



Standard Test Method for Volumetric Flow Rate of Metal Powders Using Arnold Meter and Hall Funnel¹

This standard is issued under the fixed designation B 855; 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 measuring the flow characteristics of a given volume of powder.

1.2 The values stated in SI units are to be regarded as the standard (except for the Hall Flowmeter Funnel, which is produced in inch-pound units). 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 213 Test Method for Flow Rate of Metal Powders

B 215 Practices for Sampling Metal Powders

B 243 Terminology of Powder Metallurgy

B 703 Test Method for Apparent Density of Powders Using Arnold Meter

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 *volumetric flow rate*—the time required for a given volume of powder to flow through an orifice in a standard instrument according to a specified procedure.

4. Summary of Test Method

4.1 This test method consists of slowly sliding a bushing partially filled with powder over a 20 cm³ hole in a hardened steel block. The volume of the powder obtained upon removal

of the steel block is transferred to a Hall Flowmeter and the flow rate reported in seconds per 20 cm³.

5. Significance and Use

5.1 The volumetric flow rate is a measure of the flow characteristics of a metal powder. Measuring flow by volume as compared with flow per unit mass eliminates the variable of the powder density.

5.2 The ability of a powder to flow and pack is a function of interparticle friction. As the surface area increases, the amount of friction in a powder mass also increases. Consequently, the friction between particles increases, giving less efficient flow and packing.

5.3 Knowledge of the volumetric flow permits the number of parts that can be made per hour to be estimated.

5.4 This test method may be part of the purchase agreement between powder manufacturers and powder metallurgy (P/M) part producers, or it can be an internal quality control test by either the producer or the end user.

6. Apparatus

6.1 *Arnold Density Meter*³—(Test Method **B 703**) a hardened, tempered, and demagnetized steel block 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*—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 (1.50 in.) long (**Fig. 1**).

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.

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.

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

 **B 855 – 06**

Dimensions shown in millimeters (inches).

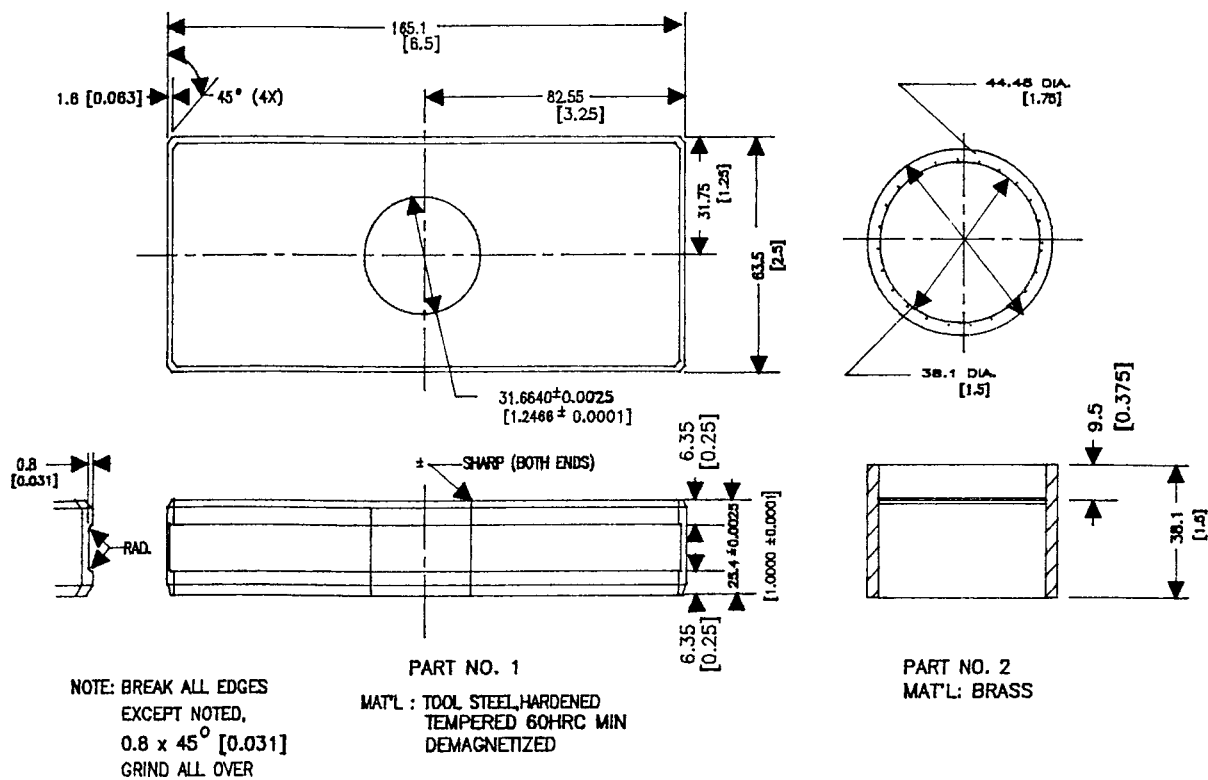


FIG. 1 Arnold Apparent Density Meter

6.3 *Hall Flowmeter*⁴—(Test Method B 213) A standard flowmeter funnel having a calibrated orifice of 0.10 in. (2.54 mm) in diameter complete with stand (Fig. 2).

6.4 *Base*—A level, vibration-free base to support the Hall Flowmeter.

6.5 *Paper*—Glazed or waxed paper measuring approximately 150 mm by 150 mm square (6.0 in. by 6.0 in.).

6.6 *Timing Device*—Stopwatch or other suitable device.

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 three-quarters of its height.

8. Preparation of Apparatus

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

9. Procedure

9.1 Place the steel block on a sheet of glazed or waxed paper.

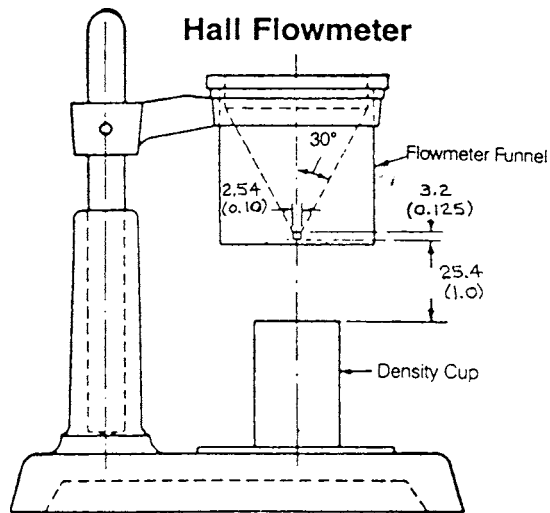


FIG. 2 Hall Flowmeter

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 towards 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,

⁴ The sole source of supply of the complete Hall Flowmeter known to the committee at this time is ACuPowder International LLC, 901 Lehigh Avenue, 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.

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 paper, being careful not to tip the block and spill additional powder on to the paper.

9.6 The volumetric flow rate of the 20 cm³ of powder may be determined using either of the following methods:

9.6.1 *Method 1—Stationary Powder Start to Flow Measurement:*

9.6.1.1 Block the discharge orifice at the bottom of the flowmeter funnel with a dry finger.

9.6.1.2 Carefully pour the 20 cm³ of powder from the paper into the center of the flowmeter funnel without any tapping, vibration, or movement of the funnel.

9.6.1.3 Place an empty weighing dish under the discharge orifice.

9.6.1.4 Simultaneously start the stopwatch and remove your finger from the discharge orifice.

9.6.1.5 If the powder fails to start flowing, one light tap on the funnel rim is permitted. Further tapping of the funnel, however, or poking or stirring of the powder in the funnel with a wire or any other implement is not permitted.

9.6.1.6 Stop the stopwatch the instant the last of the powder exits the orifice.

9.6.1.7 Record the elapsed time to the nearest 0.1 s.

9.6.1.8 More than one flow may be run if desired. Use 20 cm³ of fresh powder for each flow test. Average the flow times.

9.6.2 *Method 2—Moving Powder Start to Flow Measurement:*

9.6.2.1 Place an empty receptacle directly under the discharge orifice.

9.6.2.2 Carefully pour the 20 cm³ of powder into the center of the funnel and start the stopwatch the instant the powder exits the orifice.

9.6.2.3 Stop the stopwatch the instant the last of the powder exits the orifice.

9.6.2.4 Record the elapsed time to the nearest 0.1 s.

9.6.2.5 More than one flow may be run if desired. Use 20 cm³ of fresh powder for each flow test. Average the flow times.

10. Report

10.1 Multiply the flow time by the correction factor⁵ and report the results to the nearest second as the Arnold/Hall flow rate (s/20 cm³).

11. Precision and Bias

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

11.1.1 *Volumetric Flow Rate Using the Arnold Meter and the Hall Funnel:*

Repeatability $r = 1 \text{ s (iron), } 2 \text{ s (lubricated bronze and brass)}$ (1)

11.1.1.1 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.

Reproducibility $R = 2 \text{ s (iron), } 3 \text{ s (lubricated bronze and brass)}$ (2)

11.1.1.2 For 95 % of comparative trials done in two different laboratories and on the basis of test error alone, single tests 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 volumetric flow.

12. Keywords

12.1 Arnold/Hall flow; interparticle friction; metal powders; volumetric flow rate

⁵ The correction factor is a value supplied by the manufacturer of the funnel using a standardized powder. Periodically, the funnel must be calibrated with the standard powder to compensate for orifice wear. For the calibration procedure refer to Test Method B 213.

SUMMARY OF CHANGES

Committee B09 has identified the location of selected changes to this standard since the last issue, B 855 – 94 (1999)^{e1}, that may impact the use of this standard. (Approved July 1, 2006.)

(1) Revised the following sections: 5.1, 5.3, 8.1, and 9.4.

(2) Revised Footnote 4.

(3) Deleted previous sections 9.6 and 9.7 and listed two methods that may be used for flow measurement in a revised 9.6.

(4) Indicated in 10.1 that the results are to be reported to the nearest second.



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