Designation: B417 – 13

Standard Test Method for Apparent Density of Non-Free-Flowing Metal Powders Using the Carney Funnel[1]

This standard is issued under the fixed designation B417; 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 determining the apparent density of non-free-flowing metal powders. It is designed for those metal powders that do not freely flow through the Hall flowmeter funnel.

1.2 With the exception of the values for density and the mass used to determine density, for which the use of the gram per cubic centimeter (g/cm^3) and gram (g) units is the long-standing industry practice, the values in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B215 Practices for Sampling Metal Powders

B243 Terminology of Powder Metallurgy

B873 Test Method for Measuring Volume of Apparent Density Cup Used in Test Methods B 212, B 329, and B 417

3. Terminology

3.1 *Definitions*—Terms in Terminology B243 are applicable to this test method.

4. Summary of Test Method

4.1 A volume of powder is permitted to flow into a container of definite volume under controlled conditions. The mass of powder per unit volume is determined and reported as apparent density, Carney (AD_C).

5. Significance and Use

5.1 This test method provides a guide for evaluation of an important physical characteristic of a powder known as the apparent density. The measured apparent density bears a relationship to the mass of powder that will fill a fixed volume die cavity. The degree of correlation between the results of this test and the performance of powders during use may vary with each particular application. Note, however, that the presence of moisture, oils, stearic acid, stearates, waxes, and the temperature of the powder mass may alter the physical characteristics of the powder.

6. Apparatus

6.1 *Powder Flowmeter*[3]—A Carney Flowmeter (Fig. 1).

6.2 *Density Cup*[3]—A cylindrical brass cup (Fig. 2) having a capacity of 25 cm^3. The actual cup volume shall be determined according to Test Method B873. If the measured volume of the cup is outside the tolerance in Fig. 2 (25 ± 0.03 cm^3) the cup shall not be used.

6.3 *Stand*—A stand (Fig. 1) to support the powder funnel concentric with the density cup so that the bottom of the powder funnel is approximately 25 mm (1 in.) above the top of the density cup when the apparatus is assembled as shown in Fig. 1.

6.4 *Workbench*—A level, vibration-free table or workbench to support the powder flowmeter stand.

6.5 *Balance,* readable to 0.001 g, with a minimum capacity of 200 g capable of determining the mass to the nearest 0.01 g.

6.6 *Wire,* approximately 2.5 mm (0.10 in.) in diameter by 150 mm (6 in.) in length.

[1] This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Productsand 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.

[3] The sole source of supply of the flowmeter funnel, density cup, and stand known to the committee at this time is ACu Powder International, LLC. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

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

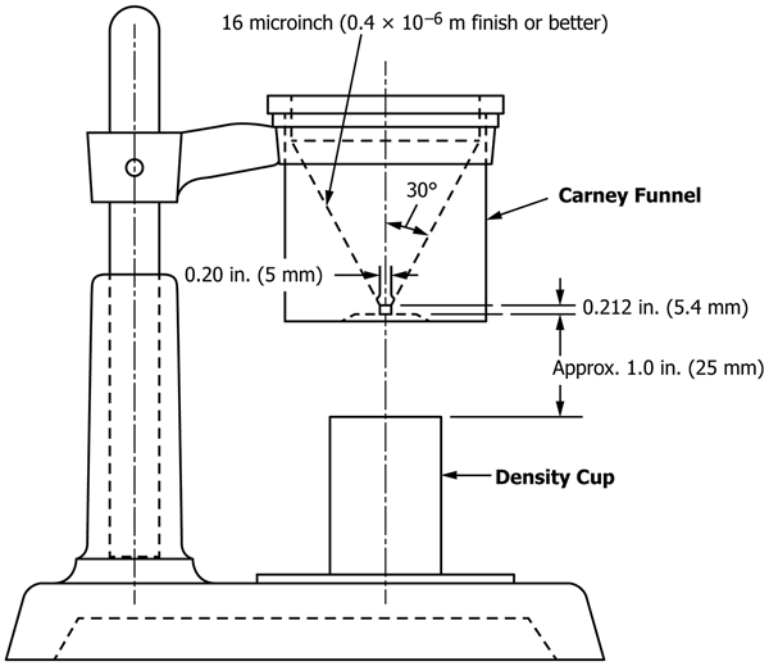

FIG. 1 Carney Flowmeter Funnel and Stand

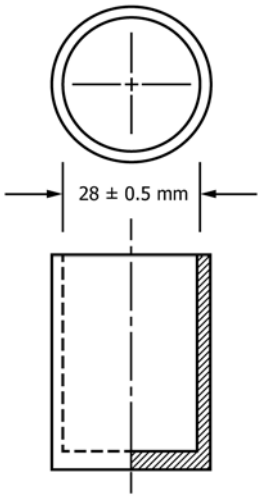

FIG. 2 Density Cup (25 ± 0.03 cm³)

6.7 *Spatula or straight edge*—A non-magnetic spatula or straight edge of suitable dimensions for leveling off the excess powder on top of the density cup.

7. Test Specimen

7.1 The test portion shall consist of a volume of approximately 30 to 40 cm^3 of metal powder obtained in accordance with Practices B215.

7.2 The test portion shall be tested as sampled. Note, however, that temperature, moisture, oils, stearic acid, stearates, waxes, and so forth may alter the characteristics of the powder.

8. Procedure

8.1 Weigh the empty density cup to the nearest 0.01 g or, alternatively, place the empty density cup on the balance and tare the balance to zero.

8.2 Load the test specimen carefully into the flowmeter funnel and permit it to run into the density cup through the discharge orifice. If necessary, it may be agitated or pushed by use of the length of wire but take care to prevent the wire from entering the density cup. The density cup should not be moved during the filling operation.

8.3 When the powder completely fills and overflows the periphery of the density cup, rotate the funnel approximately 90° in a horizontal plane so that the remaining powder falls away from the cup.

8.4 Using a nonmagnetic spatula, or straight edge, with the blade held perpendicular to the top of the cup, level off the powder flush with the top of the density cup. Take care to avoid jarring the apparatus at any time.

8.5 After the leveling operation, tap the density cup lightly on the side to settle the powder to avoid spilling in transfer.

8.6 Transfer the filled density cup to the balance and weigh to the nearest 0.01 g to determine the mass (*M*) of powder.

8.7 More than one apparent density test may be run if desired. Use a fresh test portion of powder for each test. Average the apparent density values.

9. Calculation

9.1 Calculate the apparent density as follows:

$$\text{Apparent density } AD_c,\ g/cm^3 = M/V \quad (1)$$

where:

M = mass of powder in the density cup in grams and
V = volume of the density cup in cubic centimetres.

10. Report

10.1 Report the results as apparent density, Carney (AD_c), to the nearest 0.01 g/cm^3.

11. Precision and Bias

11.1 *Precision*—The precision of this test method has not been determined by a statistically valid interlaboratory test. Results obtained by eight laboratories testing a sample of tin powder suggest the following:

11.1.1 *Repeatability r* = 1 % (tin powder)—Duplicate analysis of a tin powder by the same operator and same apparatus should not differ by more than 1 % at the 95 % confidence level.

11.1.2 *Reproducibility R* = 4 % (tin powder)—The difference between two single and independent results obtained by different operators working in different laboratories on tin powder should not differ by more than 4 % at the 95 % confidence level.

11.1.3 Measurement Uncertainty – The precision of Test Method B417 shall be considered by those performing the test when reporting Carney apparent density test results.

11.2 *Bias*—No information can be presented on the bias of the procedures in Test Methods B417 for measuring the Carney apparent density because no material having an accepted reference value is available.

12. Keywords

12.1 apparent density; Carney; flowmeter funnel; metal powders

SUMMARY OF CHANGES

Committee **B09** has identified the location of selected changes to this standard since the last issue (B417 – 11) that may impact the use of this standard.

(1) A statement has been added to Section 6.2 to indicate that if the measured volume of the cup is outside the tolerance in Fig. 2, the cup shall not be used.

(2) The dimension of the straight portion of the orifice has been changed in Fig. 1.