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Metallic powders — Determination of tap density

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3953 was developed by Technical Committee ISO/TC 119, *Powder metallurgical materials and products*, and was circulated to the member bodies in October 1975.

It has been approved by the member bodies of the following countries:

Austria	Japan	Sweden
Canada	Mexico	Turkey
Czechoslovakia	Poland	United Kingdom
France	Portugal	U.S.A.
Germany	Romania	U.S.S.R.
Italy	Spain	Yugoslavia

No member body expressed disapproval of the document.

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Metallic powders — Determination of tap density

1 SCOPE AND FIELD OF APPLICATION

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

2 PRINCIPLE

This test consists in tapping a specified amount of powder in a container, either by means of a tapping apparatus or by hand, until no further decrease of 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 AND DESIGNATIONS

TABLE 1

Symbol	Designation	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 and accuracy to satisfy the requirements shown in table 2.

4.2 Graduated glass cylinder, calibrated to contain 100 cm^3, the height of the graduated portion being approximately 175 mm. The graduations shall be at 1 cm^3 intervals, thus allowing a measuring accuracy of ± 0,5 cm^3.

Alternatively :

Graduated glass cylinder, calibrated to contain 25 cm^3, the height of the graduated portion being approximately 135 mm. The graduations shall be at 0,2 cm^3 intervals.

A 25 cm^3 cylinder shall be used for powders of apparent density higher than 4 g/cm^3, in particular for refractory metal powders, but may also be used for powder of lower apparent density.

4.3 In method 1 (see 6.3.1), an apparatus is used 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 per minute. An example of a tapping apparatus is shown in the figure.

4.4 An alternative test method (method 2, see 6.3.2), similar to method 1, consists in tapping the cylinder by hand against a hard rubber slab (about 100 mm × 100 mm × 5 mm).

5 SAMPLING

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

TABLE 2

Cylinder capacity cm^3	Apparent density g/cm^3	Mass of test portion g
100	⩾ 1	100 ± 0,5
100	< 1	50 ± 0,2
25	> 7	100 ± 0,5
25	2 to 7	50 ± 0,2
25	< 2	20 ± 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 should take place in vacuum or in 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.

6 PROCEDURE

6.1 Clean the inside wall of the graduated cylinder 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.

6.3 Proceed according to method 1 or method 2 as follows.

6.3.1 *Method 1*

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. Tap the cylinder until no further decrease of the volume of the powder takes place.

NOTE — In practice, the minimum number of taps (N) such that no further change in volume takes place would be determined. For all further tests on the same type of powder, the cylinder would be subjected to $2N$ taps except where general experience and acceptance had 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.

6.3.2 *Method 2*

Pour the test portion into the graduated cylinder according to method 1. Tap the cylinder by hand against the hard rubber slab until no further decrease of the volume takes place. Towards the end of the procedure, tap gently in order to avoid loosening the surface layers of the powder.

NOTE — In general, the mechanical (1) and manual (2) methods will give comparable results. However, for powders of very low apparent density, or for very fine powders, the results obtained by the two methods may be significantly different.

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 lowest reading of the tapped surface. Read the final volume to the nearest 0,5 cm^3 when using a 100 cm^3 cylinder and to the nearest 0,2 cm^3 when using a 25 cm^3 cylinder.

7 EXPRESSION OF RESULTS

The tap density is given by the following formula :

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

Report the arithmetical mean of the three determinations rounded to the nearest 0,1 g/cm^3 for values up to and including 4 g/cm^3 and to the nearest 0,2 g/cm^3 for values greater than 4 g/cm^3.

8 TEST REPORT

The test report shall include the following information :

a) reference to this International Standard;

b) all details necessary for identification of the test sample;

c) the drying procedure, if the powder has been dried;

d) cylinder capacity, mass of 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.