Designation: D1622 – 20

Standard Test Method for Apparent Density of Rigid Cellular Plastics[1]

This standard is issued under the fixed designation D1622; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the density of a cellular plastic. Density can be evaluated as the apparent overall density (includes forming skins) or by apparent core density (forming skins removed).

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This test method is equivalent to ISO 845.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

E456 Terminology Relating to Quality and Statistics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E2935 Practice for Conducting Equivalence Testing in Laboratory Applications

2.2 *ISO Standard:*

ISO 845 Cellular plastics and rubbers—Determination of apparent density[3]

3. Terminology

3.1 Terms used in this standard are defined in accordance with Terminology D883, unless otherwise specified. For terms relating to precision and bias and associated issues, the terms used in this standard are defined in accordance with Terminology E456.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent core density (of a cellular plastic), n*—the weight in air per unit volume of a sample, after all forming skins formed during the manufacturing process have been removed.

3.2.2 *apparent overall density (of a cellular plastic), n*—the weight in air per unit volume of a sample, including all forming skins formed during the manufacturing process.

4. Significance and Use

4.1 If the material to be tested includes forming skins, the apparent overall density, or the apparent core density, or both, shall be determined. If the material does not have forming skins, the term overall density is not applicable.

4.2 This test method is also applicable to spray foam materials.

4.3 Before proceeding with this test method, reference shall be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters, or combination thereof, covered in the relevant ASTM materials specification shall take precedence over those mentioned in this test method. If there are no relevant ASTM material specifications, then the default conditions in this method apply.

4.4 When density or apparent density is used in reference to a cellular plastic, without further qualification, it shall be interpreted as follows:

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.22 on Cellular Materials - Plastics and Elastomers.

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

4.4.1 *density*—shall be interpreted as being the *apparent overall density* if the material is to be used with forming skins intact.

4.4.2 *density*—shall be interpreted as the *apparent core density* if the forming skins have been, or will be, removed before the material is used.

5. Apparatus

5.1 *Analytical Balance or Scale,* capable of weighing the specimens to the nearest ±0.1 %.

5.2 *Micrometer Dial Gauge, Caliper, or Steel Rule,* suitable for measuring dimensions of the specimen to ±0.1 %.

5.3 *Dual Component Spray Equipment,* designed to meter the materials.

6. Test Specimen

6.1 The specimen shall be of a shape whose volume can be readily calculated, and not less than 16.4 cm^3 (1.0 $in.^3$)in volume.

6.2 If the sample is a single object whose weight and volume can be measured accurately, using the total weight and total volume to determine the sample density is acceptable. In this case, the test specimen is the entire sample.

6.3 When testing spray foam materials, specimens shall be prepared as follows:

6.3.1 Test specimens shall be taken from finished foam samples that have been sprayed from compounds in accordance with 6.3.2.

6.3.2 Spray the sample compounds at room temperature, between 20 to 24°C (68 to 75°F), unless alternative conditions are otherwise agreed upon by the contractual parties. Spray equipment shall be adjusted to the best spray pattern and optimum performance. Spray apply a minimum 1.27-cm (0.5-in.) layer of foam to a primed plywood base or other suitable substrate approximately 0.95-cm by 63.5-cm by 63.5-cm (0.375-in. by 25-in. by 25-in.). After a minimum of 5 minutes, spray apply a second layer at least 3.8 cm (1.5 in.) in thickness.

6.3.3 Cut an approximate 2.54-cm (1-in.) thick specimen from the second layer. For calculation of core density, remove the bottom layer and the top skin. For calculation of the apparent overall density, cut a specimen that includes the forming skin.

6.4 If separate test specimens are cut from the sample, a minimum of three shall be used. The specimens shall be taken from locations distributed throughout the sample.

6.5 When apparent overall density is determined using specimens cut from a larger sample, the ratio of forming skin area to total volume shall be the same for the test specimens as for the sample.

7. Conditioning

7.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618, unless otherwise specified by the contract or relevant material specifications. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity, unless otherwise specified by the contract or relevant material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

8. Number of Specimens

8.1 A minimum of three specimens shall be tested, unless the entire sample is measured as a single specimen (see Section 6).

9. Procedure

9.1 Weigh the test specimen on a balance or scale to a precision of ±0.1 %.

9.2 Measure specimen dimensions with a caliper or a gauge having a foot with a minimum area of 6.5 cm^2 (1 $in.^2$). Hold the pressure of the gauge foot to 2.7 ± 0.7 kPa (0.4 ± 0.1 psi), unless such pressure indents the specimen. In these cases, the pressure shall be reduced accordingly. When a sliding caliper gauge is used, the proper setting shall be that point at which the measuring faces of the gauge contact the surfaces of the specimen without compressing them. Do not use a steel rule for dimensions less than 25 mm (1 in.). Measure all dimensions to a precision of ±0.1 %. In general, three measurements shall be made of each dimension. It is acceptable to use a lesser number when the following conditions apply:

Measurements per Dimension	Maximum Allowed Cross-Sectional Area Perpendicular to Measured Dimension	Maximum Allowed Length of Longest Perpendicular Dimension
1	25 cm^2 (4 $in.^2$)	10 cm (4 in.)
2	100 cm^2 (16 $in.^2$)	30 cm (12 in.)

10. Calculation

10.1 Calculate the density to three significant figures as follows:

$$D = W_s/V$$

where:

D = density of specimen, kg/m^3 (lb/ft^3),
W_s = weight of specimen, kg (lb), and
V = volume of specimen, m^3 (ft^3).

NOTE 2—To obtain density in g/cm^3, divide D by 1000. To obtain density in lb/ft^3, divide D by 16.

10.2 See Appendix X1 for a density calculation that corrects for the buoyant effect of air.

NOTE 3—The air buoyancy effect will vary with time and depends on the open-cell content of the foam. Highly open-celled materials are essentially air-filled and will not exhibit the buoyant effects of air. However, freshly produced closed-cell materials are essentially air-void and will exhibit maximum buoyant effects of air. An additional 1.22 kg/m^3 (0.076 lb/ft^3) would be added to the density of an air-void specimen if the correction is used.

10.3 Calculate the standard deviation (estimated) as follows and report it to two significant figures:

$$s = \sqrt{\frac{\Sigma X^2 - nX^2}{n-1}} \text{ or } s = \left[\left(\Sigma X^2 - n\bar{X}^2\right)/(n-1)\right]^{1/2}$$

where:

s = estimated standard deviation,
X = value of a single observation,
n = number of observations, and
$\bar{X}$ = arithmetic mean of the set of observations.

11. Report

11.1 Report the following information:

11.1.1 Complete description of material tested, including type, source, code numbers, form, etc.,

11.1.2 Conditioning procedure used, if different from that specified in Section 7,

11.1.3 Number of specimens tested, if different from that specified in Section 8,

11.1.4 Density, average value, and standard deviation, and

11.1.5 Date of test.

11.2 Unless otherwise stated, the density is assumed to be the density calculated as defined in 10.1.

12. Precision and Bias[4]

12.1 *Precision:*

12.1.1 The precision of this test method is based on an interlaboratory study of this standard conducted in 1982. Five laboratories tested four different materials. Every "test result" represents an average of five individual determinations. Each laboratory was asked to submit one test result, from a single operator, for each material. Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. RR:D20-1105.

12.1.2 **Warning—**The data in Tables 1 and 2 shall not be rigorously applied to acceptance or rejection of material, as those data are specific to the interlaboratory study and are not necessarily representative of other lots, conditions, materials, or laboratories. Users of this test method shall apply the principles outlined in Practice E691 to generate data specific to their laboratory and materials, or between specific laboratories.

12.2 The precision has not been determined for the test method specific to spray foam materials.

13. Keywords

13.1 apparent core density; apparent density; apparent overall density; density; rigid cellular plastics; spray foam

TABLE 1 Within-Laboratory and Between-Laboratory Estimate of Precision Based on Round-Robin Testing Data for D1622 – 83

Material	Nominal Density	Average	Values, kg/m^3			
			S_r[A]	S_R[B]	I_r[C]	I_R[D]
M1	38	37.51	0.42	0.56	1.18	1.58
M2	50	49.63	0.30	0.46	0.86	1.31
M3	24	28.03	0.14	0.66	0.40	1.88
M4	21	20.79	0.59	1.11	1.68	3.14

[A] S_r is the within-laboratory standard deviation of the average.
[B] S_R is the between-laboratories standard deviation of the average.
[C] $I_r = 2.83S_r$.
[D] $I_R = 2.83S_R$.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1105.

TABLE 2 Within-Laboratory and Between-Laboratory Relative Precision Based on Round-Robin Testing Data for D1622 – 83

Material	Nominal Density, kg/m^3	Average, kg/m^3	Values Expressed as Percent of the Average			
			V_r[A]	V_R[B]	VI_r[C]	VI_R[D]
M1	38	37.51	1.12	1.49	3.17	4.22
M2	50	49.63	0.60	0.93	1.70	2.53
M3	24	28.03	0.50	2.35	1.42	6.65
M4	21	20.79	2.84	5.34	8.04	15.11

[A] V_r is the within-laboratory coefficient of variation of the average.
[B] V_R is the between-laboratories coefficient of variation of the average.
[C] $VI_r = 2.83 V_r$.
[D] $VI_R = 2.83 V_R$.

APPENDIX

(Nonmandatory Information)

X1. DENSITY CALCULATION USING A CORRECTION FOR THE BUOYANT EFFECT OF AIR

X1.1 Calculate the density to three significant figures as follows:

$$D = \{(W_s + W_a)/V\}$$

where:

D = density of specimen, kg/m^3 (lb/ft^3),
W_s = weight of specimen, kg (lb),
W_a = weight of displaced air, kg (lb), calculated by multiplying the volume of the specimen in cubic metres (cubic feet) by the density of air at atmospheric temperature and pressure. (The density of air at 23°C (73.4°F) and 760 mm Hg of pressure = 1.19 kg/m^3 (0.074 lb/ft^3)), and
V = volume of specimen, m^3 (ft^3).

X1.2 The error associated with the density not using the correction for the buoyant effect of air is dynamic and approaches zero as air infiltrates into a sample. Thus, the value of W_a is zero in the above calculation when the sample is at equilibrium with the air. In this case, the calculation for density is identical to the calculation in 10.1.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D1622/D1622M - 14) that may impact the use of this standard. (July 15, 2020)

(1) Remove D1622M from designation.
(2) Adopted SI units only as standard and made appropriate changes throughout the document.
(3) ASTM D20 'modifications of statistical terminology and Precision and Bias statements', adopted in April 2019.
(4) Appendix: slight modification of air density at 23°C; it appears the air density at 15°C was previously listed.
(5) Small editorial changes throughout document.