



Designation: D5502 – 21

Standard Test Method for Apparent Density by Physical Measurements of Manufactured Anode and Cathode Carbon Used by the Aluminum Industry¹

This standard is issued under the fixed designation D5502; 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 apparent density of core samples from manufactured articles of anode and cathode carbon used by the aluminum industry in the production of aluminum.

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

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

C559 *Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles*
IEEE/ASTM SI 10 *American National Standard for Metric Practice*

3. Terminology

3.1 *Definitions:*

3.1.1 *apparent density, n*—the mass per unit volume of a substance, including voids inherent in the material tested.

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 D02.05 on Properties of Fuels, Petroleum Coke and Carbon Material. Current edition approved Oct. 1, 2021. Published October 2021. Originally approved in 1994. Last previous edition approved in 2015 as D5502 – 00 (2015). DOI: 10.1520/D5502-21.

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.

4. Significance and Use

4.1 Apparent density as determined by this test method is a basic material property of importance in manufacturing and application of anode and cathode carbon.

4.2 This test method can be used for quality and process control, material characterization and description, and other purposes.

5. Apparatus

5.1 *Drying Oven*, capable of being controlled to $110\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ($230\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$).

5.2 *Desiccator*, charged with indicating desiccant.

5.3 *Balance*, capable of weighing to $\pm 0.01\text{ g}$.

5.4 *Core Drill*, drill equipped with a diamond core bit capable of producing a core with true surface qualities and a minimum diameter of 50 mm.

5.5 *Cut-Off Saw*, a saw capable of cutting the cored sample resulting in a surface free of chips or gouges.

5.6 *Micrometer*, a micrometer or other measuring device capable of measuring the diameter and length of the prepared sample to an accuracy of 0.001 cm.

6. Preparation of Test Specimens

6.1 Core drill samples with a minimum diameter of 50 mm from the manufactured article in the form of a right circular cylinder.

6.2 Cut samples from the core to a minimum length of 50 mm. It is recommended that triplicate samples from the core be prepared, analyzed, and averaged to attain a result representative of the core apparent density.

6.3 It is the responsibility of the user of this test method to establish the quantity and location of core samples from the manufactured article for testing.

6.4 No particle contained within the sample can be larger than 19 mm. If particles are larger, the sample size or quantity, or both, shall be increased accordingly to give comparable accuracy in the results.

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

6.5 During the coring operation, use no lubricant having a boiling point above 100 °C. All edges and faces of the specimen should be free of chips or gouges. Ensure that the specimen is free of any residue from the coring operation. Dry the specimen for a minimum of 2 h at 110 °C, and then allow it to cool to 25 °C ± 5 °C in a desiccator. The specimen shall not be removed from the desiccator until immediately prior to weighing.

7. Procedure

7.1 Weigh the prepared specimen to an accuracy of 0.01 g using a balance or scale.

7.2 Measure each dimension of the test specimen to an accuracy of 0.001 cm.

7.2.1 Measure the length at four points, 90° apart on the periphery of the circular end faces. Make two sets of diameter measurements. Each set shall consist of four measurements, one at each end and two at intermediate points along an axial line. These sets shall lie at 90° to each other. Determine the mean of the four length measurements (*l*) (see Fig. 1) and the mean of the eight diameter measurements (*d*) (see Fig. 2).

8. Calculation

8.1 Record the mass to the nearest 0.01 g and the dimensions to the nearest 0.001 cm. Conversion factors are available in IEEE/ASTM SI 10.

8.2 The volume of the right circular cylinder specimen can be calculated as follows:

$$V = \pi(d^2/4)l \tag{1}$$

where:

- V* = volume, cm³,
- l* = mean length, cm, and
- d* = mean diameter, cm.

8.3 The apparent density of the specimen can be calculated as follows:

$$D = M/V \tag{2}$$

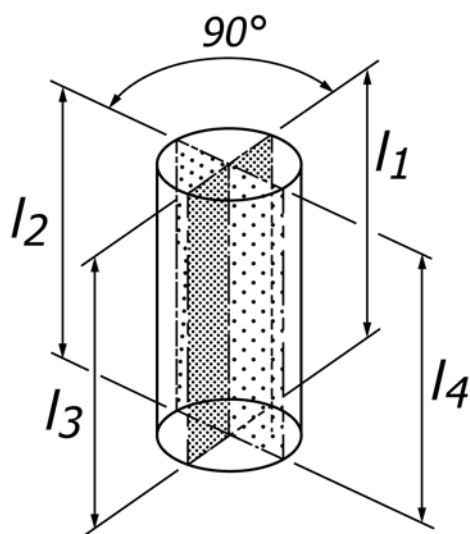


FIG. 1 Determining the Mean of the Four Length Measurements

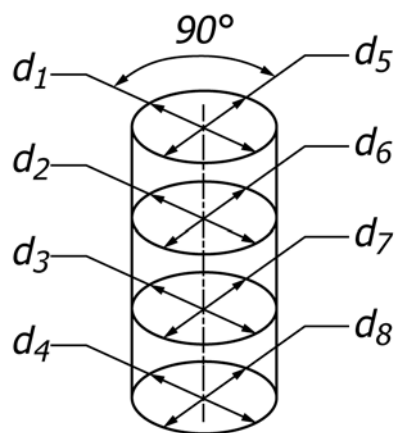


FIG. 2 Determining the Mean of the Eight Diameter Measurements

where:

- D* = apparent density, g/cm³,
- M* = mass, g, and
- V* = volume, cm³.

9. Report

9.1 Report the following information:

- 9.1.1 Type, source, and form of the original article.
- 9.1.2 Apparent densities of the individual specimens and the mean reported to the third decimal point (0.001 g/cc).

10. Precision and Bias³

10.1 *Precision*—The Interlaboratory Study (ILS) was conducted with 10 participating laboratories and 12 materials distributed in duplicate. The range of values of returned results was 1.45 g/cm³ to 1.68 g/cm³. The precision of this test method as determined by the statistical examination of the interlaboratory test results is as follows:

10.1.1 *Repeatability*—The difference between two independent results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would exceed the following value with an approximate probability of 5 % (one case in 20 in the long run) in the normal and correct operation of the test method:

$$\text{Repeatability, } r = 0.005 \text{ g/cm}^3 \tag{3}$$

10.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would exceed the following value with an approximate probability of 5 % (one case in 20 in the long run) in the normal and correct operation of the test method:

$$\text{Reproducibility, } R = 0.015 \text{ g/cm}^3 \tag{4}$$

³ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1318. Contact ASTM Customer Service at service@astm.org.