Designation: B212 – 17

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

This standard is issued under the fixed designation B212; 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 describes a procedure for determining the apparent density of free-flowing metal powders, and mixed powders; and is suitable for only those powders that will flow unaided through the specified Hall Flowmeter funnel.

1.2 With the exception of the values for mass, volume, and density, for which the use of the gram and the cubic centimetre units is the long-standing industry practice, the values stated 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.*

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]

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

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

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology B243. Additional descriptive PM 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 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, Hall (AD_H).

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 Funnel*[3]—A calibrated Hall Flowmeter funnel (Fig. 1).

6.2 *Density Cup*—A cylindrical brass cup (Fig. 2) having a nominal 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.

[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.

[3] The sole source of supply of the apparatus known to the committee at this time is ACuPowder International, LLC, 901 Lehigh Ave., Union, NJ 07083-7632. 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**

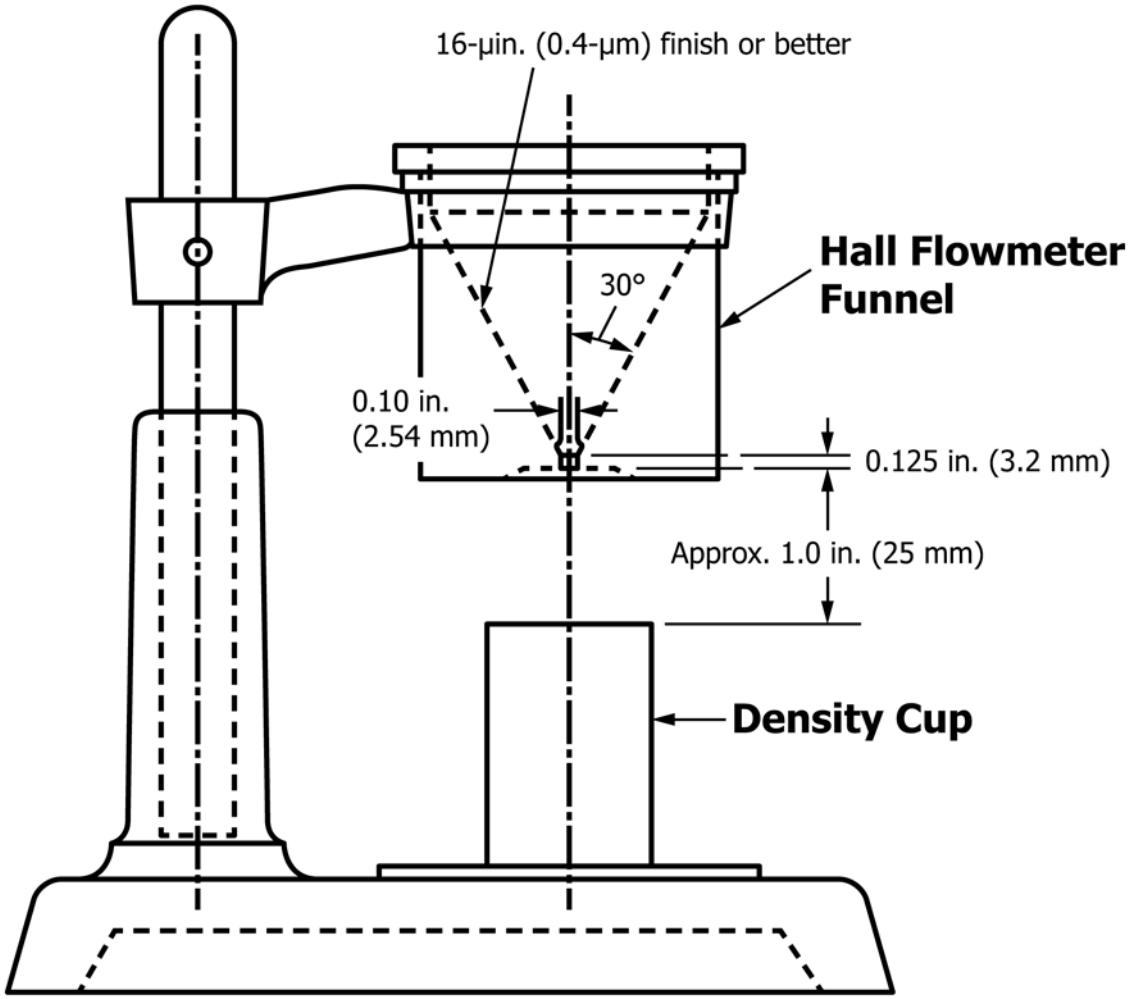

FIG. 1 Flowmeter Apparatus — Hall Funnel

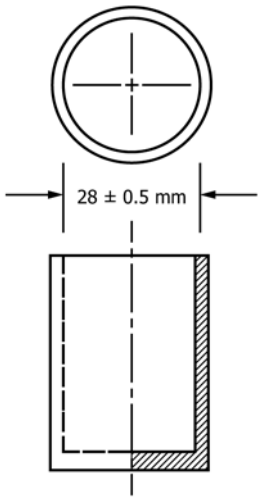

FIG. 2 Density Cup (25 ± 0.03 cm³)

6.3 *Stand*[3]—A stand (Fig. 1) to support the Hall Flowmeter funnel concentric with the density cup so that the bottom of the Hall Flowmeter funnel orifice is approximately 1 in. (25 mm) 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*—A balance, readable to 0.001 g, having a capacity of at least 200 g capable of determining the mass to the nearest 0.01 g.

6.6 *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 Portion

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.

8. Procedure

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

8.2 Carefully load the test portion into the flowmeter funnel and permit it to run into the density cup through the discharge orifice. Take care not to move the density cup.

8.3 After the powder has completely filled the cup and has begun to overflow 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 with the blade held perpendicular to the top edge 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 during transfer. Wipe off any powder sticking to the outside wall of the cup.

8.6 Transfer the filled density cup to the balance and weigh 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:

$$AD_H = \frac{M}{V} \quad (1)$$

where:

M = mass of powder in the density cup, g.
V = volume of the density cup, cm^3.
AD_H = apparent density, Hall, g/cm^3.

10. Report

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

11. Precision and Bias

11.1 An interlaboratory study of the Hall apparent density was conducted in 1992. The design of the study followed Practice E691. Unfortunately, details of the study were not summarized in a Research Report. Nevertheless, the precision of this test method as determined by the statistical examination of the interlaboratory test results is as follows:

11.1.1 *Repeatability limit, r* = 1.5%—Duplicate analyses of unlubricated or lubricated metal powders by the same operator and same apparatus should not differ by more than 1.5% at the 95% confidence level.

11.1.2 *Reproducibility limit, R* = 3% (unlubricated and lubricated iron powder), *R* = 5% (lubricated brass and bronze powders). The difference between two single and independent results obtained by different operators working in different laboratories on lubricated and unlubricated iron powders should not differ by more than 3% at the 95% confidence level. Analyses of lubricated brass and bronze metal powders should not differ by more than 5% at the 95% confidence level.

11.2 *Bias*—No information can be presented on the bias of the procedures in Test Methods B212 for measuring the Hall apparent density because no material having an accepted reference value is available.

11.3 *Measurement Uncertainty*—The precision of Test Method B212 shall be considered by those performing the test when reporting Hall apparent density test results.

12. Keywords

12.1 apparent density; Hall flowmeter funnel; metal powders

SUMMARY OF CHANGES

Committee B09.02 has identified the location of selected changes to this standard since the last issue (B212 – 13) that may impact the use of this standard. (Approved April 1, 2017.)

(1) Section 6.1 has been changed to reflect the use of a calibrated flowmeter funnel rather than orifice.
(2) The text "to the nearest 0.01 g" has been deleted in sections 8.1 and 8.2. The mass shall be determined using a balance that is readable to 0.001 g, as indicated in Section 6.5, and the values determined shall not be rounded until the AD has been calculated.

(3) The word "limit" has been added after repeatability and reproducibility in sections 11.1.1 and 11.1.2 respectively.