INTERNATIONAL STANDARD

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Second edition
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Paints and varnishes — Determination of percentage volume of non-volatile matter —

Part 1: Method using a coated test panel to determine non-volatile matter and to determine dry-film density by the Archimedes' principle

Peintures et vernis — Détermination du pourcentage en volume de matière non volatile —
Partie 1: Méthode utilisant un panneau d'essai revêtu pour déterminer la matière non volatile et pour déterminer la masse volumique du feuil sec par le principe d'Archimède

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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.

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document 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 3233-1:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the definitions and sources have been updated in Clause 3;

— a minimum mass of 25 mg of the coating on the plate has been added in 7.4.1 because measurements and simulation calculations demonstrate the need for a minimum mass for the coated panel;

— the text has been editorially revised.

A list of all parts in the ISO 3233 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.

Introduction

This method is used to measure the density and to determine the volume of a dry coating obtainable from a given volume of liquid paint. This volume is considered to be the most meaningful measure of the coverage (area of surface covered at a specified dry-film thickness per unit volume) of a paint, varnish or related product. The value obtained by this method might not be the same as that calculated on the basis of the addition of masses and volumes of the raw materials in a formulation. The volume occupied by a combination of resin and solvent can be the same as, greater than or less than the combined volume of the separate components, due to contraction or expansion of the resin and solvent. A second factor affecting the volume of a dry coating formulation is the degree to which the spaces between pigment particles are filled with binder. A third factor is the use of volatile components in reactive systems that, by their reaction, change into non-volatile film-building materials, i.e. amines and reactive solvents in high-build two-component coating materials.

Above and close to the critical pigment volume concentration, the volume of a dry paint film is greater than the theoretical volume, due to an increase in unfilled voids between pigment particles. The porosity of the film means that this method is unsuitable.

The values obtained for the non-volatile matter by volume are dependent on the temperature and time of heating, and these conditions should be carefully considered for the material being tested.

Paints and varnishes — Determination of percentage volume of non-volatile matter —

Part 1:
Method using a coated test panel to determine non-volatile matter and to determine dry-film density by the Archimedes' principle

1 Scope

This document specifies a method for determining the non-volatile matter by volume (NV_V) of coating materials and related products by measuring the density of a dried coating for any specified temperature range and period of drying or curing. This method determines the non-volatile matter immediately after application.

Using the non-volatile matter by volume results obtained in accordance with this document, it is possible to calculate the spreading rate of coating materials.

The method specified in this document is the preferred method for air-drying materials. Its use for other materials has not yet been tested.

Annex B gives an overview of the existing methods for determination of non-volatile-matter content and volume of non-volatile matter.

This document is not applicable to coating materials in which the critical pigment volume concentration is exceeded.

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 2811 (all parts), *Paints and varnishes — Determination of density*

ISO 4618, *Paints and varnishes — Terms and definitions*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

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

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

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

3.1
non-volatile matter
NV
residue by mass obtained by evaporation under specified conditions

Note 1 to entry: Instead of the term "non-volatile matter" different terms, such as solid, dry residue, dry matter, solid matter, stoving residue are being used commonly with the respective abbreviations. The term "non-volatile matter" which is also applied in ISO 3251 should be used together with the abbreviation "NV" instead of these terms.

Note 2 to entry: This document and ISO 3251 specify different conditions for the determination of NV. Therefore, in this document, the symbol NV_m is used for non-volatile matter by mass.

[SOURCE: ISO 4618:2014, 2.176 modified — Note 2 to entry added.]

3.2
non-volatile matter by volume
NV_V
percentage residue by volume obtained by evaporation under specified conditions

3.3
spreading rate
s
surface area that can be covered by a given quantity of coating material to give a dried film of requisite thickness

Note 1 to entry: It is expressed in m^2/l or m^2/kg.

[SOURCE: ISO 4618:2014, 2.238 — modified, symbol *s* added and Note 2 to entry deleted.]

3.4
practical dry-film density
ρ_p
practically determined density of a dried and cured coating

4 Principle

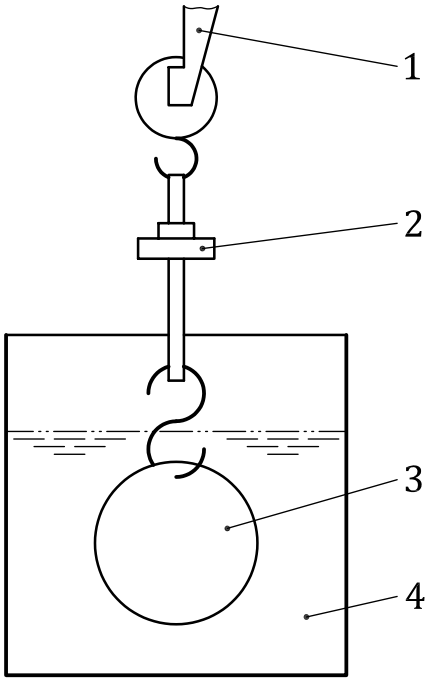
A receptacle (disc or plate) is weighed in air and in water (or other suitable liquid of known density), coated with the product to be tested, dried and reweighed in air and in the same liquid. From these measurements, the mass, the volume and hence the density of the dry coating are calculated. The non-volatile matter by volume is calculated from the quotient of the density of the coating material and the density of the dry film.

5 Apparatus and reagents

Standard laboratory apparatus, together with the following:

5.1 Analytical balance, accurate to 0,1 mg.

A single-pan balance is most convenient, and a useful modification is to replace the balance pan by a standard counterweight attachment as shown in Figure 1.



Key

1 balance arm
2 standard counterweight attachment
3 disc
4 immersion liquid

Figure 1 — Special balance support

5.2 Receptacle (see 7.2).

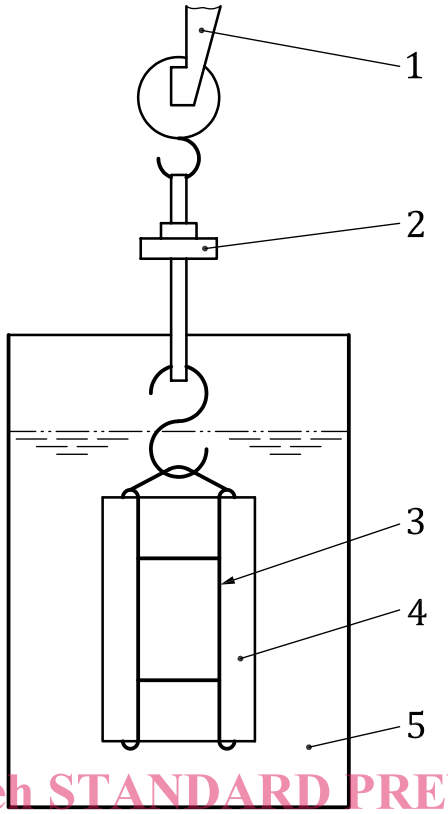
5.2.1 Disc, about 60 mm in diameter and about 0,7 mm thick, with a small hole at least 2 mm to 3 mm from the edge.

A stainless-steel disc has been found satisfactory but has the disadvantage of having a density much in excess of normal liquid coatings. Discs of lighter material, including plastics, for example poly(ethylene terephthalate), are permitted, provided they do not change in volume by contact with the solvents contained in the liquid coating, or during the heating and drying processes involved.

5.2.2 Plate, of size (75 ± 5) mm by (120 ± 5) mm, with a small hole at least 2 mm to 3 mm from the shorter side on the longitudinal axis of the panel.

Glass plates may be used as these are very flat. However, drilling a hole is difficult and therefore, if glass plates are used, they should preferably be suspended in a stirrup or cradle of thin wire (see Figure 2). The diameter of the wire shall not exceed 0,3 mm because of surface tension effects.

Plates of this size might be difficult to accommodate in a balance case. Smaller plates may therefore be used provided the coated area is no less than 5 600 mm^2.



Key

1 balance arm
2 standard counterweight attachment
3 wire cradle
4 plate
5 immersion liquid

Figure 2 — Wire cradle support for plate

5.3 Hook, made of stainless steel or synthetic thread, for attaching the receptacle to the balance during weighing operations. The diameter of the wire shall not exceed 0,3 mm because of surface tension effects.

5.4 Beaker, of size convenient for immersing the receptacle with a clearance of at least 10 mm and which can be accommodated in the balance case.

5.5 Support, for holding the beaker under the balance stirrup without jamming the pan damper, if a counterweight as recommended in 5.1 is not available.

5.6 Immersion liquid, of suitable density, in which the receptacle is immersed.

Distilled water is suitable for most coating materials. An organic liquid which does not affect the paint film may also be used.

5.7 Desiccator, containing a suitable desiccant.

5.8 Air oven, capable of maintaining the specified or agreed test temperature (see Annex A) to ±2 °C (for temperatures up to 150 °C) or ±3,5 °C (for temperatures above 150 °C and up to 200 °C). An air oven with forced ventilation shall be used.

Air ovens of the same type shall be used by all parties for referee tests.

6 Sampling

Take a representative sample of the coating material to be tested, as described in ISO 15528.

Examine and prepare the test samples for testing, as described in ISO 1513.

7 Procedure

7.1 Number of determinations and preparation

Carry out the determination in triplicate.

Samples may be applied to discs or plates by dipping, brushing or applicator as described in 7.4.

Examples of test temperatures and times of drying/curing that may be used for various types of coating material are given in Annex A.

7.2 Choice of receptacle

The choice of receptacle (disc or plate) will depend on the type of coating being measured. Discs should preferably be used for paints of low viscosity and paints which are thinned for spray application. Plates may be used for thixotropic and other coatings which can be drawn down with a doctor blade or for paints applied by dipping or by spin coating.

7.3 Determination of volume of uncoated receptacle

7.3.1 Dry the receptacle (5.2) and suspension hook (5.3) in the oven (5.8), if required, at the recommended temperature for 10 min, cool in the desiccator (5.7) and weigh the receptacle in air. Record this mass as m_1.

7.3.2 Place in the beaker (5.4) sufficient of the liquid (5.6) to ensure that it will be at least 10 mm above the top of the suspended receptacle (see Figure 3). Indicate the level on the side of the beaker and check that this level is maintained throughout the determination. The temperature of the liquid should preferably be (23 ± 1) °C. Suspend the receptacle in the liquid (see the note) and again weigh it. Record this mass as m_2.

NOTE If water is used as the immersion liquid, 1 or 2 drops of a suitable wetting agent will help to ensure rapid and thorough wetting of the receptacle.