Designation: B 703 – 94 (Reapproved 1999)ε1

Standard Test Method for Apparent Density of Powders Using Arnold Meter[1]

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.

ε[1] NOTE—An editorial change was made in 9.4 in September 1999.

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:*

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

B 215 Practices for Sampling Finished Lots of Metal Powders[2]

B 243 Terminology of Powder Metallurgy[2]

B 329 Test Method for Apparent Density Powders of Refractory Metals and Compounds by Scott Volumeter[2]

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

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 duplicates the action of the fill shoe of the press, consequently the values obtained on metal powders are approximately 0.2 g/cm^3 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, which is useful to the powder producers as well as 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 manufacturer and P/M parts producer, or it may be an internal quality control test for either party.

6. Apparatus

6.1 *Test 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.) and a height of 25.4000 ± 0.0025 mm (1.0000 ± 0.0001 in.) that corresponds to a volume of 20 cm^3 (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.

8. Preparation of Apparatus

8.1 Clean test block and bushing thoroughly to eliminate

[1] This specification is under the jurisdiction of ASTM Committee B-9 on Metal Powders and Metal Powder Productsand 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.

[3] The Arnold Density Meter complete with bushing is available from Arnold P/M Consulting Services, 648 Cedar Road, St. Marys, PA 15857. Also available from Alcan Powders & Pigments, 901 Lehigh Avenue, Union NJ 07083-7632.

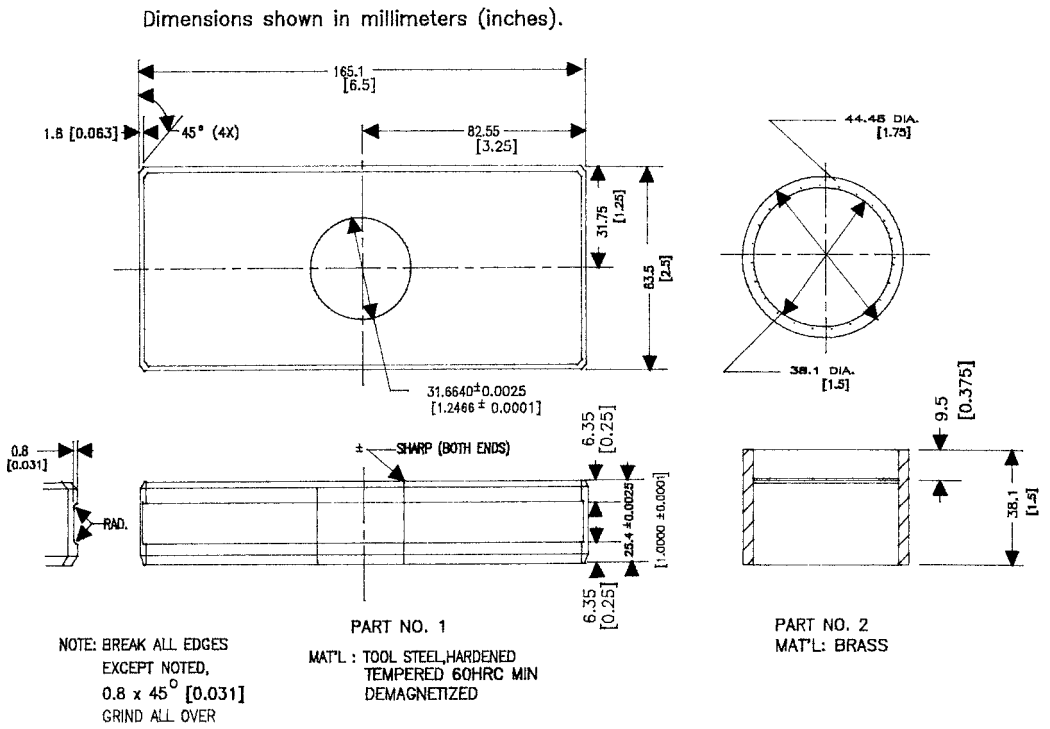

FIG. 1 Arnold Apparent Density Meter

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 block, on either side of the hole.

9.3 Fill the bushing slowly and carefully to three-quarters of its height with powder. (A 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 allow for 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 preweighed 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/cm ^{3}. To minimize confusion with other test methods, report as Arnold Density, g/cm^3.

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