



Standard Test Method for Apparent Density of Powders Using Arnold Meter¹

This standard is issued under the fixed designation B 703; 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 both free- and non-free-flowing powders, premixes, and blended mixes.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

B 212 Test Method for Apparent Density of Free-Flowing Metal Powders Using the Hall Flowmeter Funnel

B 215 Practices for Sampling Metal Powders

B 243 Terminology of Powder Metallurgy

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

B 417 Test Method for Apparent Density of Non-Free-Flowing Metal Powders Using the Carney Funnel

3. Terminology

3.1 *Definitions*—Useful definitions of terms for metal powders and powder metallurgy are found in Terminology **B 243**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Arnold Density Meter*—This instrument enables the user to determine the density of any powder or mix, whether or not the powder has flow characteristics. It simulates the action of the feed shoe of the press. The values obtained on metal powders are approximately 0.2 g/cm³ higher than those obtained with the Hall, Test Method **B 212**; Carney, Test Method **B 417**; or Scott, Test Method **B 329**, instruments.

4. Summary of Test Method

4.1 This test method consists of slowly sliding a bushing partially filled with powder over a hole in a hardened steel block, collecting and weighing the powder, and calculating its apparent density.

5. Significance and Use

5.1 The apparent density is an important measure of a material characteristic inherent in the powder that is useful to the powder producers and end users in determining lot to lot consistency. Knowledge of the apparent density of the final mix as obtained with this test method is very beneficial to the powder metallurgy (P/M) parts fabricator for setting compression ratios for fixed fill die cavities.

5.2 This test method may be part of a purchase agreement between the powder supplier and P/M parts producer, or it may be an internal quality control test for either party.

6. Apparatus

6.1 *Steel Block*³—A hardened, tempered, and demagnetized steel block (60 HRC Min.) having a center hole 31.6640 ± 0.0025 mm (1.2466 ± 0.0001 in.) in diameter and a height of 25.4000 ± 0.0025 mm (1.0000 ± 0.0001 in.) that corresponds to a volume of 20 cm³ (1.22 in.³) (**Fig. 1**).

6.2 *Bushing*³, either brass or bronze, approximately 38 mm (1.50 in.) inside diameter (ID) by 45 mm (1.75 in.) outside diameter (OD) by 38 mm long (**Fig. 1**).

6.3 *Weighing Paper*—A sheet of cellophane or glazed or waxed paper measuring approximately 150 by 150 mm square (6.0 by 6.0 in.).

6.4 *Balance*—A balance having a capacity of at least 200 g suitable for weighing to 0.01 g.

7. Sampling

7.1 Obtain a test sample in accordance with Practices **B 215**.

7.2 The powder sample shall be of sufficient volume to fill the bushing to about three quarters of its height.

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 Arnold Density Meter complete with bushing known to the committee at this time is Arnold P/M Consulting Services, 648 Cedar Road, St. Marys, PA 15857. 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.

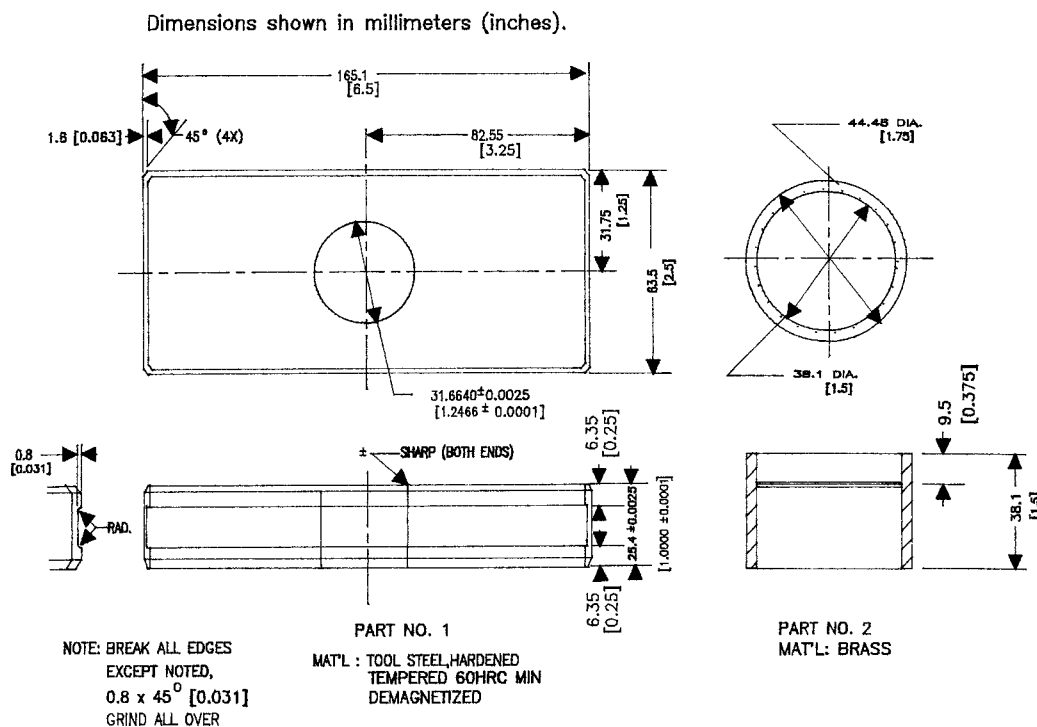


FIG. 1 Arnold Apparent Density Meter

8. Preparation of Apparatus

8.1 Clean the steel block and bushing thoroughly to eliminate any loose powder particles.

9. Procedure

9.1 Place the steel block on a sheet of preweighed or tared paper.

9.2 Place the bushing on the steel block, on either side of the hole.

9.3 Fill the bushing slowly and carefully to three-quarters of its height with powder. (An inscribed ring on the ID of the bushing indicates the proper fill height.)

9.4 With downward pressure on the bushing, slowly slide the bushing toward the hole while twisting it. This gives a snowplow action to the powder as it falls slowly into the hole. Continue this motion until the bushing passes the hole. Stop, and again with downward pressure on the bushing, slide it straight back over the hole to its starting position. The sliding action must be slow enough to permit complete filling of the steel block cavity.

9.5 Remove the steel block from the preweighed paper being careful not to tip the block and spill additional powder on to the paper.

9.6 Transfer the pre-weighed or tared paper to a balance and weigh. Calculate the density from the following equation:

$$\text{Apparent Density, g/cm}^3 = \frac{\text{Mass in grams}}{20 \text{ cm}^3} \quad (1)$$

10. Report

10.1 Report the apparent density to the nearest 0.01 g/cm³. To minimize confusion with other test methods, report as Apparent Density, Arnold, g/cm³.

11. Precision and Bias

11.1 *Precision*—Precision has been determined from an interlaboratory study performed by Subcommittee B09.02.

11.1.1 *Apparent Density Using the Arnold Meter:*

$$\text{Repeatability } r = 0.08 \text{ g/cm}^3 \quad (2)$$

11.1.2 In 95 % of such tests, on the basis of test error alone, duplicate tests in the same laboratory by the same operator, on one homogeneous lot of powder, will differ by no more than the stated amount.

$$\text{Reproducibility } R = 0.15 \text{ g/m}^3 \quad (3)$$

11.1.3 For 95 % of comparative trials done in two different laboratories and on the basis of test error alone, a single test on the same homogeneous lot of powder will differ by no more than the stated amount.

11.2 *Bias*—No bias statement can be made because there is no accepted standard or reference powder for apparent density.

12. Keywords

12.1 apparent density, Arnold Density, density of non-free-flowing powders, metal powders



SUMMARY OF CHANGES

Committee B09 has identified the location of selected changes to this standard since the last issue, B 703 – 94 (1999)^{e1}, that may impact the use of this standard. (Approved Oct. 1, 2005.)

- (1) Revised 3.2.1, Arnold Density Meter.
- (2) Revised 5.1, Significance and Use.

- (3) Revised 9.4, Procedure.

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