INTERNATIONAL STANDARD

ISO 3369

Second edition
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Impermeable sintered metal materials and hardmetals — Determination of density

Matériaux en métal fritté imperméable et métaux-durs — Détermination de la masse volumique

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 3369 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 3, *Sampling and testing methods for sintered metal materials (excluding hardmetals)*.

This second edition cancels and replaces the first edition (ISO 3369:1975) which has been technically revised by giving correct values for the density of distilled water in Table 1 and by adding Clause 9, Precision statement (Statement of accuracy). Editorial changes have also been made.

Impermeable sintered metal materials and hardmetals — Determination of density

1 Scope

This International Standard specifies a method of determining the density of impermeable sintered metal materials and hardmetals.

NOTE For the determination of density of permeable sintered metal materials, see ISO 2738:1999, *Sintered metal materials, excluding hardmetals — Permeable sintered metal materials — Determination of density, oil content and open porosity.*

2 Normative references

The following referenced documents are indispensable for the application 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 4489, *Sintered hardmetals — Sampling and testing*

3 Principle

Weighing of a test piece, first in air and then in a liquid, and determination of the density by calculation.

4 Apparatus and materials

4.1 Precision balance, having a capacity which will permit readings within ± 0,1 mg, on weighings up to 10 g and ± 0,001 % above 10 g.

The weights shall be calibrated and have a density of not less than 7 g/cm^3.

4.2 Arrangement of racks or a **suspension wire**, according to Figures 1 and 2. In each case, the suspension wire shall have a maximum diameter of 0,25 mm. A heavier gauge wire shall only be used if this is necessary to support the test piece.

4.3 Vessel, for the weighing liquid. For test pieces of volume less than 10 cm^3 the vessel shall be dimensioned so that, when the test piece is lowered into the liquid, the rise in liquid level is less than 2,5 mm.

4.4 Distilled or deionized and preferably degassed water, to which 1 or 2 drops of a wetting agent have been added.

The following values shall be used for the density in air, ρ_w, of distilled water (see Table 1).

Table 1 — Density in the air, ρ_w, of distilled water

Temperature °C	ρ_w g/cm^3
15	0,999 1
16	0,998 9
17	0,998 8
18	0,998 6
19	0,998 4
20	0,998 2
21	0,998 0
22	0,997 8
23	0,997 5
24	0,997 3
25	0,997 0
26	0,996 8
27	0,996 5
28	0,996 2
29	0,995 9
30	0,995 6

NOTE 1 Other liquids may be used if their density in air, at the testing temperature, is known to four decimal places.

NOTE 2 Using brass weights in air, the value of ρ_w is 0,001 06 g/cm^3 smaller than the true density of water measured in a vacuum.

5 Test piece

5.1 Sampling shall be carried out in accordance with ISO 4489.

5.2 The volume of the test piece shall be at least 0,5 cm^3. If it is required to determine the density of pieces having a volume less than 0,5 cm^3, group several pieces together to make one determination, provided that each piece has a volume not less than 0,05 cm^3.

5.3 The surface of the test piece shall be thoroughly cleaned from adhering foreign material, such as dirt, grease and oil.

6 Procedure

6.1 Place the test piece in the upper rack (Figure 1) or pan (Figure 2). The lower rack shall be completely immersed and the suspension wire shall be hanging freely from the pan and partially immersed in the liquid. Remove all air bubbles and weigh the test piece (m_1).

6.2 Place the test piece on the lower rack (Figure 1) or suspend it by means of the wire (Figure 2). Lower the test piece into the vessel containing the liquid so that only the suspension wire breaks the surface of the liquid. Remove all air bubbles and weigh.

6.3 Weighings up to 10 g shall be read to 0,1 mg, and weighings above 10 g shall be read to 0,001 %.

6.4 The test piece, liquid and surrounding air shall be at the same temperature when weighing is carried out. The temperature of the liquid shall be determined. When distilled water is used, its density shall be taken from Table 1.

7 Expression of results

The density ρ, of the test piece, in grams per cubic centimetre, is given by the formula:

$$\rho = \frac{m_1 \times \rho_l}{m_2}$$

where

ρ_l is the density in air of the liquid, in grams per cubic centimetre;

m_1 is the mass, in grams, of the test piece determined by weighing in air;

m_2 is the mass, in grams, of the liquid displaced by the test piece, determined by subtracting the apparent mass of the test piece in the liquid from the mass of the test piece in air.

Report the result, rounded to the nearest 0,01 g/cm^3.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard;

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

c) the result obtained;

d) all operations not specified by this International Standard, or regarded as optional;

e) details of any occurrence which may have affected the result.

9 Precision statement (Statement of accuracy)

For test specimens of over 5 g mass, the repeatability interval, r, is 0,025 g/cm^3. Duplicate results from the same laboratory should not be considered suspect at the 95 % confidence level, unless they differ by more than r.

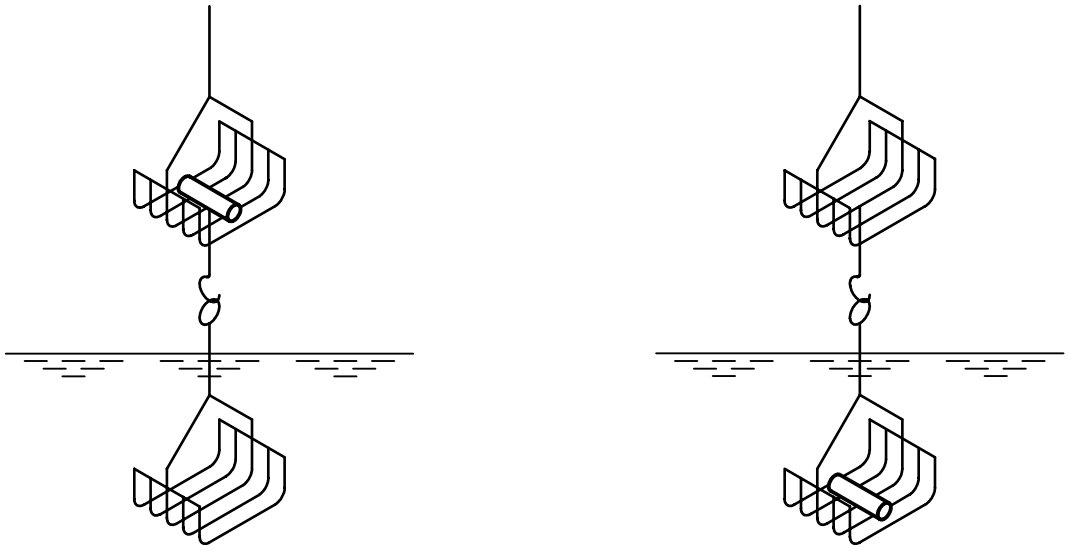
For test specimens of over 5 g mass, the reproducibility interval, R, is 0,03 g/cm^3. Test results from two different laboratories should not be considered suspect at the 95 % confidence level, unless they differ by more than R.

For test specimens of 1 g to 5 g mass, the repeatability interval, r, is 0,025 g/cm^3.

For test specimens of 1 g to 5 g mass, the reproducibility interval, R, is 0,05 g/cm^3.

There is no estimate of bias because there is no accepted reference material.

NOTE With permission, this clause was taken from ASTM (American Society for Testing and Materials) Standard B 311-93: *Test method for density determination for powder metallurgy (P/M) materials containing less than two percent porosity*.



a) Weighing in air

b) Weighing in water

Figure 1 — Rack method

a) Weighing in air

b) Weighing in water

Figure 2 — Pan method