Designation: B855 – 22

Standard Test Method for Volumetric Flow Rate of Metal Powders Using the Arnold Meter and Hall Flowmeter Funnel[1]

This standard is issued under the fixed designation B855; 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 laboratory procedure for the quantitative determination of the flow rate of a specific volume of a free-flowing metal powder or lubricated powder mixture.

1.2 *Units*—With the exception of the values for mass, volume, and density, for which the use of the gram and the cubic centimetre unit is 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, 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]

B213 Test Methods for Flow Rate of Metal Powders Using the Hall Flowmeter Funnel

B215 Practices for Sampling Metal Powders

B243 Terminology of Powder Metallurgy

B703 Test Method for Apparent Density of Metal Powders and Related Compounds Using the Arnold Meter

E456 Terminology Relating to Quality and Statistics

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

2.2 *MPIF Standard*[3]

MPIF Standard 48 Determination of Apparent Density of Metal Powders using the Arnold Meter

3. Terminology

3.1 *Definitions*—Useful definitions of terms for metal powders and powder metallurgy used in this test method are found in Terminology B243. Additional descriptive PM information is available under "General Information on PM" on the B09 web page.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *volumetric flow rate, n*—the relation between time and volume of a free-flowing metal powder determined by measuring the time for a specific volume to flow through the orifice in a Hall Flowmeter Funnel and expressing the ratio in seconds per 20 cubic centimetres (s/20 cm^3).

4. Summary of Test Method

4.1 A 20 cm^3 test portion of powder is prepared from the lot to be tested following the procedures in Test Methods B215 and B703.

4.2 This 20 cm^3 test portion is timed as it flows through the orifice in a Hall Flowmeter Funnel following the procedure in Test Method B213.

4.3 The volumetric flow rate is calculated and reported in seconds per 20 cubic centimetres (s/20 cm^3).

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 compared with flow per unit mass eliminates the variable of the powder density and relates to the production practice of die filling by volume.

5.2 The ability of a powder to flow and pack is a function of interparticle friction. As the surface area increases, the amount

[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] Available from ASTM or Metal Powder Industries Federation, 105 College Road East, Princeton, NJ 08540 and initially reported in MPIF Standard 48

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

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 rate permits the part producer to estimate the number of parts that can be compacted per hour.

5.4 This test may be part of the purchase agreement between metal powder producers and powder metallurgy (PM) part producers, or it can be an internal quality control test for any company using metal powders.

6. Apparatus

6.1 *Workbench*—A level, vibration-free table or laboratory workbench to support the Arnold Meter and the Hall Flowmeter apparatus.

6.2 *Arnold Meter*[4]—The steel die block and powder delivery cylinder described in Test Method B703 that is used to obtain the 20 cm^3 test portion of powder.

6.3 *Collection Paper*—A 6 by 6 in. square sheet of glazed or waxed paper (~150 by 150 mm) used to collect the 20 cm^3 test portion of powder from the die block of the Arnold Meter.

6.4 *Powder Scoop*—A small nonmagnetic spoonlike laboratory utensil with handle, having a minimum capacity of 25 cm^3, used for the controlled transfer of the 20 cm^3 test portion of powder from the collection paper into the Hall Flowmeter Funnel.

6.5 *Hall Flowmeter Funnel*[5]—A calibrated Hall flowmeter funnel having a nominal orifice of 0.10 in. (2.5 mm) with support stand as is shown in Test Method B213. The funnel is stamped with a correction factor determined by the manufacturer using a Certified Flow Standard.

6.6 *Timing Device*—A stopwatch or other instrumentation capable of measuring the flow time of the powder to the nearest 0.1 s.

7. Sampling

7.1 Obtain a sample of approximately 150 cm^3 from the lot that is to be tested following the procedure in Practices B215.

7.2 Using a micro-sample rotary riffler or a micro-splitter, divide the quantity into three samples of approximately 50 cm^3 each.

8. Procedure

8.1 Using the Arnold Meter and one of the 50 cm^3 samples, follow the procedure described in Test Method B703 to prepare an exact 20 cm^3 test portion of powder.

8.2 Using the scoop to carefully pour the sample into the center of the funnel, determine the time required for the powder to flow through the funnel following either of the procedures described in Test Method B213.

8.3 Repeat 8.1 and 8.2 two more times, using a new 50 cm^3 test portion each time, and record each of the three flow time determinations to the nearest 0.1 s.

9. Calculation

9.1 Average the three flow times, multiply by the Correction Factor[6] for the funnel being used, and calculate the Arnold/Hall Volumetric Flow Rate in s/20 cm^3 units as follows:

Arnold/Hall Flow Rate, s/20 cm^3=

$$\frac{Avg.\ flow\ time \times Funnel\ Correction\ Factor}{20\ cm^3} \quad (1)$$

10. Report

10.1 Report the Arnold/Hall Volumetric Flow Rate as the average of three determinations in s/20 cm^3 units rounded to the nearest second.

10.2 Report the B213 Flow Method, Static or Dynamic, that was used.

11. Precision and Bias

11.1 *Interlaboratory Test Program*—An interlaboratory study of the Arnold/Hall Volumetric Flow Rate test method was conducted by ASTM Subcommittee B09.02 in 1991 in conjunction with the Metal Powder Producers Association of the Metal Powder Industries Federation. Each of eight laboratories tested three randomly drawn test portions of both an iron powder and a lubricated bronze powder mixture. The design of the study followed Practice E691, and within-between analysis of the data are given in MPIF research report MPPA-R-48-00.

11.2 *Test Results*—The repeatability information presented was calculated based on individual determinations prior to averaging. The reproducibility information was calculated for the comparison of two test results, each of which was the average of three individual test determinations.

11.3 *Precision*—The 95 % repeatability limit, *r*, as defined by Terminology E456, is 1 s for the iron powder and 2 s for the lubricated bronze powder mixture. The repeatability was determined based on three individual tests in each laboratory before averaging. The reproducibility, *R*, as defined by Terminology E456, is 2 s for the iron powder and 3 s for the lubricated bronze powder mixture. The reproducibility was based on the standard deviation of the average of three determinations in each laboratory.

11.4 *Bias*—No information can be presented on the bias of the procedure in Test Method B855 for measuring the Arnold/Hall Volumetric Flow Rate because no material having an accepted reference value is available.

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[4] 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.

[5] 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.

[6] The correction factor is a value supplied by the manufacturer of the funnel using a Certified Flow Standard.. Periodically, the funnel must be calibrated with the standard powder to compensate for orifice wear. For the calibration procedure. refer to Test Method B213.