SRI LANKA STANDARD 1256: PART 5: 2019
(ISO 2811-1: 2016)
UDC 667.661

METHODS OF TEST FOR PAINTS AND VARNISHES
PART 5: DETERMINATION OF DENSITY
(FIRST REVISION)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard
METHODS OF TEST FOR PAINTS AND VARNISHES
PART 5: DETERMINATION OF DENSITY
(FIRST REVISION)

SLS 1256: Part 5: 2019
(ISO 2811-1: 2016)

Gr. E

SRI LANKA STANDARDS INSTITUTION
17, Victoria Place
Elvitigala Mawatha
Colombo - 08
Sri Lanka.

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract

Sri Lanka Standard
METHODS OF TEST FOR PAINTS AND VARNISHES
PART 5: DETERMINATION OF DENSITY
(FIRST REVISION)

NATIONAL FOREWORD

This Standard was approved by the Sectoral Committee on Chemical and Polymer Technology and authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2019-10-22

This Sri Lanka Standard was first published in 2004 which was an adoption of ISO 2811-1: 1997 Paints and varnishes, Determination of density, Part 1: Pycnometer method. The text of the above International Standard has been technically revised as ISO 2811-1: 2016 Paints and varnishes, Determination of density, Part 1: Pycnometer method. The International Standard ISO 811-1: 2016 has been accepted for adoption as the First Revision of SLS 1256: Part 5: 2019.

This Sri Lanka Standard is identical with ISO 2811-1: 2016 Paints and varnishes – Determination of density, Part 1: Pycnometer method, published by the International Organization for Standardization (ISO).

TERMINOLOGY AND CONVENTIONS

The text of the International Standard has been accepted as suitable for publication, without deviation, as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following:

a) Wherever the words “International Standard” appear referring to a particular Standard they should be interpreted as “Sri Lanka Standard”.

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards it is the current practice to use the full point at the base as the decimal marker.

c) Wherever page numbers are quoted, they are ISO page numbers.

Cross References

International Standard	Corresponding Sri Lanka Standard
ISO 1513, Paints and varnishes - Examination and preparation of test samples	SLS 1256, Methods of test for paints and varnishes Part 1: Examination and preparation of samples for testing
ISO 3696, Water for analytical laboratory use - Specification and test methods	No corresponding Sri Lanka Standard
ISO 15528, Paints, varnishes and raw materials for paints and varnishes - Sampling	SLS 523, Methods of sampling for paints, varnishes and raw materials for paints and varnishes

.....

INTERNATIONAL STANDARD

ISO 2811-1

Third edition
2016-03-01

Paints and varnishes — Determination of density —

Part 1: Pycnometer method

Peintures et vernis — Détermination de la masse volumique —

Partie 1: Méthode pycnométrique

Reference number
ISO 2811-1:2016(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This third edition cancels and replaces the second edition (ISO 2811-1:2011), which has been technically revised with the following changes:

a) the information on the accuracy of the analytical balance (6.2) and the thermometer (6.3) was changed;

b) a requirement was added that the sample shall be free from air bubbles;

c) the spelling of pycnometer was corrected.

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

— *Part 1: Pycnometer method*

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

— *Part 3: Oscillation method*

— *Part 4: Pressure cup method*

Paints and varnishes — Determination of density —

Part 1:
Pycnometer method

1 Scope

This part of ISO 2811 specifies a method for determining the density of paints, varnishes and related products using a metal or Gay-Lussac pycnometer.

The method is limited to materials of low or medium viscosity at the temperature of test. The Hubbard pycnometer (see ISO 3507) can be used for highly viscous materials.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 1 to entry: It is expressed in grams per cubic centimetre.

4 Principle

A pycnometer is filled with the product under test. The density is calculated from the mass of the product in the pycnometer and the known volume of the pycnometer.

5 Temperature

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

For international reference purposes, it is essential to standardize one test temperature, and (23,0 ± 0,5) °C is specified in this part of ISO 2811. It can be more convenient, however, to carry out comparative testing at some other agreed temperature, for example (20,0 ± 0,5) °C, as specified by relevant weights and measures legislation (see B.2).

The test sample and pycnometer 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 Pycnometer

6.1.1 Metal pycnometer, with a volume of either 50 cm^3 or 100 cm^3, a circular cross-section and a cylindrical form, made of a smoothly finished corrosion-resistant material with a snugly fitting lid having a hole in its centre.

The inside of the lid shall be concave (see Figure 1).

or

6.1.2 Glass pycnometer, with a volume in the range 10 cm^3 to 100 cm^3 (Gay-Lussac type) (see Figure 2).

6.2 Analytical balance, accurate to 1 mg for pycnometers for less than 50 ml or accurate to 10 mg for 50 ml to 100 ml pycnometers.

The accuracy of the balance required depends on the size of the pycnometer used (see also 8.2).

6.3 Thermometer, with an accuracy of 0,2 °C.

NOTE Typically, a thermometer with an accuracy of 0,2 °C has a resolution of 0,05 °C.

6.4 Temperature-controlled chamber, capable of accommodating the balance, pycnometer and test sample and maintaining them at the specified or agreed temperature (see Clause 5), or **water bath**, capable of maintaining the pycnometer and test sample at the specified or agreed temperature.

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. The sample shall be free from any air bubbles.

8 Procedure

8.1 General

Carry out a single determination on a fresh test sample.

The pycnometer shall be calibrated. An example of a calibration method is given in Annex A.

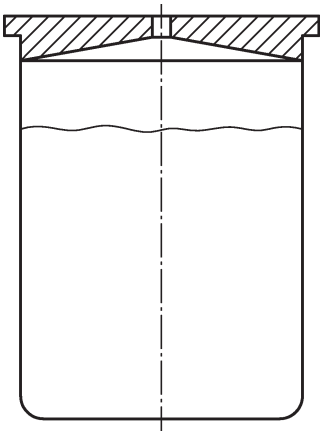


Figure 1 — Metal pycnometer

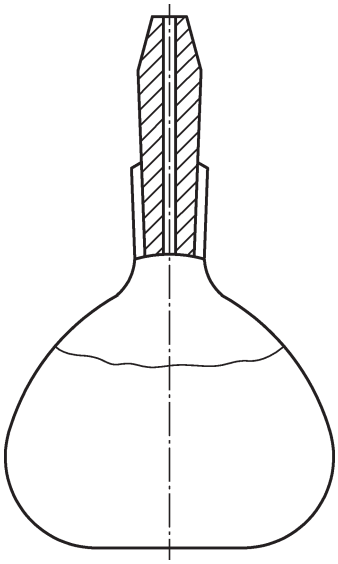


Figure 2 — Gay-Lussac pycnometer

8.2 Determination

If working with a temperature-controlled chamber (see 6.4), put the pycnometer (6.1) and the test sample next to the balance (6.2) in the chamber maintained at the specified or agreed temperature.

If working with a water bath (see 6.4) rather than a temperature-controlled chamber, put the pycnometer and the test sample in the water bath, maintained at the specified or agreed temperature.

Allow approximately 30 min for temperature equilibrium to be reached.

Using the thermometer (6.3), measure the temperature, t_T, of the test sample.

Check throughout the determination that the temperature of the chamber or water bath remains within the specified limits.

Weigh the pycnometer and record the mass, m_1, to the nearest 10 mg for 50 cm^3 to 100 cm^3 pycnometers and to the nearest 1 mg for pycnometers less than 50 cm^3 in volume.

Fill the pycnometer with the product under test, taking care to avoid the formation of air bubbles. Place the lid or stopper of the pycnometer firmly in position and wipe off any excess liquid from the outside of the pycnometer with an absorbent material wetted with solvent; wipe carefully with cotton wool.

Record the mass of the pycnometer filled with the product under test, m_2.

NOTE Liquid adhering to the ground-glass surfaces of a glass pycnometer or to the areas of contact between the lid and body of a metal pycnometer causes too high a balance reading. This source of error can be minimized by ensuring that the joints are firmly seated and by limiting air bubbles.

9 Calculation

Calculate the density, ρ, of the product, in grams per cubic centimetre, at the test temperature, t_T, using Formula (1):

$$\rho = \frac{m_2 - m_1}{V_t} \quad (1)$$

where

m_1 is the mass, in grams, of the empty pycnometer;

m_2 is the mass, in grams, of the pycnometer filled with the product at the test temperature, t_T;

V_t is the volume, in cubic centimetres, of the pycnometer at the test temperature, t_T, determined in accordance with Annex B.

NOTE The result is not corrected for air buoyancy because the uncorrected value is required by most filling-machine control procedures and the correction (0,001 2 g/cm^3) is negligible in relation to the precision of the method.

If the test temperature used is not the reference temperature, the density may be calculated using Formula (B.2).

10 Precision

10.1 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 for solvents, and

— 0,005 g/cm^3 for coating materials.

10.2 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 for solvents, and

— 0,007 g/cm^3 for coating materials.

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 2811-1;

c) the type of pycnometer used;

d) the test temperature;

e) the result of the density measurement, in grams per cubic centimetre, rounded to the nearest 0,001 g/cm^3 for pycnometers less than 50 cm^3 in volume and to the nearest 0,01 g/cm^3 for 50 cm^3 to 100 cm^3 pycnometers;

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)

Example of a calibration method

A.1 Procedure

Clean the pycnometer carefully inside and outside using a solvent which leaves no residue on evaporation and thoroughly dry it. Avoid leaving fingerprints on the pycnometer as they can falsify the balance reading.

Allow the pycnometer to stand next to the balance for 30 min to reach ambient temperature, then weigh it (m_1).

Fill the pycnometer with distilled or deionized water, of grade 2, as defined in ISO 3696, which has been previously boiled and then brought to a temperature not more than 1 °C below the test temperature and close it with the lid or stopper. Take care to prevent the formation of bubbles in the pycnometer.

Place the pycnometer on the water bath or in the temperature-controlled chamber and allow it to reach the test temperature. Remove any overflow by wiping with absorbent material (cloth or paper). Remove the pycnometer from the water bath or chamber and thoroughly dry its outer surface. Prevent any further heating of the pycnometer and ensure that there is no further overflow of water. Immediately weigh the filled pycnometer (m_3).

Since handling the pycnometer with bare hands increases its temperature and causes more overflow, as well as leaving fingerprints, the use of tongs or cellulose wadding for handling is recommended.

Immediate and rapid weighing of the filled pycnometer is necessary in order to minimize loss in mass due to evaporation of water through the overflow orifice.

It is essential that the pycnometer be calibrated at the same temperature as the density of the product under test is determined, since the volume of the pycnometer varies with the temperature. Otherwise, a correction should be made, as specified in Annex B.

A.2 Calculation of the volume of the pycnometer

Calculate the volume of the pycnometer, V_t, in cubic centimetres, at temperature, t_T, using Formula (A.1) or (A.2):

$$V_t = \frac{m_3 - m_1}{\rho_W - \rho_A} \times \left(1 - \frac{\rho_A}{\rho_G}\right) \tag{A.1}$$

$$V_t = \frac{m_3 - m_1}{\rho_W - 0,001\ 2} \times 0,999\ 85 \tag{A.2}$$

where

m_1 is the mass, in grams, of the empty pycnometer;

m_3 is the mass, in grams, of the pycnometer filled with distilled water at the test temperature, t_T;

ρ_W is the density, in grams per cubic centimetre, of pure water at the test temperature, t_T (see Table A.1);

ρ_A is the density of air (= 0,001 2 g/cm^3);

ρ_G is the density of the balance weights used (for steel, ρ_G = 8 g/cm^3).

Table A.1 — Density of pure, air-free water

Temperature t_T °C	Density ρ_W g/cm^3	Temperature t_T °C	Density ρ_W g/cm^3	Temperature t_T °C	Density ρ_W g/cm^3
10	0,999 7	22	0,997 8	25	0,997 0
11	0,999 6				
12	0,999 5	22,1	0,997 8	25,1	0,997 0
13	0,999 4	22,2	0,997 7	25,2	0,997 0
14	0,999 2	22,3	0,997 7	25,3	0,997 0
15	0,999 1	22,4	0,997 7	25,4	0,996 9
16	0,998 9	22,5	0,997 7	25,5	0,996 9
17	0,998 8	22,6	0,997 6	25,6	0,996 9
18	0,998 6	22,7	0,997 6	25,7	0,996 9
19	0,998 4	22,8	0,997 6	25,8	0,996 8
		22,9	0,997 6	25,9	0,996 8
20	0,998 2	23	0,997 5	26	0,996 8
				27	0,996 5
20,1	0,998 2	23,1	0,997 5	28	0,996 2
20,2	0,998 2	23,2	0,997 5	29	0,995 9
20,3	0,998 1	23,3	0,997 5	30	0,995 7
20,4	0,998 1	23,4	0,997 4	31	0,995 3
20,5	0,998 1	23,5	0,997 4	32	0,995 0
20,6	0,998 1	23,6	0,997 4	33	0,994 7
20,7	0,998 1	23,7	0,997 4	34	0,994 4
20,8	0,998 0	23,8	0,997 3	35	0,994 0
20,9	0,998 0	23,9	0,997 3		
21	0,998 0	24	0,997 3	36	0,993 7
				37	0,993 3
21,1	0,998 0	24,1	0,997 3	38	0,993 0
21,2	0,998 0	24,2	0,997 2	39	0,992 6
21,3	0,997 9	24,3	0,997 2	40	0,992 2
21,4	0,997 9	24,4	0,997 2		
21,5	0,997 9	24,5	0,997 2		
21,6	0,997 9	24,6	0,997 1		
21,7	0,997 8	24,7	0,997 1		
21,8	0,997 8	24,8	0,997 1		
21,9	0,997 8	24,9	0,997 1		

Annex B
(informative)

Temperature variation

B.1 Correction for thermal expansion of the pycnometer

If the test temperature, t_T, differs by more than 5 °C from the temperature at which the volume of the pycnometer is known, the density should preferably be corrected for the change in volume of the pycnometer.

Calculate, to five significant figures, the volume, V_t, in cubic centimetres, of the pycnometer at the test temperature using Formula (B.1):

$$V_t = V_C \left[1 + \gamma_P \left(t_T - t_C\right)\right] \quad \text{(B.1)}$$

where

V_C is the volume, in cubic centimetres, of the pycnometer at the calibration temperature, t_C;

γ_P is the volume coefficient of thermal expansion, in reciprocal degrees Celsius ($°C^{-1}$), of the material from which the pycnometer is made (see Table B.1);

t_T is the test temperature, in degrees Celsius;

t_C is the calibration temperature, in degrees Celsius.

Table B.1 — Volume coefficient of thermal expansion, γ_P, of materials used for pycnometers

Material	Volume coefficient of thermal expansion γ_P $°C^{-1}$
Borosilicate glass	10×10^{-6}
Soda-lime glass	25×10^{-6}
Austenitic stainless steel	48×10^{-6}
Copper-zinc alloy (brass)	54×10^{-6} [Value for CuZn37 (Ms63)]
Aluminium	69×10^{-6}

B.2 Calculation of density at the reference temperature from measurements at other temperatures

If the density of the product under test is determined at a temperature different from the reference temperature, the density, ρ_C, in grams per cubic centimetre, at the reference temperature can be calculated as given by Formula (B.2):

$$\rho_C = \frac{\rho_t}{\left[1 + \gamma_m \left(t_C - t_T\right)\right]} = \rho_t \left[1 - \gamma_m \left(t_C - t_T\right)\right] \quad \text{(B.2)}$$

where

ρ_t is the density, in grams per cubic centimetre, of the product at the test temperature;

γ_m is the volume coefficient of thermal expansion of the product under test, the approximate value of γ_m being $2 \times 10^{-4}\ °C^{-1}$ for waterborne paints and $7 \times 10^{-4}\ °C^{-1}$ for other paints;

t_C is the reference temperature, in degrees Celsius;

t_T is the test temperature, in degrees Celsius.

Bibliography

[1] ISO 3507, *Laboratory glassware — Pyknometers*

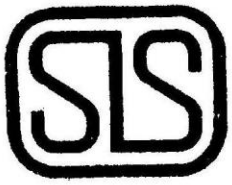
ICS 87.040

Price based on 10 pages

SLS CERTIFICATION MARK

The Sri Lanka Standards Institution is the owner of the registered certification mark shown below. Beneath the mark, the number of the Sri Lanka Standard relevant to the product is indicated. This mark may be used only by those who have obtained permits under the SLS certification marks scheme. The presence of this mark on or in relation to a product conveys the assurance that they have been produced to comply with the requirements of the relevant Sri Lanka Standard under a well designed system of quality control inspection and testing operated by the manufacturer and supervised by the SLSI *which includes surveillance inspection of the factory, testing of both factory and market samples.*

Further particulars of the terms and conditions of the permit may be obtained from the Sri *Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.*



Printed at SLSI (Printing Unit)

SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

The Institution is financed by Government grants, and by the income from the sale of its publications and other services offered for Industry and Business Sector. Financial and administrative control is vested in a Council appointed in accordance with the provisions of the Act.

The development and formulation of National Standards is carried out by Technical Experts and representatives of other interest groups, assisted by the permanent officers of the Institution. These Technical Committees are appointed under the purview of the Sectoral Committees which in turn are appointed by the Council. The Sectoral Committees give the final Technical approval for the Draft National Standards prior to the approval by the Council of the SLSI.

All members of the Technical and Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such fields of standardization as are of special interest to Sri Lanka.

Printed at the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.