Designation: B873 – 17

Standard Test Method for Measuring Volume of Apparent Density Cup Used in Test Methods B212, B329, and B417[1]

This standard is issued under the fixed designation B873; 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 a procedure for measuring the volume of the apparent density cups used in Test Methods B212, B329, and B417.

1.2 The apparent density cup, particularly its rim, may become worn during use, and it is recommended that the volume of the cup be checked periodically (at least every 6 months) in order to ensure that it complies with the specified volume.

1.3 With the exception of the values for density and the mass used to determine density, for which the use of the gram per cubic centimetre (g/cm^3) and gram (g) units is the long standing industry practice, the values in SI units are to be regarded as standard.

1.4 *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.*

1.5 *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]

B212 Test Method for Apparent Density of Free-Flowing Metal Powders Using the Hall Flowmeter Funnel

B243 Terminology of Powder Metallurgy

B329 Test Method for Apparent Density of Metal Powders and Compounds Using the Scott Volumeter

B417 Test Method for Apparent Density of Non-Free-Flowing Metal Powders Using the Carney Funnel

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

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B243. Additional descriptive information is available in the Related Materials section of Vol 02.05 of the *Annual Book of ASTM Standards*.

4. Summary of Test Method

4.1 The apparent density cup is filled with water and weighed to obtain the mass of water contained, which is then converted to a volume.

5. Significance and Use

5.1 This test method enables the measurement of the volume of the apparent density cup to ensure that it complies with the specified volume of 25.00 ± 0.03 cm^3 (cylindrical cup), or 16.39 ± 0.05 cm^3 (square cup). Use of an out-of-specification cup will give erroneous apparent density values using the formulae in Test Methods B212, B329, and B417.

6. Apparatus

6.1 *Density Cup*—A cylindrical cup (see Fig. 1) designed to have a capacity of 25.00 ± 0.03 cm^3 (as in Test Methods B212, B329, and B417) or a square cup designed to have a capacity of 16.39 ± 0.05 cm^3 (as in Test Method B329).

6.2 *Balance,* readable to 0.0001 g with a minimum capacity of 200 g to be used for determining mass to the nearest 0.001 g.

6.3 *Microscope Slide*—A transparent microscope slide at least as wide as the outer diameter of the apparent density cup.

6.4 *Water*—Distilled or deionized water boiled to remove dissolved air.

6.5 *Alcohol*—Low residue ethyl alcohol.

6.6 *Wire*—A wire not exceeding 2.5 mm in diameter by 150 mm long.

[1] This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.02 on Base Metal Powders.

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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.

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

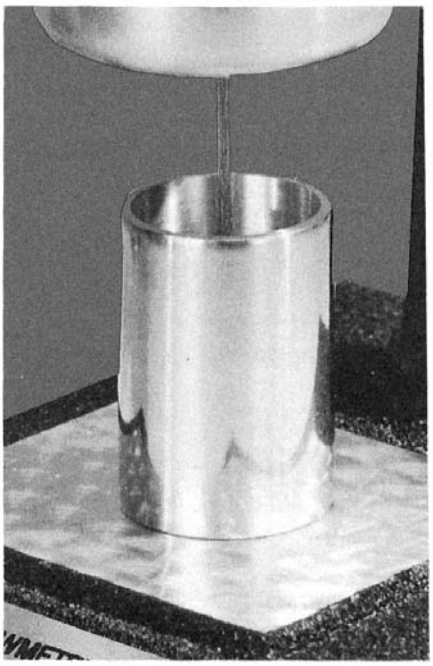

FIG. 1 Cylindrical Apparent Density Cup

6.7 *Thermometer*—A thermometer capable of measuring the temperature of the water to the nearest 1°C.

7. Procedure

7.1 Boil at least 150 mL of distilled or deionized water for 5 min to remove dissolved air. Cool to room temperature and handle so as to avoid the introduction of air bubbles.

7.2 Clean the density cup with alcohol and dry thoroughly.

7.3 Weigh the density cup along with a clean, clear microscope slide. This is the tare mass, *T*.

7.4 Fill the density cup with the prepared water until the water overflows.

7.5 Dislodge any air bubbles inside the density cup with a clean wire.

7.6 Slide the clean, clear microscope slide horizontally across the rim of the density cup, spilling the excess water over the sides of the cup and center the microscope slide on top of the cup.

7.7 If any air bubbles appear, remove the microscope slide and return to 7.4.

7.8 Dry the outside of the density cup and the exposed surfaces of the microscope slide with paper toweling. Ensure that the absorbency of the toweling does not wick water from inside the cup.

7.9 Weigh the dried density cup filled with water with the microscope slide on top. This is the gross mass, *G*.

7.10 Measure the temperature of the water to the nearest 1°C and determine the density of the water, ρ_w, from Table 1.

TABLE 1 Density of Air-Free Water[A]

Temperature (°C)	ρ_w, Density (g/cm^3)
15	0.9991
16	0.9989
17	0.9988
18	0.9986
19	0.9984
20	0.9982
21	0.9980
22	0.9978
23	0.9975
24	0.9973
25	0.9970
26	0.9968
27	0.9965
28	0.9962
29	0.9959
30	0.9956

[A] *Metrological Handbook 145*," Quality Assurance for Measurements," National Institute of Standards and Technology, 1990, p. 9, 10.

8. Calculation

8.1 Calculate the mass of water contained in the density cup from the following formula:

$$M = G - T \quad (1)$$

where:

M = mass of water in the density cup, g,
G = gross mass of density cup, plus water, plus microscope slide, g, and
T = tare mass of density cup plus microscope slide, g.

8.2 Calculate the volume of the density cup, *V*, from the following relationship:

$$V = \frac{M}{\rho_w} \quad (2)$$

where:

V = volume of the density cup, cm^3,
M = mass of water in the density cup, g, and
ρ_w = density of the water from Table 1, g/cm^3.

9. Report

9.1 Report the volume of the density cup to the nearest 0.01 cm^3.

10. Precision and Bias

10.1 The precision of this standard was developed by the Metal Powder Industries Federation (MPIF) and is used herein with their permission.

The repeatability limit (*r*) and reproducibility limit (*R*) of this test method were determined in 2014 by an interlaboratory study in which eight laboratories participated. Six laboratories supplied single data sets while one provided two sets and another three, making a total of eleven data sets. Three density cups were circulated to participants and three repetitions were performed for each cup. The data were analyzed using Practice E691 and the results are summarized in Research Report: MPPA-R-53-2014. A copy of the report is available from MPIF.

10.2 The repeatability limit (*r*), was found to be 0.02 cm^3 . Duplicate results from the same laboratory (individual determinations prior to averaging) should be considered acceptable at the 95% confidence level unless they differ by more than r, the repeatability limit.

10.3 The reproducibility limit (*R*), was found to be 0.04 cm^3 . Duplicate results from two different laboratories (individual determinations prior to averaging) should be considered acceptable at the 95% confidence level unless they differ by more than *R*, the reproducibility limit.

11. Keywords

11.1 apparent density cup; cup volume; density cup; measuring cup volume; volume of cup

SUMMARY OF CHANGES

Committee B09 has identified the location of selected changes to this standard since the last issue (B873 – 12) that may impact the use of this standard.

(1) Deleted "to the nearest 0.001 g" in Sections 7.3 and 7.9 to prevent rounding prior to calculation.

(2) Added a precision statement in Section 10.