INTERNATIONAL STANDARD

ISO 11890-1

Second edition
2007-07-01

Paints and varnishes — Determination of volatile organic compound (VOC) content —

Part 1: Difference method

Peintures et vernis — Détermination de la teneur en composés organiques volatils (COV) —

Partie 1: Méthode par différence

Reference number
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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 11890-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 11890-1:2000), which has been technically revised. The main change is that, in order to allow the method to be used for multi-component systems as well as single-component systems, the test portion preparation procedures for the determination of the non-volatile-matter content of each of these two types of system has been included in Subclause 7.4.

ISO 11890 consists of the following parts, under the general title *Paints and varnishes — Determination of volatile organic compound (VOC) content*:

— *Part 1: Difference method*

— *Part 2: Gas-chromatographic method*

Paints and varnishes — Determination of volatile organic compound (VOC) content —

Part 1: Difference method

1 Scope

This part of ISO 11890 is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products.

It specifies a method for the determination of the volatile organic compound (VOC) content of paints, varnishes and their raw materials. This part may be used where the expected VOC content is greater than 15 % by mass. When the expected VOC content is greater than 0,1 % by mass and less than 15 % by mass, ISO 11890-2 should be employed.

This method assumes that the volatile matter is either water or organic. However, other volatile inorganic compounds can be present and might need to be quantified by another suitable method and allowed for in the calculations.

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 760, *Determination of water — Karl Fischer method (General method)*

ISO 1513, *Paints and varnishes — Examination and preparation of samples for testing*

ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pyknometer method*

ISO 2811-2, *Paints and varnishes — Determination of density — Part 2: Immersed body (plummet) method*

ISO 2811-3, *Paints and varnishes — Determination of density — Part 3: Oscillation method*

ISO 2811-4, *Paints and varnishes — Determination of density — Part 4: Pressure cup method*

ISO 3251:2003, *Paints, varnishes and plastics — Determination of non-volatile-matter content*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 11890-2, *Paints and varnishes — Determination of volatile organic compound (VOC) content — Part 2: Gas-chromatographic method*

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
volatile organic compound
VOC
any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure of the atmosphere with which it is in contact

NOTE 1 As to correct usage of the term VOC in the field of coating materials, see volatile organic compound content (VOC content).

NOTE 2 Under U.S. government legislation, the term VOC is restricted solely to those compounds that are photochemically active in the atmosphere (see ASTM D 3960). Any other compound is defined as being an exempt compound.

[ISO 4618:2006]

NOTE 3 Under European legislation, EU Directive 2004/42/EC, the term VOC refers to volatile organic compounds with boiling points up to 250 °C, measured at a standard pressure of 101,3 kPa.

3.2
volatile organic compound content
VOC content
mass of the volatile organic compounds present in a coating material, as determined under specified conditions

NOTE 1 The properties and the amounts of the compounds to be taken into account will depend on the field of application of the coating material. For each field of application, the limiting values and the methods of determination or calculation are stipulated by regulations or by agreement.

[ISO 4618:2006]

NOTE 2 If the term VOC refers to compounds with a defined maximum boiling point (see Note 3 to 3.1), the compounds considered to be part of the VOC content are those with boiling points below that limit and compounds with higher boiling points are considered to be non-volatile organic compounds.

3.3
exempt compound
organic compound that does not participate in atmospheric photochemical reactions

NOTE See Notes 2 and 3 to 3.1.

3.4
ready for use
state of a product when it is mixed in accordance with the manufacturer's instructions in the correct proportions and thinned, if required, using the correct thinners so that it is ready for application by the approved method

4 Principle

After preparation of the sample, the non-volatile matter content is determined in accordance with ISO 3251, and the water content is determined using a titration technique employing Karl Fischer reagent in accordance with ISO 760. The contents of exempt compounds, if applicable, are then determined using the method specified in ISO 11890-2. The VOC content of the sample is then calculated.

5 Required supplementary information

For any particular application, the test method specified in this part of ISO 11890 shall be completed by supplementary information. The items of supplementary information are given in Annex A.

6 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system) as specified in ISO 15528.

Examine and prepare each sample for testing, as specified in ISO 1513, preparing the final sample for testing in the “ready for use” state.

7 Procedure

7.1 Number of determinations and general test conditions

Carry out all tests in duplicate at (23 ± 2) °C and a relative humidity of (50 ± 5) % unless otherwise agreed (see ISO 3270).

7.2 Determination of parameters

Determine the parameters required by the calculation (see 8.2 to 8.5) as specified in 7.3 to 7.6. Some may be determined by difference, depending on the compounds present in the sample.

7.3 Density

If required by the calculation (see 8.3 to 8.5), determine the density of the sample using the part of ISO 2811 which will give the best precision for the type of sample concerned. Determine the density at 23 °C.

7.4 Non-volatile-matter content

For single-component products, weigh test portions of the appropriate size (see Table 1 in ISO 3251:2003) into dishes as specified in ISO 3251. Proceed in accordance with ISO 3251.

For multi-component systems, thoroughly mix the components in accordance with the manufacturer’s instructions. Immediately weigh test portions of the appropriate size (see Table 1 in ISO 3251:2003) into dishes as specified in ISO 3251. Allow the test portions to stand in the dishes for 1 h at (23 ± 2) °C and atmospheric pressure. Then place the dishes in the oven and proceed in accordance with ISO 3251.

If any unusual decomposition or degradation occurs during heating, periods of time and/or temperatures different from those given in ISO 3251 may be used by agreement between the interested parties.

7.5 Water content

Determine the water content, as a percentage by mass, by the method given in ISO 760, selecting the reagents so that there will be no interference from the compounds contained in the sample. If the compounds are not known, then determine them qualitatively, e.g. by the method given in ISO 11890-2.

NOTE 1 Typical compounds likely to cause interference are ketones and aldehydes. Reagent manufacturers normally publish literature for guidance on correct reagent selection.

NOTE 2 If the product to be tested is well characterized and known not to contain water, it is not necessary to determine the water content, and the water content can be assumed to be zero.

7.6 Exempt compounds (only where national legislation applies)

7.6.1 If the organic compounds contained in the sample are not known, then determine them qualitatively, e.g. by the method specified in ISO 11890-2.

7.6.2 Determine the contents of the exempt compounds contained in the sample using the method specified in ISO 11890-2.

7.6.3 Determine the densities of the exempt compounds by the method given in 7.3, or by referring to published reference data.

8 Calculation

8.1 General

Calculate the VOC content by the method specified in the referring specification. If no particular method is specified, calculate the VOC content by method 1.

Method 1 is the preferred calculation method as the precision is better since it does not involve the determination of density, which introduces the potential for additional errors.

8.2 Method 1: VOC content, as a percentage by mass, of the product "ready for use"

$$\mathrm{VOC} = 100 - \mathrm{NV} - w_{\mathrm{w}} \tag{1}$$

where

VOC is the VOC content, as a percentage by mass, of the product "ready for use";

NV is the non-volatile-matter content, as a percentage by mass (see 7.4);

w_{w} is the water content, as a percentage by mass (see 7.5).

8.3 Method 2: VOC content, in grams per litre, of the product "ready for use"

$$\mathrm{VOC} = (100 - \mathrm{NV} - w_{\mathrm{w}}) \times \rho_{\mathrm{s}} \times 10 \tag{2}$$

where

VOC is the VOC content, in grams per litre, of the product "ready for use";

NV is the non-volatile-matter content, as a percentage by mass (see 7.4);

w_{w} is the water content, as a percentage by mass (see 7.5);

ρ_{s} is the density, in grams per millilitre, of the sample at 23 °C (see 7.3);

10 is a conversion factor to convert to grams per litre.

8.4 Method 3: VOC content, in grams per litre, of the product “ready for use” less water

$$\mathrm{VOC_{lw}} = \left(\frac{100 - \mathrm{NV} - w_\mathrm{w}}{100 - \rho_\mathrm{s} \times \dfrac{w_\mathrm{w}}{\rho_\mathrm{w}}} \right) \times \rho_\mathrm{s} \times 1\,000 \qquad (3)$$

where

$\mathrm{VOC_{lw}}$ is the VOC content, in grams per litre, of the product “ready for use” less water;

NV is the non-volatile-matter content, as a percentage by mass (see 7.4);

w_w is the water content, as a percentage by mass (see 7.5);

ρ_s is the density, in grams per millilitre, of the sample at 23 °C (see 7.3);

ρ_w is the density, in grams per millilitre, of water at 23 °C (ρ_w = 0,997 537 g/ml at 23 °C);

1 000 is a conversion factor to convert grams per millilitre to grams per litre.

8.5 Method 4: VOC content, in grams per litre, of the product “ready for use” less water and less exempt compounds (only required if national legislation applies)

$$\mathrm{VOC_{lwe}} = \left(\frac{100 - \mathrm{NV} - w_\mathrm{w} - \sum_{i=1}^{i=n} w_{\mathrm{ec}i}}{100 - \rho_\mathrm{s} \times \dfrac{w_\mathrm{w}}{\rho_\mathrm{w}} - \rho_\mathrm{s} \times \sum_{i=1}^{i=n} \dfrac{w_{\mathrm{ec}i}}{\rho_{\mathrm{ec}i}}} \right) \times \rho_\mathrm{s} \times 1\,000 \qquad (4)$$

where

$\mathrm{VOC_{lwe}}$ is the VOC content, in grams per litre, of the product “ready for use” less water and less exempt compounds;

NV is the non-volatile-matter content, as a percentage by mass, of the sample (see 7.4);

w_w is the water content, as a percentage by mass (see 7.5);

$w_{\mathrm{ec}i}$ is the content, as a percentage by mass, of exempt compound i (see 7.6.2);

ρ_s is the density, in grams per millilitre, of the sample at 23 °C (see 7.3);

ρ_w is the density, in grams per millilitre, of water at 23 °C (ρ_w = 0,997 537 g/ml at 23 °C);

$\rho_{\mathrm{ec}i}$ is the density, in grams per millilitre, of exempt compound i (see 7.6.3);

1 000 is a conversion factor to convert grams per millilitre to grams per litre.

9 Expression of results

If the two results (duplicates) differ by more than the value indicated in 10.2, repeat the procedure.

Calculate the mean of two valid results (replicates) and report the result to the nearest 1 %.

10 Precision

10.1 General

The precision of the test method was determined by interlaboratory testing in accordance with ISO 5725-1 and ISO 5725-2. Three different materials were tested by five to seven laboratories. Some of the results were not considered when calculating the precision because they were not within the scope of the test method (see footnote “a” to Table 1). Their VOC content was below 15 % by mass but they were tested for a better comparison with the precision of ISO 11890-2.

10.2 Repeatability limit r

The repeatability limit r is the value below which the absolute difference between two single test results, each the mean of duplicates, obtained on identical material by one operator in one laboratory within a short interval of time using the standardized test method, may be expected to lie.

The repeatability for five repeated determinations made using this test method, expressed as the repeatability coefficient of variation CV(r), is 1 %.

10.3 Reproducibility limit R

The reproducibility limit R is the value below which the absolute difference between two test results, each the mean of duplicates, obtained on identical material by operators in different laboratories using the standardized test method, may be expected to lie.

The reproducibility for this test method, expressed as the reproducibility coefficient of variation CV(R), is 2 %.

Table 1 — Results of interlaboratory testing

Parameter	Cathodic electro-deposition paint [a]	Water-borne paint [a]	Two-component varnish
Number of laboratories	7	5	6
Number of repeated determinations	5	5	5
Mean value (% by mass)	11,46	11,11	39,8
Reproducibility standard deviation	0,93	2,25	0,76
Reproducibility coefficient of variation	8,1	20,3	1,9
Repeatability standard deviation	0,54	0,29	0,23
Repeatability coefficient of variation	4,7	2,6	0,6

[a] Not considered for the precision because the mean value is below 15 % by mass.

11 Test report

The test report shall contain at least the following information:

a) a reference to this part of ISO 11890 (ISO 11890-1);

b) all details necessary for complete identification of the product tested (manufacturer, trade name, batch number, etc.);

c) the items of supplementary information referred to in Annex A;

d) a reference to the international or national standard, product specification or other document supplying the information referred to in c) above;

e) the results of the test, as indicated in Clause 8, and the method of calculation used (8.2, 8.3, 8.4 or 8.5);

f) any deviation from the test method specified;

g) the date of the test.

Annex A
(normative)

Required supplementary information

The items of supplementary information listed in this annex shall be supplied as appropriate to enable the method to be carried out.

The information required should preferably be agreed between the interested parties and may be derived, in part or totally, from an international or national standard or other document related to the product under test.

a) The organic compound(s) to be determined (if known).

b) The analytical method(s) to be used to identify these compounds.

c) Which of the organic compounds in a) are exempt compounds (see 7.6).

d) The method of calculation to be used (see Clause 8).

Bibliography

[1] ISO 4618:2006, *Paints and varnishes — Terms and definitions*

[2] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[3] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

[4] ASTM D 3960, *Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings*

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