
**Metallic powders — Determination
of flow rate by means of a calibrated
funnel (Hall flowmeter)**

*Poudres métalliques — Détermination du temps d'écoulement au
moyen d'un entonnoir calibre (appareil de Hall)*

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Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Apparatus	1
6 Calibration of the funnel	3
6.1 Calibration by the manufacturer of the funnel	3
6.2 Calibration by the user of the funnel	3
7 Sampling	4
7.1 General	4
7.2 Test sample weight	4
7.3 Test portion weight	4
7.4 Number of test portions	4
8 Procedure	4
9 Expression of results	4
10 Precision	5
11 Test report	5
Bibliography	7

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 2, *Sampling and testing methods for powders (including powders for hardmetals)*.

This fifth edition, which cancels and replaces the fourth edition (ISO 4490:2014), has been revised to include a precision statement together with some other minor clarifications.

Metallic powders — Determination of flow rate by means of a calibrated funnel (Hall flowmeter)

1 Scope

This document specifies a method for determining the flow rate of metallic powders, including powders for hard metals, by means of a calibrated funnel (Hall flowmeter).

The method is applicable only to powders which flow freely through the specified test orifice.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Principle

Measurement of the time required for 50 g of a metallic powder to flow through the orifice of a calibrated funnel of standardized dimensions.

5 Apparatus

5.1 Calibrated funnel, the dimensions of which are shown in [Figure 1](#). The funnel shall be made of a non-magnetic, corrosion-resistant metallic material with sufficient wall thickness and hardness to withstand distortion and excessive wear.

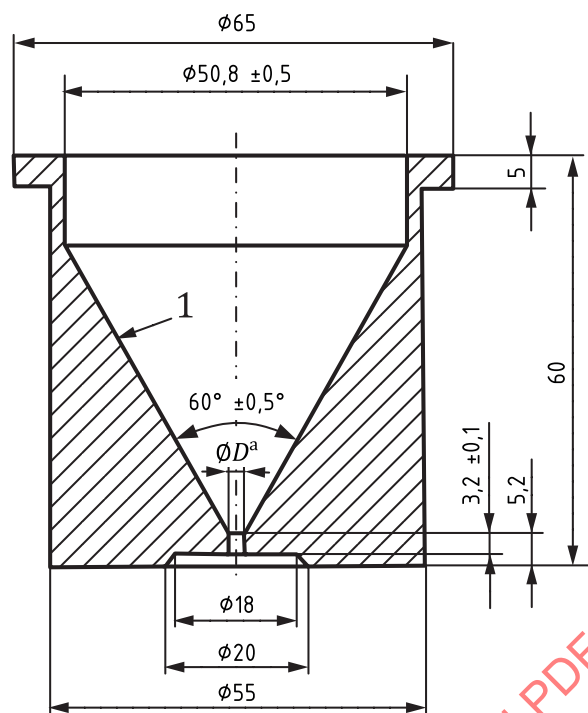
5.2 Stand and horizontal vibration-free base, which shall support the funnel rigidly. An example is shown in [Figure 2](#).

5.3 Balance of sufficient capacity, capable of weighing the test portion to an accuracy of $\pm 0,05$ g.

5.4 Timing device, capable of measuring the elapsed time to an accuracy of $\pm 0,1$ s.

5.5 Reference grit, a reference powder¹⁾ used for calibration of the funnel, shall be used.

1) Material complying with [5.5](#) can be purchased as “Chinese emery grit” from ACuPowder International, LLC, 901 Lehigh Avenue, Union, NJ 07083, USA. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the company named above. Equivalent products may be used if they can be shown to lead to the same results.

**Key**

1 polished to $R_a \leq 0,4 \mu\text{m}$

a $D = 2,5^{+0,4}_0$.

Figure 1 — Calibrated funnel (Hall flowmeter)

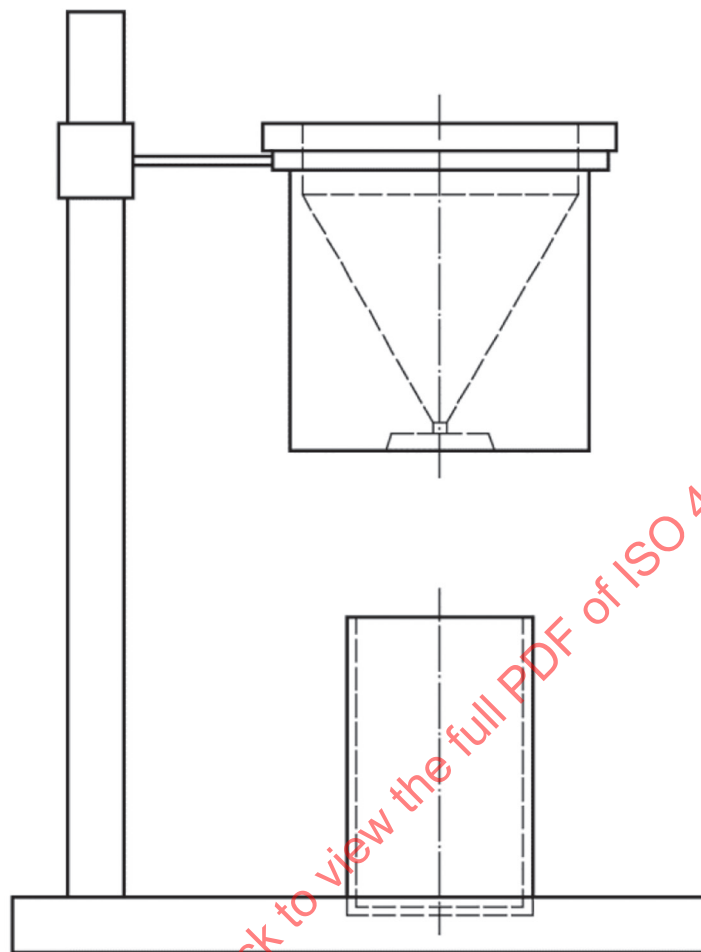


Figure 2 — Arrangement of calibrated funnel and stand

6 Calibration of the funnel

6.1 Calibration by the manufacturer of the funnel

The manufacturer shall supply the flowmeter calibrated as follows.

- Dry the reference grit (5.5) in an open and clean glass jar at 110 °C for 60 min in air.
- Cool the reference grit to room temperature in a desiccator.
- Weigh out 50 g $\pm$ 0,1 g of the reference grit.
- Follow the procedure outlined in Clause 8.
- Repeat the procedure with the same 50 g mass of reference grit, until there are five determinations within 0,4 s.
- The average of these five determinations is stamped on the bottom of the funnel and the duration of flow shall be within 40,0 s $\pm$ 0,5 s.

6.2 Calibration by the user of the funnel

It is recommended that the users periodically verify whether a correction is needed or not.

The flow rate of the reference sample shall be determined by the above method. If the flow rate has changed to be outside $40,0 \text{ s} \pm 0,5 \text{ s}/50 \text{ g}$, a correction factor shall be used when measuring different powders. This correction factor is obtained by dividing 40,0 by the value obtained above.

It is recommended that, before a correction factor is adopted, the cause of the change be investigated. If the flow rate has decreased, it is probable that repeated use has burnished the orifice and a (new) correction factor is justified. An increase in flow rate may indicate a coating of soft powder on the orifice. This coating should be carefully removed and the calibration test repeated.

It is recommended that the use of a funnel be discontinued after the duration of flow of the reference sample has decreased to less than 37 s.

7 Sampling

7.1 General

In general, the powder shall be tested in the as-received condition. In certain cases, and after agreement between the supplier and user, 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, it shall not be dried.

7.2 Test sample weight

The mass of the test sample shall be at least 200 g.

7.3 Test portion weight

Immediately before the test, weigh out a $50 \text{ g} \pm 0,1 \text{ g}$ test portion.

7.4 Number of test portions

The determination shall be carried out on three test portions.

8 Procedure

- Transfer the test portion to the funnel, keeping the discharge orifice properly closed, for example with a dry finger or a mechanical shutter. Take care that the stem of the funnel is filled with powder.
- Start the timing device (5.4) when the orifice is opened and stop it at the instant when the last of the powder leaves the orifice.
- Record the elapsed time measured to the nearest 0,1 s.

Alternatively, the orifice can be kept open when the test portion is transferred to the funnel, with the rest of the procedure being the same.

If the powder does not begin to flow when the orifice is opened, one slight tap on the funnel to start the flow is permitted. If this has no effect, or if the flow stops during the test, the powder is considered to possess no flowability according to the test method described in this document.

9 Expression of results

Calculate the arithmetic mean of the results of the three determinations and report the value in seconds per 50 g, rounded to the nearest second. If a correction factor (see 6.2) is used, the average shall be multiplied by this correction factor.

10 Precision

Three iron powders, see [Table 1](#), were included in the inter-laboratory study to develop this precision statement.

Table 1 — Types of powders included in the inter laboratory study

Type of powder
Plain atomized iron powder
Plain sponge iron powder
Stainless steel powder

In [Table 2](#) the repeatability and reproducibility are presented as one standard deviation.

Table 2 — Repeatability and reproducibility as standard deviations

Tested powder	Level Average flow time s	Repeatability (s_r) Standard deviation s	Reproducibility (s_R) Standard deviation s
Plain atomized iron powder	25	0,4	1,1
Plain sponge iron powder	33	0,3	1,1
Stainless steel powder	32	0,2	1,2

The difference between two test results found on identical test material by one operator using the same apparatus within the shortest feasible time interval will exceed the repeatability limit (r), see [Table 3](#), on average not more than once in 20 cases in the normal and correct operation of the method.

Test results on identical test material reported by two laboratories will differ by more than the reproducibility limit (R), see [Table 3](#), on average not more than once in 20 cases in the normal and correct operation of the method.

Table 3 — Repeatability and reproducibility, difference between two tests at 95 % probability level

Tested powder	Level Average flow time s	Repeatability (r) Limit s	Reproducibility (R) Limit s
Plain atomized iron powder	25	1,1	3,1
Plain sponge iron powder	33	0,7	3,0
Stainless steel powder	32	0,6	3,2

The accuracy data were determined from an experiment organized and analysed in accordance with ISO 5725-2[1] in 2014 involving 14 laboratories and three levels. Data from two of the laboratories contained outliers for the stainless steel powder. These data points were excluded in the calculations of the precision statement.

The repeatability and reproducibility are valid for powders similar to the powders evaluated for the precision statement. Other types of metal powders, with properties different from the evaluated powders, may have repeatability and reproducibility that are different from what is reported in this precision statement.

11 Test report

The test report shall include the following information:

- a reference to this document (i.e. ISO 4490);