
Metallic powders — Determination of tap density

Poudres métalliques — Détermination de la masse volumique après tassement

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Published in Switzerland

Foreword

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ISO 3953 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 2, *Sampling and testing methods for powders (including powders for hardmetals)*.

This fourth edition cancels and replaces the third edition (ISO 3953:1993), of which it constitutes a minor revision.

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Metallic powders — Determination of tap density

1 Scope

This International Standard specifies a method for the determination of tap density, i.e. the density of a powder that has been tapped into a container under specified conditions.

2 Principle

A specified amount of powder in a container is tapped by means of a tapping apparatus until no further decrease in the volume of the powder takes place. The mass of the powder divided by its volume after the test gives its tap density.

3 Symbols

For the purposes of this document, the symbols in Table 1 apply.

Table 1 — Symbols

Symbol	Meaning	Unit
ρ_t	Tap density	g/cm ³
m	Mass of the powder	g
V	Volume of the tapped powder	cm ³

4 Apparatus

4.1 Balance, of appropriate capacity to satisfy the requirements shown in Table 2 and of an accuracy to weigh to the nearest 0,1 g.

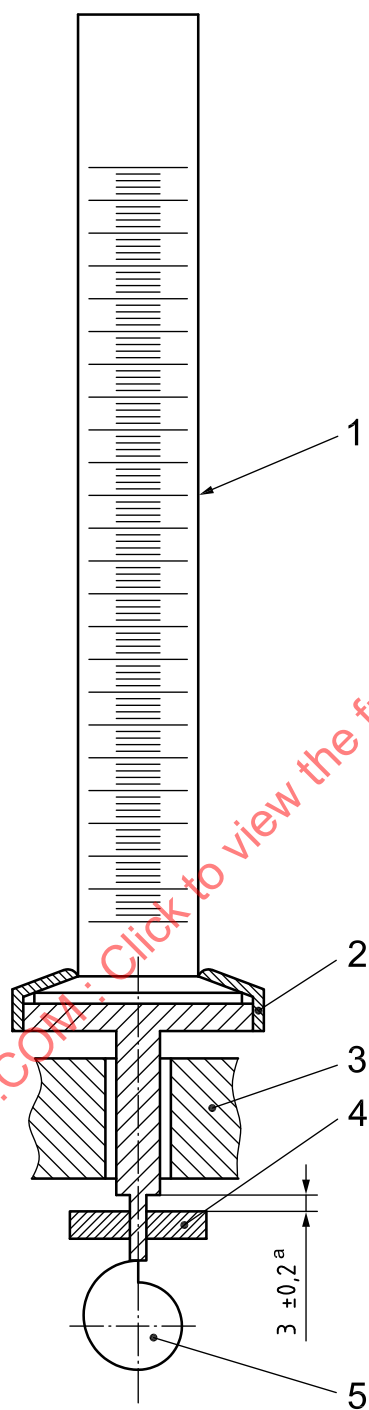
4.2 Graduated glass cylinder, calibrated to contain 100 cm³, the height of the graduated portion being approximately 175 mm. The graduations shall be at 1 cm³ intervals, thus allowing a measuring accuracy of $\pm 0,5$ cm³.

Alternatively:

Graduated glass cylinder, calibrated to contain 25 cm³, the height of the graduated portion being approximately 135 mm. The graduations shall be at 0,2 cm³ intervals.

A 25 cm³ cylinder shall be used for powders of apparent density higher than 4 g/cm³, in particular for refractory metal powders, but may also be used for powders of lower apparent density.

4.3 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 Figure 1.

**Key**

- 1 graduated measuring cylinder
- 2 holder with guide-pin
- 3 guide-bearing
- 4 anvil (steel)
- 5 cam

^a Height of stroke.

Figure 1 — Example of tapping apparatus

5 Sampling

5.1 For the quantities of powder required for each test, see Table 2.

Table 2 — Required sample quantities

Apparent density g/cm ³	Cylinder capacity cm ³	Mass of test portion g
1 to 4	100	100 ± 0,5
< 1	100	50 ± 0,2
> 7	25	100 ± 0,5
> 2 to 7	25	50 ± 0,2
0,8 to 2	25	20 ± 0,1
< 0,8	25	10 ± 0,1

5.2 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 an inert gas. If the powder contains volatile substances, it shall not be dried.

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

6 Procedure

6.1 Clean the inside wall of the graduated cylinder (4.2) 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 re-use.

6.2 Weigh, to the nearest 0,1 g, the mass of the test portion as indicated in Table 2, using the balance (4.1).

6.3 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 (4.3). Tap the cylinder until no further decrease in the volume of the powder takes place (see Note).

NOTE In practice, the minimum number of taps, N , would be determined such that no further change in volume takes place. For all further tests on the same type of powder, the cylinder would be subjected to $2N$ taps, except where general experience and acceptance has established a specific number of taps (no less than N taps) as being satisfactory. For fine refractory metal powders, 3 000 taps has been found to be satisfactory for all sizes.

6.4 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 0,2 cm³ when using a 25 cm³ cylinder.

7 Expression of results

The tap density is given by the following equation:

$$\rho_t = \frac{m}{V}$$

where ρ_t , m and V are as defined in Table 1.

Report the arithmetical mean of the number of determinations rounded to the nearest 0,1 g/cm³ for values up to and including 4 g/cm³, and to the nearest 0,2 g/cm³ for values greater than 4 g/cm³.

8 Test report

The test report shall include the following information:

- a) a reference to this International Standard, i.e. ISO 3953:2011;
- b) all details necessary for identification of the test sample;
- c) the drying procedure, if the powder has been dried;
- d) the cylinder capacity, mass of the test portion and method used;
- e) the result obtained;
- f) all operations not specified in this International Standard or regarded as optional;
- g) details of any occurrence which may have affected the result.