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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Measuring Volume of Apparent Density Cup Used in Test Methods B 212, B 329, and B 417[1]

This standard is issued under the fixed designation B 873; 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 cup used in Test Methods B 212, B 329, and B 417.

1.2 The cylindrical cup, particularly its rim, may become worn during usage, and it is recommended that the volume of the cup be checked periodically (at least every 6 months) in order to ensure it complies with the specified volume of 25.00 ± 0.03 cm^3.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 212 Test Method for Apparent Density of Free-Flowing Metal Powders[2]

B 243 Terminology of Powder Metallurgy[2]

B 329 Test Method for Apparent Density of Metal Powders and Related Compounds Using the Scott Volumeter[2]

B 417 Test Method for Apparent Density of Non-Free-Flowing Metal Powders[2]

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B 243. 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. Use of an out-of-specification cup will give erroneous apparent density values using the formulae in Test Methods B 212, B 329, and B 417.

6. Apparatus

6.1 *Density Cup*—A cylindrical cup (see Fig. 1) designed to have a capacity of 25.00 ± 0.03 cm^3.

6.2 *Balance*, suitable for weighing at least 200 g 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.

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, to the nearest 0.001 g, 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, to the nearest 0.001 g, the dried density cup filled with water with the microscope slide on top. This is the gross mass, *G*.

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[1] This test method is under the jurisdiction of ASTM Committee B-9 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] *Annual Book of ASTM Standards*, Vol 02.05.

FIG. 1 Apparent Density Cup

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.

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 = gross mass of density cup, plus water, plus microscope slide, and
T = tare mass of density cup plus microscope slide.

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

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

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.

where:
V = volume of the density cup,
M = mass of water in the density cup, and
ρ_w = density of the water from Table 1.

9. Report

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

9.2 If the measured volume of the density cup falls within the specified range 25.00 ± 0.03 cm^3, it is permissible to use 25 cm^3 in the formula for calculating apparent density in Test Methods B 212, B 329, and B 417.

9.3 If the measured volume of the density cup falls outside the specified range of 25.00 ± 0.03 cm^3 but falls within the broader range of 24.8 to 25.2 cm^3 then the measured volume should be used in the formula for calculating apparent density in Test Methods B 212, B 329, and B 417.

10. Precision and Bias

10.1 The precision and bias of this test method is currently under development in Subcommittee B09.02 on Base Metal Powders.

11. Keywords

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