INTERNATIONAL STANDARD

ISO
2811-3

Second edition
2011-03-01

Paints and varnishes — Determination of density —

Part 3:
Oscillation method

Peintures et vernis — Détermination de la masse volumique —

Partie 3: Méthode par oscillation

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Contents

Page

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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 2811-3 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 2811-3:1997), which has been technically revised.

The main changes are:

a) The unit for the density has been changed from grams per millilitre to grams per cubic centimetre, because this is the more common SI unit.

b) The determination in duplicate has been changed to a single determination.

c) The precision data has been corrected.

d) The normative references have been updated.

ISO 2811 consists of the following parts, under the general title *Paints and varnishes — Determination of density*:

⎯ *Part 1: Pyknometer method*

⎯ *Part 2: Immersed body (plummet) method*

⎯ *Part 3: Oscillation method*

⎯ *Part 4: Pressure cup method*

Paints and varnishes — Determination of density —

Part 3:
Oscillation method

1   Scope

This part of ISO 2811 specifies a method for determining the density of paints, varnishes and related products using an oscillator.

The method is suitable for all materials, including paste-like coatings. If a pressure-resistant type of apparatus is used, the method is also applicable to aerosols.

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 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
density
ρ
mass divided by the volume of a portion of a material

NOTE   This is expressed in grams per cubic centimetre.

4   Principle

A glass or stainless-steel U-tube is filled with the product under test. The tube is clamped at both ends and then subjected to oscillation. The resonance frequency of the filled tube varies with the mass contained in the tube, i.e. the density of the product under test.

5   Temperature

The effect of temperature on density is highly significant with respect to filling properties, and – varies with the type of product.

Carry out the test at $(23,0 \pm 0,5)$ °C.

NOTE   For some purposes a different temperature, for example $(20,0 \pm 0,5)$ °C, might be needed.

The test sample, tube and oscillator shall be conditioned to the specified or agreed temperature, and it shall be ensured that the temperature variation does not exceed 0,5 °C during testing.

6   Apparatus

Ordinary laboratory apparatus and glassware, together with the following.

6.1   Oscillator, consisting of a glass or stainless-steel U-tube and apparatus to cause the U-tube to oscillate. One model displays the resonance frequency; another calculates and displays the density.

6.2   Thermometer, accurate to 0,2 °C and graduated at intervals of 0,2 °C or finer.

6.3   Temperature-controlled chamber, capable of maintaining the oscillator and test sample at the specified or agreed temperature (see Clause 5).

6.4   Disposable plastic syringe, of sufficient capacity to fill the U-tube.

7   Sampling

Take a representative sample of the product under test, as described in ISO 15528. Examine and prepare the sample as described in ISO 1513.

8   Procedure

8.1   General

Carry out a single determination on a fresh test sample.

8.2   Determination

Ensure that the apparatus is clean, both by inspection and by checking that the display indicates the density of air (or the corresponding period of oscillation at resonance).

Fill the U-tube with the product under test (about 2 cm^3) in accordance with the oscillator manufacturer's instructions (i.e. until the level is above the upper of the two clamps holding the U-tube). Avoid introducing air bubbles, which cause unsteady readings.

NOTE   The presence of non-visible air bubbles becomes apparent due to the fact that the measured values vary considerably.

Close the upper filler-hole. Using the thermometer (6.2), check that the temperature of the temperature-controlled chamber is within the specified limits.

Start up and operate the oscillator in accordance with the manufacturer's instructions.

If using an apparatus which displays the period of oscillation at resonance, take at least three readings of the period of oscillation, T, and at least two of the temperature. The values of T shall not differ by more than 0,000 1 ms. If they do, make three more measurements.

If using an apparatus which displays the density directly, take at least three readings of the density and at least two of the temperature. The density values shall not differ by more than 0,000 2 g/cm^3. If they do, make three more measurements.

After the measurements, clean the apparatus in accordance with the manufacturer's instructions. It is essential to leave it clean and dry, and to check that the display indicates the density of air (or the corresponding period of oscillation).

9 Calculation

If the period of oscillation, T, has been read, calculate the density, ρ, using Equation (1):

$$\rho = \frac{1}{A} \times \left(T^2 - B\right)$$

(1)

where A and B are two apparatus constants (see Annex A).

If the temperature used is not the reference temperature, the density can be calculated using Equation (C.1).

10 Precision

10.1 General

The precision of the method depends on the characteristics of the product to be tested. For materials which contain no entrapped air, the values in 10.2 and 10.3 are valid.

10.2 Repeatability limit, r

The value below which the absolute difference between two single test results, obtained on identical material by one operator in one laboratory using the same equipment within a short interval of time using the standardized test method, may be expected to lie, with a 95 % probability, is 0,001 g/cm^3.

10.3 Reproducibility limit, R

The value below which the absolute difference between two test results, obtained on identical material by operators in different laboratories using the standardized test method, may be expected to lie, with a 95 % probability, is 0,002 g/cm^3.

11 Test report

The test report shall include at least the following information:

a) all details necessary to identify the product tested;

b) a reference to this part of ISO 2811, i.e. ISO 2811-3:2011;

c) the type (model) of apparatus used;

d) the test temperature;

e) the density measurement determined in accordance with 8.2, or the density calculated in accordance with Clause 9, in grams per cubic centimetre, rounded to the nearest 0,001 g/cm^3;

f) any deviation from the test method specified;

g) any unusual features (anomalies) observed during the test;

h) the date of the test.

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Annex A
(normative)

Calibration of the apparatus — Determination of the apparatus constants

A.1 General

If using an apparatus which displays the period of oscillation at resonance, the apparatus constants need to be determined for use in Equation (A.1). If using an apparatus which displays the density directly, the constants are entered into the memory of the data-processing unit of the apparatus.

The apparatus constants have to be determined and regularly checked by the user. They are usually obtained by measurements in air and in distilled or deionized water of at least grade 2 purity, as defined in ISO 3696.

A.2 Procedure

Make several measurements with air and water over a period of several minutes in each case, as described in 8.2. If the values obtained are not constant, repeat the measurements.

The apparatus constants are valid only at temperatures which do not differ from the temperature, t_T, at which they were determined by more than 0,5 °C. For other test temperatures, the constants shall be determined again.

The apparatus constants shall be determined at the beginning of each series of measurements and checked at the end.

NOTE   Differences can occur in the period of oscillation due to the presence of impurities.

A.3 Calculation of apparatus constants

Calculate the mean values of the period of oscillation for water, T_W, and for air, T_A. Use these mean values to calculate the two apparatus constants, A and B, as given by Equation (A.1):

$$\rho = \frac{1}{A} \times \left(T^2 - B \right) \tag{A.1}$$