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# INTERNATIONAL STANDARD



# 2738

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Permeable sintered metal materials — Determination of density and open porosity

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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 2738 was drawn up by Technical Committee ISO/TC 119, *Powder metallurgical materials and products*, and circulated to the Member Bodies in July 1972.

It has been approved by the Member Bodies of the following countries :

Australia	Ireland	South Africa, Rep. of
Austria	Italy	Spain
Canada	Japan	Sweden
Egypt, Arab Rep. of	Mexico	Thailand
France	Portugal	U.S.A.
Germany	Romania	

The Member Body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

# Permeable sintered metal materials – Determination of density and open porosity

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods of determining the density of permeable sintered metal materials and their open porosity.

For impermeable materials see the standards for these materials.

## 2 REFERENCE

ISO 2737, *Permeable sintered metal materials – Determination of oil content.*

## 3 PRINCIPLE

A test piece is cleaned of oil and weighed in air.

For simultaneous determination of density and open porosity, the test piece is completely impregnated with a suitable liquid, weighed again in air and then in water. The density is calculated as the ratio of the mass of the clean test piece in air to its volume, the latter being found from the apparent mass loss of the impregnated test piece when weighed in water. The open porosity (defined as the volume of the communicating pores expressed as a percentage of the volume of the sintered piece) is calculated from the increase in the mass of the test piece on impregnation, the density of the impregnating liquid being known.

For determination of the density only, the test piece, after being cleaned and weighed, may be either only partially impregnated or coated with a protective film before being weighed again in air and then in water.

## 4 APPARATUS

**4.1 Analytical balance** of sufficient capacity, capable of weighing the test piece to within an accuracy of 0,01 %.

**4.2 Vessel** containing distilled water (preferably degassed) and large enough to accommodate the test piece and the device (4.3) for weighing it.

**4.3 Device** to allow the test piece to be weighed in air and in water. (See Figures 1 and 2.)

**4.4 Device** to allow the specimen to be vacuum impregnated.

## 5 TEST PIECE

The volume of the test piece must be at least 0,5 cm<sup>3</sup>.

## 6 PROCEDURE

### 6.1 Test temperature

The test piece and the water in the vessel (4.2) shall be at the same temperature.

### 6.2 Degreasing

Completely degrease the test piece in accordance with the method specified in ISO 2737.

Weigh the dry test piece in air.

### 6.3 Simultaneous determination of density and open porosity

Immerse the test piece in a liquid which wets it and is immiscible with water. Choose the liquid and the temperature of impregnation to ensure complete impregnation and retention of the liquid in the pores of the test piece during subsequent operations. The following conditions are given by way of example :

If it is wished to operate at ambient temperature, it is recommended that a liquid having a viscosity of between  $50 \times 10^{-6}$  and  $300 \times 10^{-6}$  m<sup>2</sup>/s (50 and 300 cSt) at 20 °C be used.

The use of a temperature of approximately 65 °C allows the operation to be carried out more quickly, but in this case it is necessary to plunge the test piece into liquid at ambient temperature to cool it. The liquid shall not change properties by fractional evaporation under the impregnation conditions (temperature and pressure) given below.

Reduce the pressure in the receptacle which contains the test piece and the liquid to less than 0,1 bar<sup>1)</sup> and maintain this reduced pressure for 30 min or at least until the complete cessation of bubbling. Then re-establish air pressure, allowing the test piece to remain immersed in the liquid for a time equal to that under reduced pressure. Take the test piece from the liquid and wipe it clean using a non-absorbent cloth.

Weigh the test piece in air and then in water.

#### 6.4 Determination of density only

When only the density is to be determined, the test can be shortened by not giving a total impregnation.

Alternatively, instead of impregnation, a surface film which is not wetted by water may be applied to the test piece. The test piece may, for example, be immersed in a 0,1 % solution of silicone oil in a suitable solvent, or in a 5 % solution of paraffin wax.

The increase in the mass of the test piece thus treated is often negligible but the test piece must be dried so that its mass remains constant.

Weigh the dry test piece in air and then in water.

### 7 EXPRESSION OF RESULTS

#### 7.1 Density

7.1.1 When using the method specified in 6.3, the density of the test piece,  $\rho$ , is given by the following formula :

$$\rho = \frac{m_1 \times \rho_W}{m_2 - m_3}$$

where

$m_1$  is the mass of the dry test piece in air;

$m_2$  is the mass of the totally impregnated test piece (and of the wire, if used) in air;

$m_3$  is the apparent mass of the totally impregnated test piece (and of the wire, if used) in water;

$\rho_W$  is the density of water, which may be taken as 0,997 g/cm<sup>3</sup>.

7.1.2 When using either of the methods given in 6.4, the formula above is modified to :

$$\rho = \frac{m_1 \times \rho_W}{m_2' - m_3'}$$

where  $m_2'$  and  $m_3'$  are respectively the mass in air and the apparent mass in water of the partially impregnated or coated test piece.

7.1.3 Report the result to within  $\pm 0,25$  %.

#### 7.2 Open porosity

The open porosity,  $P$ , as a percentage by volume, is given by the following formula :

$$P = \frac{(m_2 - m_1) \rho_W}{(m_2 - m_3) \rho_i} \times 100$$

where

$m_1$ ,  $m_2$ ,  $m_3$ , and  $\rho_W$  are as defined in 7.1.1;

$\rho_i$  is the density of the impregnating liquid.

Report the result to within  $\pm 0,5$  % absolute value.

### 8 TEST REPORT

The test report shall include the following information :

- reference to this International Standard;
- all details necessary for identification of the test piece;
- the results obtained and the method used;
- all operations not specified by this International Standard, or regarded as optional;
- details of any occurrence which may have affected the results.

If necessary, the data required for the identification of the test piece shall be agreed between manufacturer and user.

1) 1 bar = 10<sup>5</sup> Pa

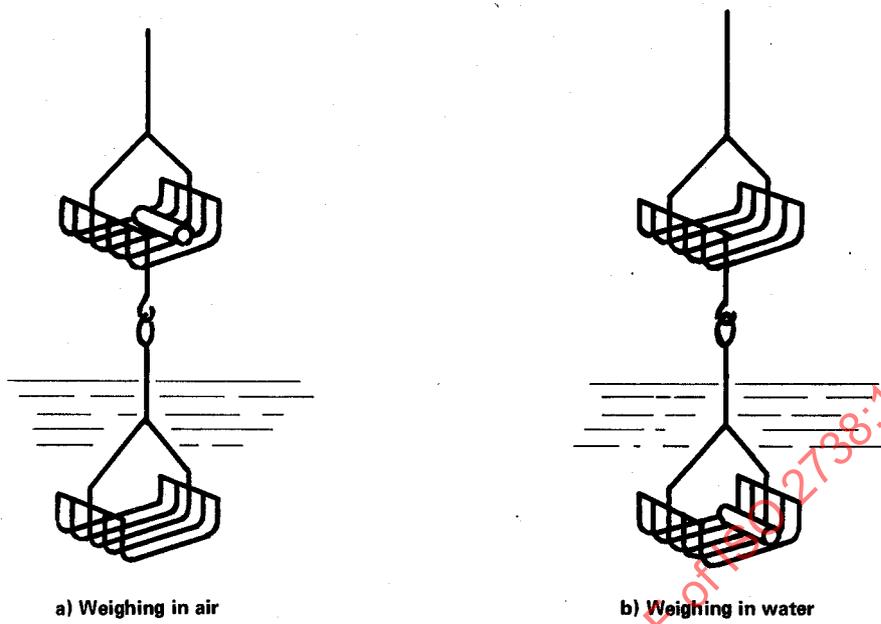


FIGURE 1

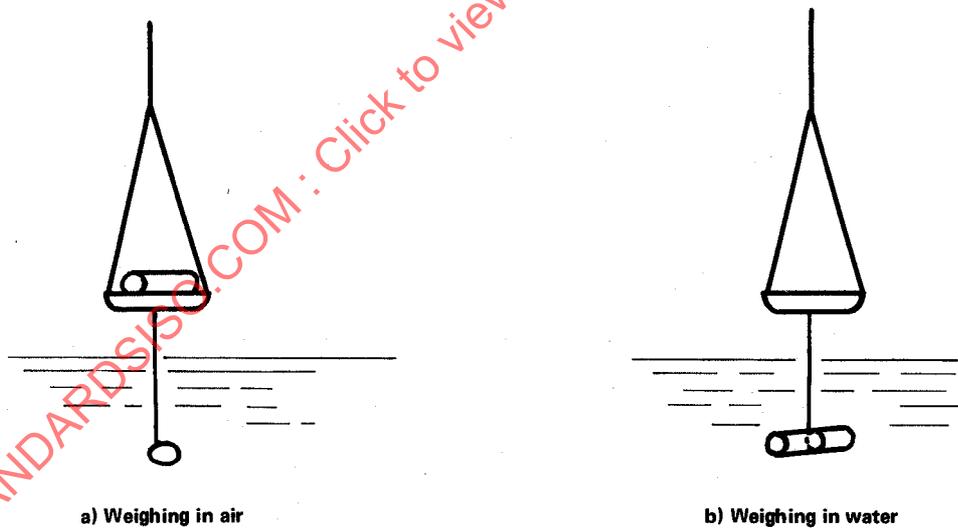


FIGURE 2

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