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Metallic powders — Determination of particle size by dry sieving

Poudres métalliques — Détermination de la granulométrie par tamisage à sec

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Contents

Page

Foreword

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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 of 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 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)*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/SS M11, *Powder metallurgy*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 4497:1983), which has been technically revised. The main changes compared to the previous edition is as follows:

— inclusion of a precision statement.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Metallic powders — Determination of particle size by dry sieving

1 Scope

This document specifies a method of determining the particle size distribution of metallic powders by dry sieving into size fractions.

The method is applicable to dry, unlubricated metallic powders, but not applicable to powders in which the morphology differs markedly from being equiaxial, for example flake-type powders.

The method is not applicable to metallic powders having a particle size wholly or mostly under 45 µm.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

ISO 2591-1, *Test sieving — Part 1: Methods using test sieves of woven wire cloth and perforated metal plate*

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

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

The metallic powder are separated into particle size fractions by shaking through a set of wire cloth test sieves. The test sieves shall be stacked in consecutive order of size of aperture openings.

The fractions retained on each sieve and the fraction passing the finest sieve are weighed.

5 Test equipment

5.1 Calibrated cloth sieves.

A calibrated series of non-magnetic wire cloth sieves, having different nominal aperture sizes shall be used. Each sieve cloth shall be mounted in a non-magnetic metal frame having a nominal diameter of 200 mm and a nominal depth within the range 25 mm to 50 mm.

NOTE ISO 3310-1 specifies a nominal depth of 50 mm or 25 mm.

The test sieve frames and spacers, if used, shall nest seamlessly with one another, and the set shall be completed with a lid on top and a collecting pan below the bottom sieve.

The calibration of sieves shall be carried out according to ISO 3310-1.

The aperture size of the test sieves shall be chosen from the principal size (R 20/3) sieves of ISO 565. If this is not appropriate the principal sizes can be partly or totally replaced from one of the intermediate sizes (R 40/3 or R 20). The aperture sizes of the test sieves shall be chosen so as to determine adequately the particle size distribution of the sample (see Clause 8).

If mechanical sieving machine is used, see 7.1.

5.2 **Balance**, capable of weighing at least 100 g to an accuracy of ± 0,05 g shall be used.

5.3 **A soft brush**, shall be used.

6 Preparation of test portion

6.1 General

In general, the powder shall be tested in the as-received condition. If necessary, the powder may be dried. However, if the powder is susceptible to oxidation, the drying shall take place in vacuum or an inert gas.

6.2 Mass of test portion

The test portion shall have a mass of approximately 100 g for powders having an apparent density greater than 1,50 g/cm^3. If the apparent density of the powder is 1,50 g/cm^3 or less, the mass of the test portion shall be approximately 50 g.

7 Procedure

7.1 General

The series of test sieves selected shall be assembled complete with lid and collecting pan in consecutive order of size of apertures, with the sieve having the largest aperture on top. The test portion shall be placed on the top sieve and this shall be closed by a lid.

The sieving shall be performed either by hand or by means of a mechanical sieving machine.

NOTE 1 As different types of sieving machines are known to give different results when using the same sieves and the same powder, it is generally possible to establish a correlation between different machines for a particular powder.

A partial set or sieves of different frame diameter may be selected, if agreed between the supplier and the purchaser.

For other than 200 mm size of frame diameter, mass of test portion should be adapted to the sieve area. The minimum mass of the test portion should be 10 g.

NOTE 2 The precision statement in Clause 9 is based on 200 mm sieve frame diameter and 100 g test portions. The precision statement is not valid for sieve frame diameters other than 200 mm or test portion mass other than 100 g.

7.2 Sieving time

The sieving process shall be continued either until the end point of the sieving is reached or for a time to be agreed between the supplier and the purchaser. The end point is reached when the quantity passing

through the sieve retaining the largest fraction of the test portion in 1 min is less than 0,1 % of the test portion in accordance with ISO 2591-1.

7.3 Measurement

After the sieving process, weigh the fraction contained on each sieve and in the pan to the nearest 0,1 g in the case of 100 g test portion and to the nearest 0,05 g in the case of 50 g test portion, commencing with the coarsest fraction and finishing with the fraction in the pan.

The powder fraction retained on each sieve shall be collected for weighing as follows.

Remove the sieve from the nest. Gently tip the contents of the sieve to one side and, with the aid of a soft brush, transfer them onto a sheet of glazed paper. Brush any powder adhering to the bottom of the sieve and its frame with a soft brush into the next finer sieve. Invert the sieve over the glazed paper and gently tap the sieve frame.

Collect the fraction in the pan for weighing in a similar manner.

The sum of the masses of all the fractions shall be not less than 98 % of the mass of the test portion.

8 Expression of results

The mass of the fractions retained on each sieve and of the one collected in the pan shall be expressed as percentages of the sum of the masses of all the fractions and reported to the nearest 0,1 %. Any fraction whose percentage is less than 0,1 % shall be reported as "trace".

Table 1 shows expression of results and is given by way of example only.

Table 1 — Example of expression of results

Sieve size range		Sieve fractions	
µm		g	% mass fraction
	≥ 180	trace	trace
< 180	≥ 150	0,2	0,2
< 150	≥ 106	21,3	21,6
< 106	≥ 75	25,5	25,9
< 75	≥ 63	11,6	11,8
< 63	≥ 45	14,1	14,3
< 45		25,8	26,2
Total		98,5	100,0
Mass of test portion		99,9	
Loss		1,4	

9 Precision

Five metal powders, see Table 2, were in included in the interlaboratory study to develop this precision statement.

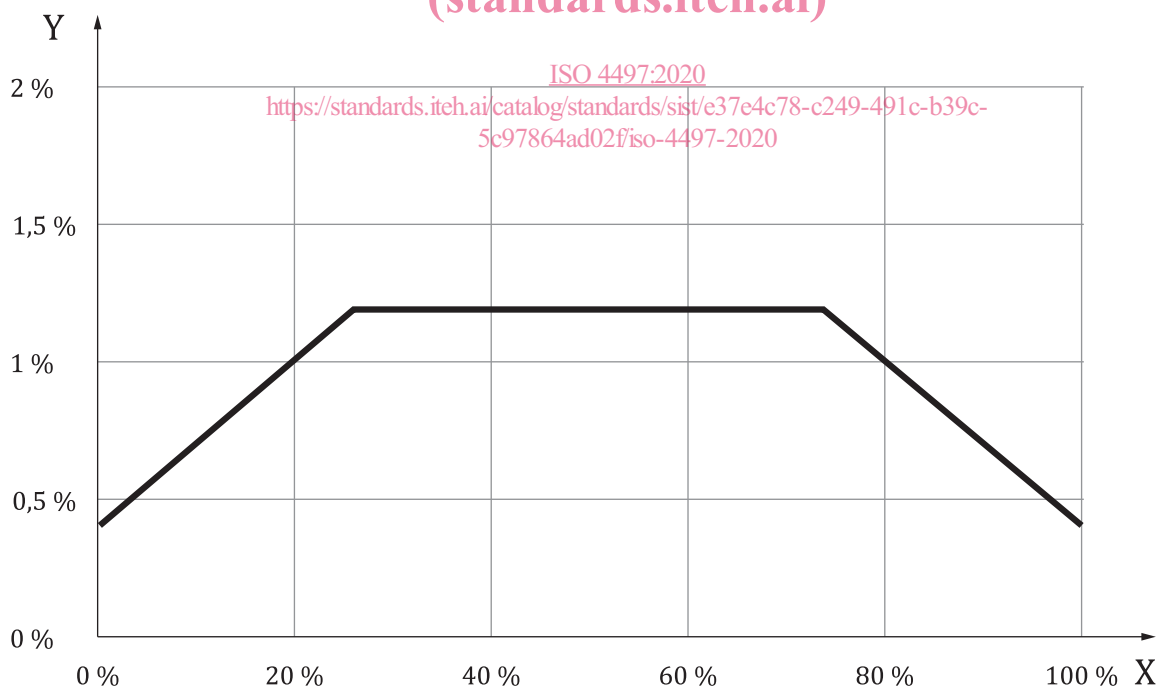
Table 2 — Type of powders included in the interlaboratory study

Powder type	Particle size µm
Pure atomized iron powder	up to 212
Electrolytic copper powder	up to 63
Gas atomized stainless steel powder 1	50 up to 150
Gas atomized stainless steel powder 2	50 up to 150
Water atomized stainless steel powder	up to 212

The difference between two test results found on identical test material by one operator using the same test equipment within the shortest feasible time interval will exceed the repeatability (*r*), see Figure 1, on average not more than once in 20 cases in the normal and correct operation of the method. Repeatability depend on the size of the fraction and the 95 % repeatability is expressed as a function of the size fraction in the diagram.

Test results on identical test material reported by two laboratories will differ by more than the reproducibility (*R*), see Figure 2, on average not more than once in 20 cases in the normal and correct operation of the method. The 95 % reproducibility depend on the size of the fraction and the 95 % reproducibility is expressed as a function of the size of fraction in the diagram. Furthermore, a powder with a narrow particle distribution, such as 50 µm up to 150 µm, have higher 95 % reproducibility compared to a powder with a wider up to 212 µm particle size distribution.

The repeatability and reproducibility given below covers the percent retained between any pair of sieves, as well as cumulative percentages calculated from all sieves of greater openings above any sieve in the set.

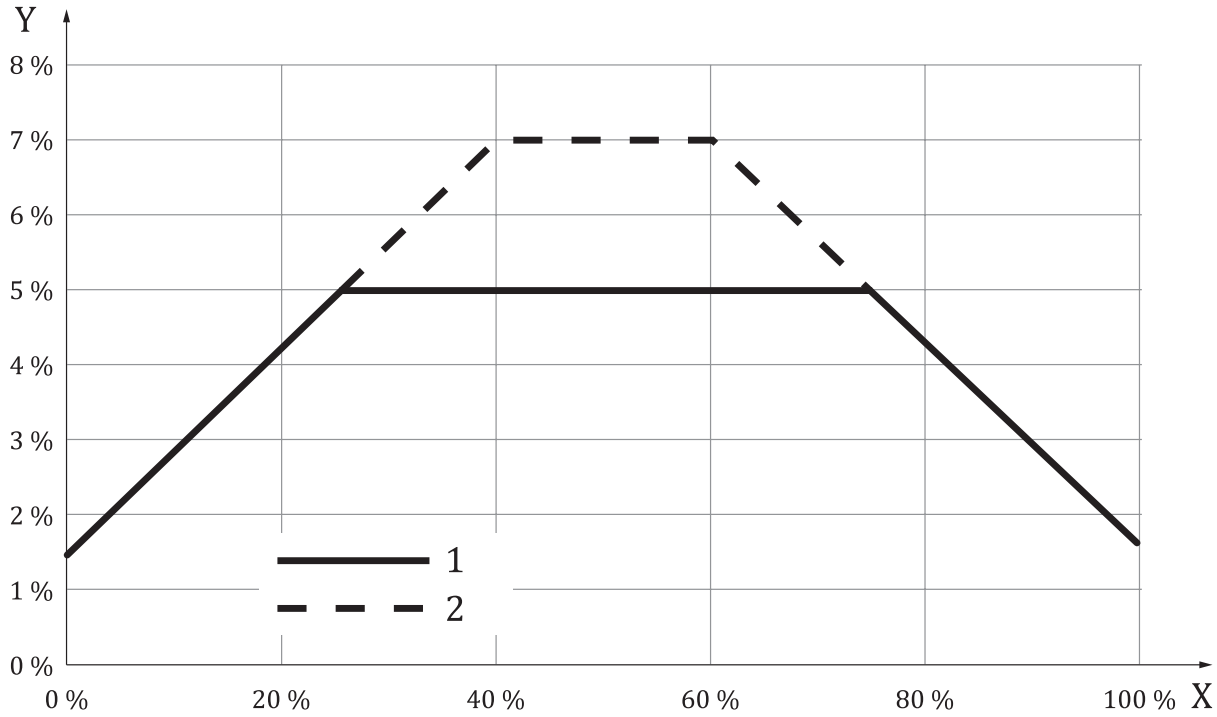


Key

Y repeatability, *r*

X relative size of fraction of distribution in %

Figure 1 — Repeatability, *r*, versus size of fraction



Key

Y reproducibility, *R*

X relative size of fraction of distribution in %

1 up to 212 µm particle size distribution

2 50 µm up to 150 µm particle size distribution

Figure 2 — Reproducibility, *R*, versus size of fraction

The precision data were determined from an experiment organized and analysed in accordance with ISO 5725-2 in year 2016 and 2018 involving 13 laboratories and 2 levels.

The laboratories participating in the study were following the test procedure described in this document. All participating laboratories used their own test equipment (wire cloth sieves, sieving machine, and scale) for the study. The sets of sieves used for the trials included sieves with openings of 180 µm, 150 µm, 106 µm, 75 µm, 63 µm and 45 µm.