
**Plastics — Methods for determining the
density of non-cellular plastics —**

**Part 1:
Immersion method, liquid pycnometer
method and titration method**

iTeh STANDARD PREVIEW

*Plastiques — Méthodes de détermination de la masse volumique des
plastiques non alvéolaires*

*Partie 1: Méthode par immersion, méthode du pycnomètre en milieu
liquide et méthode par titrage*

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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 1183-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

Together with the other parts (see below), this part of ISO 1183 cancels and replaces ISO 1183:1987, which has been technically revised.

ISO 1183 consists of the following parts, under the general title *Plastics — Methods for determining the density of non-cellular plastics*:

- *Part 1: Immersion method, liquid pycnometer method and titration method*
- *Part 2: Density gradient column method*
- *Part 3: Gas pycnometer method*

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Plastics — Methods for determining the density of non-cellular plastics —

Part 1: Immersion method, liquid pycnometer method and titration method

WARNING — The use of this part of ISO 1183 may involve hazardous materials, operations or equipment. This part of ISO 1183 does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this part of ISO 1183 to establish appropriate health and safety practices and to determine the applicability of any regulatory limitations prior to use.

1 Scope

This part of ISO 1183 specifies three methods for the determination of the density of non-cellular plastics in the form of void-free moulded or extruded objects, as well as powders, flakes and granules.

- **Method A: Immersion method**, for solid plastics (except for powders) in void-free form.
- **Method B: Liquid pycnometer method**, for particles, powders, flakes, granules or small pieces of finished parts.
- **Method C: Titration method**, for plastics in any void-free form.

NOTE This part of ISO 1183 is applicable to pellets as long as they are void-free. Density is frequently used to follow variations in physical structure or composition of plastic materials. Density may also be useful in assessing the uniformity of samples or specimens. Often the density of plastic materials will depend upon the choice of specimen preparation method. When this is the case, precise details of the specimen preparation method will have to be included in the appropriate material specification. This note is applicable to all three methods.

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 31-3, *Quantities and units — Part 3: Mechanics*

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472:1999, *Plastics — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

3.1

mass

quantity of matter contained in a body

NOTE It is expressed in kilograms (kg) or grams (g).

3.2

apparent mass

mass of a body obtained by measuring its weight using an appropriately calibrated balance

NOTE It is expressed in kilograms (kg) or grams (g).

3.3

density

ρ

the ratio of the mass m of a sample to its volume V (at the temperature t), expressed in kg/m³, kg/dm³ (g/cm³) or kg/l (g/ml)

NOTE The following terms, based upon ISO 31-3, are given here for clarification.

Table 1 — Density terms

Term	Symbol	Formulation	Units
Density	ρ	m/V	kg/m ³ kg/dm ³ (g/cm ³) kg/l(g/ml)
Specific volume	v	$V/m (= 1/\rho)$	m ³ /kg dm ³ /kg (cm ³ /g) l/kg(ml/g)

4 Conditioning

The test atmosphere shall be in accordance with ISO 291. In general, conditioning specimens to constant temperature is not required, because the determination itself brings the specimen to the constant temperature of the test.

Specimens which change in density during the test to such an extent that the change is greater than the required accuracy shall be conditioned prior to measurement in accordance with the applicable material specification. When changes in density with time or atmospheric conditions are the primary purpose of the measurements, the specimens shall be conditioned as described in the material specification and, if no material specification exists, then as agreed upon by the interested parties.

5 Methods

5.1 Method A — Immersion method

5.1.1 Apparatus

5.1.1.1 Analytical balance or instrument specifically designed for measurement of density, accurate to 0,1 mg.

NOTE An automatically operating instrument may be used. The calculation of density may be done automatically using a computer.

5.1.1.2 Immersion vessel: a beaker or other wide-mouthed container of suitable size for holding the immersion liquid.

5.1.1.3 Stationary support, e.g. a pan straddle, to hold the immersion vessel above the balance pan.

5.1.1.4 Thermometer, graduated at 0,1 °C intervals, covering the range 0 °C to 30 °C.

5.1.1.5 Wire (if required), corrosion-resistant, of diameter not greater than 0,5 mm, for suspending specimens in the immersion liquid.

5.1.1.6 Sinkers, of suitable mass to ensure complete immersion of the specimen, for use when the density of the specimen is less than that of the immersion liquid.

5.1.1.7 Pycnometer, with a side-arm overflow capillary, for determining the density of the immersion liquid when this liquid is not water. The pycnometer shall be equipped with a thermometer graduated at 0,1 °C intervals from 0 °C to 30 °C.

5.1.1.8 Liquid bath, capable of being thermostatically controlled to within $\pm 0,5$ °C, for use in determining the density of the immersion liquid.

5.1.2 Immersion liquid

Use freshly distilled or deionized water or another suitable liquid containing not more than 0,1 % of a wetting agent to help in removing air bubbles. The liquid or solution with which the specimen comes into contact during the measurement shall have no effect on the specimen.

The density of immersion liquids other than distilled water need not be measured provided they are obtained from an accredited source and are accompanied by certificate.

5.1.3 Specimens

Specimens may be in any void-free form except for powder. They shall be of a convenient size to give adequate clearance between the specimen and the immersion vessel and should preferably have a mass of at least 1 g.

When cutting specimens from larger samples, proper equipment shall be used to ensure that the characteristics of the material do not change. The surface of the specimen shall be smooth and free from cavities to minimize the entrapment of air bubbles upon immersion in the liquid, otherwise errors will be introduced.

5.1.4 Procedure

5.1.4.1 Weigh the specimen in air while suspended with a wire of maximum diameter 0,5 mm. Weigh specimens of mass less than or equal to 10 g to the nearest 0,1 mg. Weigh those of mass greater than 10 g to the nearest 1 mg. Record the mass of the specimen.

5.1.4.2 Immerse the specimen, still suspended by the wire, in the immersion liquid (5.1.2), contained in the immersion vessel (5.1.1.2) on the support (5.1.1.3). The temperature of the immersion liquid shall be $23\text{ °C} \pm 2\text{ °C}$ (or $27\text{ °C} \pm 2\text{ °C}$). Remove any adhering air bubbles with a fine wire. Weigh the immersed specimen to the nearest 0,1 mg.

If the measurement is carried out in a temperature-controlled room, the temperature of the whole apparatus, including the immersion liquid, shall be within the range $23\text{ °C} \pm 2\text{ °C}$ (or $27\text{ °C} \pm 2\text{ °C}$).

5.1.4.3 If necessary, determine the density of immersion liquids other than water as follows. Weigh the pycnometer (5.1.1.7) empty and then containing freshly distilled or deionized water at a temperature of $23\text{ °C} \pm 0,5\text{ °C}$ (or $27\text{ °C} \pm 0,5\text{ °C}$). Weigh the same pycnometer, after cleaning and drying, filled with the immersion liquid [also at a temperature of $23\text{ °C} \pm 0,5\text{ °C}$ (or $27\text{ °C} \pm 0,5\text{ °C}$)]. Use the liquid bath (5.1.1.8) to bring the water and immersion liquid to the correct temperature. Calculate the density ρ_{IL} , in grams per cubic centimetre, of the immersion liquid at 23 °C (or 27 °C), using the equation:

$$\rho_{IL} = \frac{m_{IL}}{m_W} \times \rho_W \quad (1)$$

where

m_{IL} is the mass, in grams, of the immersion liquid;

m_W is the mass, in grams, of the water;

ρ_W is the density, in grams per cubic centimetre, of water at 23 °C (or 27 °C).

5.1.4.4 Calculate the density ρ_S , in grams per cubic centimetre, of the specimen at 23 °C (or 27 °C), using the equation:

$$\rho_S = \frac{m_{S,A} \times \rho_{IL}}{m_{S,A} - m_{S,IL}} \quad (2)$$

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where

$m_{S,A}$ is the apparent mass, in grams, of the specimen in air;

$m_{S,IL}$ is the apparent mass, in grams, of the specimen in the immersion liquid;

ρ_{IL} is the density of the immersion liquid at 23 °C (or 27 °C), in grams per cubic centimetre, as stated by the supplier or determined as specified in 5.1.4.3.

For specimens having a density less than that of the immersion liquid, the test may be performed in exactly the same way as described above, with the following exception: a sinker of lead or other dense material is attached to the wire, such that the sinker rests below the liquid level, as does the specimen, during immersion. The sinker may be considered as a part of the suspension wire. In this case, the upthrust exerted by the immersion liquid on the sinker shall be allowed for by using the following equation, rather than Equation (2), to calculate the density of the specimen:

$$\rho_S = \frac{m_{S,A} \times \rho_{IL}}{m_{S,A} + m_{K,IL} - m_{S+K,IL}} \quad (3)$$

where

$m_{K,IL}$ is the apparent mass, in grams, of the sinker in the immersion liquid;

$m_{S+K,IL}$ is the apparent mass, in grams, of the specimen and sinker in the immersion liquid.

The buoyancy of the suspension wire in air is normally considered to be negligible, but for correction for air buoyancy see Clause 6.

5.1.4.5 Perform the test on a minimum of three specimens and calculate the mean result to three decimal places.

5.2 Method B — Liquid pycnometer method

5.2.1 Apparatus

- 5.2.1.1** **Balance**, accurate to 0,1 mg.
- 5.2.1.2** **Stationary support** (see 5.1.1.3).
- 5.2.1.3** **Pyknometer** (see 5.1.1.7).
- 5.2.1.4** **Liquid bath** (see 5.1.1.8).
- 5.2.1.5** **Dessicator**, connected to a vacuum system.

5.2.2 Immersion liquid

As specified in 5.1.2.

5.2.3 Specimens

Specimens of powders, granules or flakes shall be measured in the form in which they are received. The specimen mass shall be in the range of 1 g to 5 g.

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5.2.4 Procedure <https://standards.iteh.ai/catalog/standards/sist/52aacd74-7dcd-4bb2-9a39-8783945bf5e4/iso-1183-1-2004>

5.2.4.1 Weigh the pycnometer (5.2.1.3) empty and dry. Weigh a suitable quantity of the plastic material in the pycnometer. Cover the test specimen with immersion liquid (5.2.2) and remove all the air by placing the pycnometer in the desiccator (5.2.1.5) and applying a vacuum. Break the vacuum and almost completely fill the pycnometer with immersion liquid. Bring it to constant temperature [$23\text{ °C} \pm 0,5\text{ °C}$ (or $27\text{ °C} \pm 0,5\text{ °C}$)] in the liquid bath (5.2.1.4) and then complete filling exactly to the limit of the capacity of the pycnometer.

Wipe dry and weigh the pycnometer with the specimen and immersion liquid.

5.2.4.2 Empty and clean the pycnometer. Fill it with deaerated distilled or deionized water, remove any remaining air as above, and determine the mass of the pycnometer and its contents at the temperature of test.

5.2.4.3 Repeat the process with the immersion liquid if an immersion liquid other than water was used, and determine its density as specified in 5.1.4.3.

5.2.4.4 Calculate the density ρ_S , in grams per cubic centimetre, of the specimen at 23 °C (or 27 °C), using the following equation:

$$\rho_S = \frac{m_S \times \rho_{IL}}{m_1 - m_2} \quad (4)$$

where

m_S is the apparent mass, in grams, of the specimen;

m_1 is the apparent mass, in grams, of the liquid required to fill the empty pycnometer;