Designation: D 3142 – 97

Standard Test Method for Density of Liquid Asphalts (Hydrometer Method)[1]

This standard is issued under the fixed designation D 3142; 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 of cutback asphalts using a glass hydrometer. It is applicable to cutback asphalts which are liquid at room temperature (see Note 1). It provides more explicit testing procedures than those in Test Method D 1298.

NOTE 1—For materials that are solid or semi-solid at room temperature, use Test Method D 70 or Test Method D 3289.

1.2 The values in SI units are to be regarded as 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:*

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials[2]

D 70 Test Method for Density of Semi-Solid and Solid Bituminous Materials (Pycnometer Method)[3]

D 140 Practice for Sampling Bituminous Materials[3]

D 1250 Petroleum Measurement Tables[4]

D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method[4]

D 2026 Specification for Cutback Asphalt (Slow-Curing Type)[3]

D 2027 Specification for Cutback Asphalt (Medium-Curing Type)[3]

D 2028 Specification for Cutback Asphalt (Rapid-Curing Type)[3]

D 3289 Test Method for Density of Semi-Solid and Solid Bituminous Materials (Nickel Crucible Method)[3]

D 4311 Practice for Determining Asphalt Volume Correction to a Base Temperature[3]

E 1 Specification for ASTM Thermometers[5]

E 100 Specification for ASTM Hydrometers[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *API gravity*—a function of specific gravity 15.6/15.6°F, represented by the equation:

$$°\text{API} = (141.5/\text{SG } 15.6/15.6°\text{C}) - 131.5 \quad (1)$$

3.1.2 *density*—the mass per unit volume of a material.

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 *relative density*—the ratio of the mass of a given volume of a material to the mass of the same volume of water at the same temperature.

3.1.4.1 *Discussion*—Relative density is also called specific gravity.

3.1.5 *specific gravity*—relative density.

4. Summary of Test Method

4.1 The sample is brought to the testing temperature and transferred to a cylinder at approximately the same temperature. The cylinder and its contents are placed in a 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. The hydrometer reading is converted to the density at 15°C using standard tables.

4.2 The hydrometer reading is corrected to density at 15°C by referring to standard tables.

5. Significance and Use

5.1 Values of density are used for converting volumes to units of mass, and for correcting measured volumes from the temperature of measurement to a standard temperature using Practice D 4311.

6. Apparatus

6.1 *Hydrometers*, glass, graduated in units of specific gravity, or API gravity as required, conforming to Specification E 100 as listed in Table 1.

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[1] This test method is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.47 on Miscellaneous Asphalt Tests.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.03.

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

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

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

6.2 Other hydrometers conforming to the performance and accuracy requirements of Specification E 100 may be used.

6.3 *Thermometers*—Calibrated liquid in glass total immersion thermometers with a maximum scale error of 0.1°C. Thermometer 12C as defined in Specification E 1 is suitable. Any other thermometric device of equal accuracy may be used.

6.4 *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 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 clearance between the bottom of the hydrometer and the bottom of the cylinder.

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

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

6.6 *Oven*, for preheating the sample, and capable of maintaining the selected testing temperature to within ±3°C.

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 vapours which may be generated. Keep sources of ignition away from materials being tested.

8. Sampling

8.1 Take samples in accordance with Practice D 140. 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 liquid 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 cst.

TABLE 2 Recommended Testing Temperatures for Various Grades of Liquid Asphalts

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

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 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.

NOTE 3—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 15°C.

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 of the test temperature but without exceeding it. The container shall be covered 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—When metal cylinders are used, accurate reading of the hydrometer can only be ensured if the level of the sample is within 5 mm of the top of the cylinder.

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

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 thermometer, keeping the mercury thread fully immersed. Record the temperature of the sample to the nearest 0.2°C (Note 5). Should this temperature differ from the previous reading by more than 0.5°C repeat the hydrometer and the thermometer observations until the temperature becomes stable within 0.5°C.

NOTE 5—After use at a temperature higher than 100°F (37.7°C), 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 to the nearest 0.1°API, 0.001 relative density (specific gravity), or 1 kg/m^3 the corrected hydrometer reading. After application of any relevant corrections, record to the nearest 0.5°C 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 at 15°C, use the following tables from Tables D 1250:

11.2.1 When an API gravity hydrometer has been used, use Table 5A to convert the hydrometer reading to the API gravity. Then use Table 3 to obtain the density at 15°C.

11.2.2 When a relative density (specific gravity) hydrometer has been used, use Table 23A to convert the hydrometer reading to the relative density 15.6/15.6°C. Then use Table 21 to obtain 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.

12. Report

12.1 Report the density at 15°C to the nearest 1 kg/m^3.

13. Precision and Bias

13.1 *Single Operator Precision*—The single-operator standard deviation for the relative density 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 5.5 kg/m^3 (0.0055 kg/L).

13.2 *Multilaboratory Precision*—The multilaboratory standard deviation for the relative density of cutback asphalts has 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 7.8 kg/m^3.

NOTE 6—These numbers represent the 1S and D2S limits as described in Practice C 670.

13.3 *Bias*—The bias of this test method has not been determined.

14. Keywords

14.1 cutback asphalt; density; liquid asphalt