



Designation: B527 – 23

Standard Test Method for Tap Density of Metal Powders and Compounds¹

This standard is issued under the fixed designation B527; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This test method specifies a method for the determination of tap density (packed density) of metal powders and compounds, that is, the density of a powder that has been tapped, to settle contents, in a container under specified conditions.

1.2 *Units*—With the exception of the values for density and the mass used to determine density, for which the use of the gram per cubic centimetre (g/cm^3) and gram (g) units is the long-standing industry practice, the values in SI units are to be regarded as 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, health, and environmental 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

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

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

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 B09.03 on Refractory 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. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology B243. Additional descriptive PM information is available in the *Committee Documents* section of the B09 Committee web page.

4. Significance and Use

4.1 This test method covers the evaluation of the tap density physical characteristic of metal powders and related compounds. The measured tap density bears a relationship to the mass of powder that will fill a fixed volume die cavity or other container in situations where the container is tapped, vibrated, or otherwise agitated. The degree of correlation between the results of this test method and the quality of powders in use will vary with each particular application and has not been fully determined.

5. Apparatus

5.1 *Balance*, of appropriate capacity to satisfy the requirements shown in Table 1 and accuracy of ± 0.05 g.

5.2 *Graduated Glass Cylinder*, calibrated to contain 100 cm^3 at 20°C , the height of the graduated portion being approximately 175 mm. The graduations shall be at 1 cm^3 intervals, thus allowing a measuring accuracy of $\pm 0.5\text{ cm}^3$. For apparent densities equal to or greater than $4\text{ g}/\text{cm}^3$, do not use the 100 cm^3 cylinder; see 5.2.1.1.

5.2.1 Alternatively, the following may be used:

5.2.1.1 *Graduated Glass Cylinder*, calibrated to contain 25 cm^3 at 20°C , the height of the graduated portion being approximately 135 mm. The graduations shall be at 0.2 cm^3 intervals, thus allowing a measuring accuracy of $\pm 0.1\text{ cm}^3$.

5.2.1.2 A 25 cm^3 cylinder shall be used for powders of apparent density equal to or greater than $4\text{ g}/\text{cm}^3$, in particular for refractory metal powders.

5.3 *Tapping Apparatus*, which permits the tapping of the graduated cylinder against a firm base. The tapping shall be such that a densification of the powder can take place without any loosening of its surface layers. The stroke shall be 3 mm and the tapping frequency shall be between 100 and 300 taps/min. An example of a tapping apparatus is shown in Fig. 1.

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

TABLE 1 Capacity and Accuracy of the Test Portion Mass and Graduated Cylinder

Apparent Density g/cm ³	Mass of Test Portion g	Cylinder Capacity cm ³	Cylinder Graduations cm ³	Measuring Accuracy ±cm ³
<1	50 ± 0.2	100	1	0.5
1 to <4	100 ± 0.5	100	1	0.5
≥4	100 ± 0.5	25	0.2	0.1

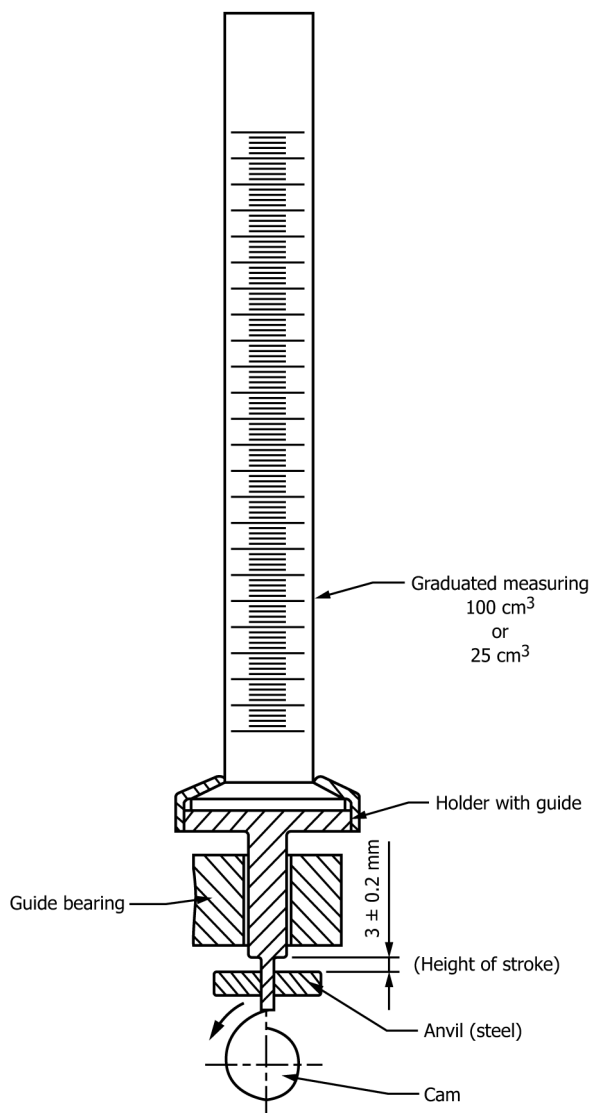


FIG. 1 Example of Tapping Apparatus

6. Test Specimen

6.1 For the quantities of powder required for each test, see **Table 1**. Obtain test portions according to Practices **B215**.

6.2 In general, the powder should be tested in the as-received condition. In certain instances, the powder may be dried. However, if the powder is susceptible to oxidation, the drying shall take place in a vacuum or in inert gas. If the powder contains volatile substances other than water, it shall not be dried.

6.3 The test shall be carried out on three test portions, if possible.

7. Procedure

7.1 Clean the inside wall of the graduated cylinder (see **5.2**) with a suitable clean brush or, if necessary, by rinsing with a solvent, such as acetone. If a solvent is used, thoroughly dry the cylinder before reuse.

7.2 Weigh, to the nearest 0.1 g, the mass of the test portion as indicated in **Table 1**, using a balance (see **5.1**).

7.3 Pour the test portion into the graduated cylinder. Take care that a level surface of the powder is formed. Place the cylinder in the tapping apparatus (see **5.3**). Tap the cylinder until no further decrease in the volume of the powder takes place (see **Note 1**).

NOTE 1—In practice, the minimum number of taps, N , such that no further change in volume takes place would be determined. For all further tests on the same type of powder, the cylinder would be subjected to $2N$ taps, except where general experience and acceptance have established a specific number of taps (no less than N taps) as being satisfactory. For fine refractory metal powders, 3000 taps has been found to be satisfactory for all sizes.

7.4 If the tapped surface is level, read the volume directly. If the tapped surface is not level, determine the tap volume by calculating the mean value between the highest and the lowest reading of the tapped surface. Read the final volume to the nearest 0.5 cm³ when using a 100 cm³ cylinder and to the nearest 0.1 cm³ when using a 25 cm³ cylinder.

8. Calculation

8.1 The tap density is given in the following equation

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

where:

TD = tap density, g/cm³,
 M = mass of powder, g, and
 V = volume of tapped powder, cm³.

9. Report

9.1 Report the following information:

- 9.1.1 Reference to this test method;
- 9.1.2 All details necessary for identification of the test sample;
- 9.1.3 The drying procedure, if the powder has been dried;
- 9.1.4 Cylinder capacity, mass of test portion, and method used;
- 9.1.5 All results obtained. Report tap density to the nearest 0.1 g/cm³ for powders with apparent densities up to and including 8 g/cm³. For powders with apparent densities higher than 8 g/cm³, report to the nearest 0.2 g/cm³;
- 9.1.6 All operations not specified in this test method or regarded as optional; and
- 9.1.7 Details of any occurrence that may have affected the result.

10. Precision and Bias

10.1 The precision of this test method is based on an interlaboratory study of Test Method B527 conducted in 2018,