INTERNATIONAL STANDARD

ISO 2811-3

Third edition

Paints and varnishes — Determination of density —

Part 3: Oscillation method

Peintures et vernis — Détermination de la masse volumique —

Partie 3: Méthode par oscillation

PROOF/ÉPREUVE

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Foreword

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This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, *Paints and varnishes,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 2811-3:2011), which has been technically revised.

The main changes are as follows:

— a requirement has been added to 8.2, to de-aerate the sample prior to the determination in order to achieve reproducible results for the density;

— Table B.3 has been deleted;

— a bibliography has been added.

A list of all parts in the ISO 2811 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paints and varnishes — Determination of density —

Part 3: Oscillation method

1 Scope

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

Note 1 to entry: It is expressed in grams per cubic centimetre.

[SOURCE: ISO 2811-1:2023, 3.1]

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 ± 0,5) °C.

NOTE For some purposes, a different temperature such as (20,0 ± 0,5) °C can be required.

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, with an uncertainty of measurement of 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 specified in ISO 15528. Examine and prepare the sample as specified 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). Density values for damp air are shown in Annex B.

Depending on the matrix, the sample shall be de-aerated prior to the determination in order to achieve reproducible results for the density.

NOTE 1 For waterborne coating matrices, de-aeration with a suitable mixing machine for about 30 s at 2 000 min^{-1} was found to be suitable.

Fill the U-tube with the product under test (about 2 cm^3), if necessary, after de-aeration, 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 2 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 the apparatus 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 Formula (1):

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

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 Annex C.

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, can 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, can 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 document, i.e. ISO 2811-3:—;

c) the type (model) of apparatus used;

d) the test temperature;

e) the density of the product tested, either directly read from the display of the test apparatus in accordance with 8.2 or 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.

Annex A
(informative)

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 shall be determined for use in Formula (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 shall 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. Density values for damp air and air-free water are shown in Tables B.1 and B.2.

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 Formula (A.1):

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

Annex B
(informative)

Density values for damp air and air-free water

Table B.1 — Density of damp air

Temperature	Pressure hPa (mbar) 900	920	940	960	980	1 000	1 013,25	1 050	Relative humidity
°C	Density ρ_A g/cm^3								%
15	0,001 08	0,001 11	0,001 13	0,001 15	0,001 18	0,001 20	0,001 22	0,001 26	89
20	0,001 06	0,001 09	0,001 11	0,001 13	0,001 16	0,001 18	0,001 20	0,001 24	65
25	0,001 05	0,001 07	0,001 09	0,001 12	0,001 14	0,001 16	0,001 18	0,001 22	48
30	0,001 03	0,001 05	0,001 07	0,001 10	0,001 12	0,001 14	0,001 16	0,001 20	35,8
35	0,001 01	0,001 03	0,001 06	0,001 08	0,001 10	0,001 12	0,001 14	0,001 18	27
40	0,001 00	0,001 02	0,001 04	0,001 06	0,001 08	0,001 11	0,001 12	0,001 16	20,6
45	0,000 98	0,001 00	0,001 02	0,001 05	0,001 07	0,001 09	0,001 10	0,001 14	15,9
50	0,000 96	0,000 99	0,001 01	0,001 03	0,001 05	0,001 07	0,001 09	0,001 13	12,3

