asphalts

Grade	Testing Temperature, °F	Testing Temperature, °C
MC-30	Room	Room
SC-70, MC-70, RC-70	104	40
SC-250, MC-250, RC-250	140	60
SC-800, MC-800, RC-800	176	80
SC-3000, MC-3000, RC-3000	212	100

NOTE 3—When metal cylinders are used, accurate reading of the hydrometer can only be ensured if the level of the sample is within 5 mm [¼ in.] of the top of the cylinder.

10. Procedure

10.1 Select the test temperature in accordance with the indications given in Section 9. Heat the sample in an oven to within 3°C [5°F] of the test temperature but without exceeding it. Cover the container with a loose-fitting cover to prevent solvent evaporation. Bring the hydrometer cylinder and thermometer to approximately the same temperature as the sample to be tested.

10.2 Transfer the sample to a clean hydrometer cylinder (Note 4) without splashing, 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. 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 before inserting the hydrometer.

NOTE 4—Volume and density correction tables are based on an average coefficient of expansion for a number of typical materials. Since the same coefficients were used in computing both sets of tables, corrections made over the same temperature interval minimize errors arising from possible differences between the coefficients of the material under test and the standard coefficients. This effect becomes more important as temperatures diverge significantly from the standard table temperatures of 15°C or 60°F.

10.3 Place the cylinder containing the sample in the constant-temperature bath previously brought up to the test temperature ±0.5°C [1.0°F]. Allow sufficient time for the sample to reach the bath temperature ± 0.5°C [1.0°F] and verify its temperature with the thermometric device. If a thermohydrometer is used, it may be lowered into the sample at this point instead of the thermometric device. As soon as a steady thermometer reading is obtained, record the temperature of the sample to the nearest 0.2°C [0.5°F].

10.4 Lower the hydrometer gently into the sample. Take care to avoid wetting the stem above the level to which it will be immersed in the liquid. 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.

10.5 When the hydrometer has come to rest, floating freely away from the walls of the cylinder, read the hydrometer to the nearest scale division. Take the reading by observing with the eye slightly above the plane of the surface of the liquid, the point on the hydrometer scale to which the sample rises. This reading, at the top of the meniscus, requires correction since hydrometers are calibrated to be read at the principal surface of the liquid. The corrections for the particular hydrometer in use may be determined by observing the maximum height above the principal surface of the liquid to which oil rises on the hydrometer scale when the hydrometer in question is immersed in a transparent oil having a surface tension similar to that of the sample under test. For routine work, determine the height of the meniscus by sighting across the principal surface of the liquid and estimating the rise of the meniscus on the hydrometer scale.

10.6 Immediately after observing the hydrometer scale value, cautiously stir the sample with the thermometric device. Record the temperature of the sample to the nearest 0.2°C [0.5°F] (Note 5). Should this temperature differ from the previous reading by more than 0.5°C [1.0°F], repeat the hydrometer and the temperature observations until the temperature becomes stable within 0.5°C [1.0°F].

NOTE 5—After use at a temperature higher than 40°C [100°F], allow all hydrometers of the lead shot in wax type to drain and cool in a vertical position.

11. Calculation

11.1 Apply any relevant corrections to the observed thermometer reading (for scale and bulb) and to the hydrometer reading (scale). Make the appropriate correction to the observed hydrometer reading. Record the specific gravity to the nearest 0.001, the API gravity to the nearest 0.1°, or the density to the nearest 1 kg/m^3. After application of any relevant corrections, record to the nearest 0.5°C [1.0°F] the mean of the temperature values observed immediately before and after the final hydrometer reading.

11.2 To convert the observed hydrometer reading to density to standard temperature, use the following guidance to select the correct table from Guide D1250 and ASTM D1250 Petroleum Measurement Tables:[3,4]

11.2.1 When an API gravity hydrometer has been used, use Table 5A to convert the hydrometer reading to the API gravity. Then, if desired, use Table 3 to obtain the specific gravity 60/60°F or the density at 15°C.

11.2.2 When a specific gravity hydrometer has been used, use Table 23A to convert the hydrometer reading to the specific gravity 60/60°F. Then, if desired, use Table 21 to obtain the API gravity at 60°F or the density at 15°C.

11.2.3 When a density scaled hydrometer has been used, use Table 53A to obtain the density at 15°C. Then, if desired, use Table 51 to obtain specific gravity 60/60°F or API gravity at 60°F.

12. Report

12.1 Report the final value as specific gravity 60/60°F, or density at 15°C, kg/m^3, or as gravity in degrees API, as applicable.

13. Precision and Bias

13.1 *Single Operator Precision*—The single-operator standard deviation for the specific gravity of cutback asphalts has been found to be 0.00195. Therefore, results of two properly conducted tests by the same operator on the same material should not differ by more than 0.0055 for specific gravity 60/60°F, 5.5 kg/m^3 for density at 15°C, or 1.1 for API gravity at 60°F.

13.2 *Multilaboratory Precision*—The multilaboratory standard deviation for the specific gravity of cutback asphalts has

[3] Petroleum Measurement Tables, approved by International Standards Organization as Recommendation R91, published jointly by ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, under designation D1250 and the Institute of Petroleum, 61 New Cavendish St., London W1, England, under designation IP-200.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJD1250CS.

been found to be 0.00276. Therefore, results of two properly conducted tests by two laboratories on samples of the same material should not differ by more than 0.0078 for specific gravity 60/60°F, 7.8 kg/m^3 for density at 15°C, or 1.1 for API gravity at 60°F.

NOTE 6—These numbers represent the 1S and D2S limits as described in Practice C670.

13.3 *Bias*—No information can be presented on the bias of the procedure in Test Method D3142 for measuring Specific Gravity, API Gravity, or Density of Cutback Asphalts by the Hydrometer Method because no material having an acceptable reference value is available.

14. Keywords

14.1 API gravity; cutback asphalt; density; relative density; specific gravity