
**Paints and varnishes — Practical
determination of non-volatile and
volatile matter content during
application**

*Peintures et vernis — Détermination pratique de la matière non
volatile et de la matière volatile pendant l'application*





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Contents		Page
Foreword		iv
Introduction		v
1 Scope		1
2 Normative references		1
3 Terms and definitions		1
4 Principle		2
5 Apparatus and materials		2
6 Sampling		3
7 Procedure		3
7.1 General.....		3
7.2 Method A: Determination with aluminium foils.....		3
7.3 Method B: Determination with test panels.....		4
8 Evaluation		4
9 Precision		4
9.1 Repeatability limit (<i>r</i>).....		4
9.2 Reproducibility limit (<i>R</i>).....		5
10 Test report		5
Annex A (informative) Comments on precision		6
Bibliography		9

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*.

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

When applying coatings, the size or the size distribution of the generated drops is of great importance for the application result. By varying the application parameters, such as spraying energy and the rate of flow of the coating material as well as the technical properties such as solvent composition and rheological flow performance, the quality of the application result can be controlled. Also, climatic conditions during the application (e.g. temperature, relative humidity, and air falling speed) highly influence the result. By determining the non-volatile matter after application or after intermediate or final drying, it is possible to characterize the wet or dry application result and, consequently, to indirectly refer to the generated drop size distribution and the solvent emission during the application. By means of the calculated volatile matter, the sufficient intermediate drying of the respective coating is determined before applying an additional coating.

Paints and varnishes — Practical determination of non-volatile and volatile matter content during application

1 Scope

This document specifies a test method for the determination of non-volatile matter of coatings directly after application or after intermediate or final drying. In practice, the determination of volatile matter is applied particularly in regard to water-thinnable coatings which are re-coated with an additional coating material.

Furthermore, the method can be used to compare the efficiency of different application and drying methods.

The content of non-volatile or volatile matter of a product after application is no absolute variable but depends on the application and drying conditions applied during the test. Consequently, applying this method gives only relative values and not the real values for the content of non-volatile matter, due to solvent retention, thermal decomposition and evaporation of low-molecular contents.

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 1514, *Paints and varnishes — Standard panels for testing*

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

process step

operations and time periods, which have to be successive in regard to the coating method in order to result in a given coating system.

Note 1 to entry: Depending on the focus several successive operations can be subsumed as one process step.

3.2

non-volatile matter after defined process step

NV_p

residue by mass obtained after the application from the single process steps of examination under specified conditions of test

3.3

volatile matter

VM

loss by mass obtained by evaporation under specified conditions of test

3.4

volatile matter after defined process step

VM_p

loss by mass obtained after the application from the single process steps of examination under specified conditions of test

4 Principle

An aluminium foil or a test panel in production or in laboratory spray booth is coated in accordance with the specified conditions. The coated aluminium foil or test panel is carefully folded down the centre and weighed after the process step of examination and then unfolded. Subsequently, the aluminium foil is dried in horizontal position in a laboratory drying box in accordance with the agreed drying conditions and weighed afterwards. The content of non-volatile or volatile matter is calculated from the difference.

5 Apparatus and materials

Ordinary laboratory apparatus, together with the following:

5.1 Application device

Coating unit and, if necessary, conveying drier for the process step of examination.

5.2 Laboratory drying box, capable of maintaining the specified or agreed test temperature to ± 2 °C (for temperatures up to 150 °C) or $\pm 3,5$ °C (for temperatures above 150 °C and up to 200 °C). A laboratory drying box with technical ventilation shall be used.

WARNING — Due to explosion and fire control, careful handling is indispensable for products containing flammable volatile constituents.

5.3 Method A with aluminium foil

5.3.1 Aluminium foil, soft quality with a thickness of (30 ± 2) μm , cut to the format of 90 mm \times 130 mm or as agreed.

5.3.2 Magnetic fixture frame to secure the foils on the object to be coated matching the measures of the foil piece (e.g. outside: 110 mm \times 150 mm, inside: 60 mm \times 100 mm).

NOTE PVC/polyvinylidene chloride coated fixture frames have been found suitable.

5.3.3 Appropriate tape to secure the fixture frames on non-magnetic substrate.

5.3.4 Precision balance, weighing to 0,1 mg.

5.4 Method B with test panel

5.4.1 Test panel measuring approximately 200 mm \times 100 mm and of a thickness of 0,7 mm to 1,0 mm and shall be prepared, coated, and dried/cured in accordance with ISO 1514.

5.4.2 Appropriate tape to secure the test panel (if necessary).

5.4.3 Precision balance, weighing to 1 mg.

6 Sampling

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

Examine samples of coating materials in accordance with ISO 1513 and prepare for further testing.

7 Procedure

7.1 General

The determination of non-volatile and volatile matter can be carried out directly on the coating object during the coating process in production or in the laboratory spray booth. Method A is appropriate for both coating locations, whereas method B should be restricted to the application in the laboratory spray booth. Only for the procedure of handling method A, a contamination of the recently applied coatings can be avoided.

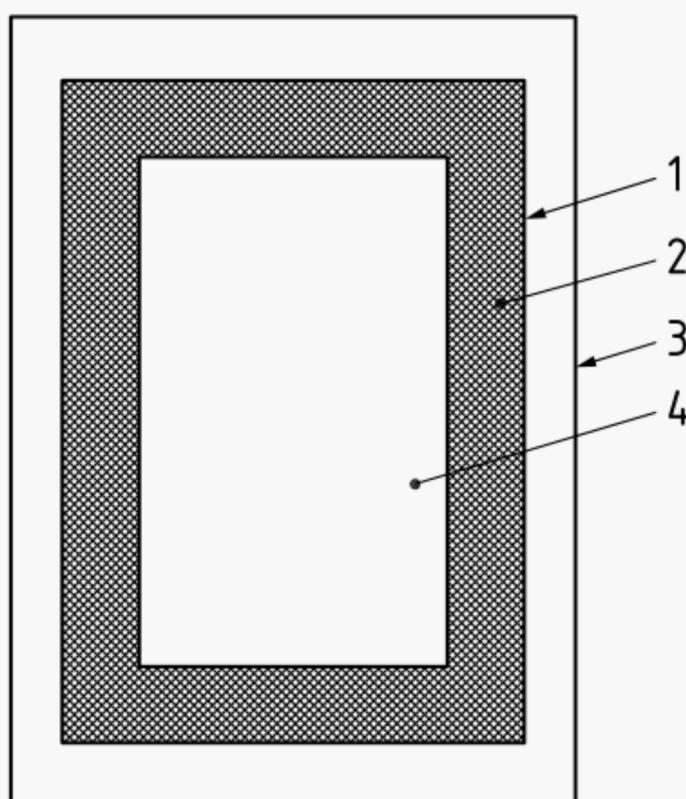
7.2 Method A: Determination with aluminium foils

When carrying out in spray booth under laboratory conditions, carry out the determination in duplicate.

Weigh the aluminium foils, which have been marked on the back side with an appropriate felt tip pen (m_0).

For the coating process on coating objects in production, attach the aluminium foils by means of fixture frames several times on specified spots, preferably on horizontally and vertically aligned plane areas.

When applying on non-magnetic materials, secure the fixture frame with the aluminium foil with appropriate tape — see [Figure 1](#).



Key

- 1 aluminium foil 130 mm × 90 mm × 0,030 mm
- 2 aluminium foil, covered by magnetic fixture frame
- 3 magnetic fixture frame 155 mm × 110 mm
- 4 coated area 100 mm × 60 mm

Figure 1 — Test arrangement method A

Afterwards, carry out the application in production or in the laboratory spray booth under the specified conditions.

Carefully fold the coated aluminium foils down the centre after the process step of examination and fold in the open sides to avoid further evaporation of solvents. Weigh the folded aluminium foils (m_p).

Unfold the aluminium foils after weighing. Subsequently, dry the aluminium foils in a laboratory drying box in accordance with the agreed drying conditions. In order to do so, roll up the foils loosely and, in a tin jar, dry upright. Cool down to room temperature in a dust-free environment.

Weigh the aluminium foils with the dried paint film (m_T).

7.3 Method B: Determination with test panels

When carrying out in laboratory spray booth, carry out the determination in duplicate.

Weigh the test panels which have been marked on the back side with an appropriate felt tip pen (m_0).

Affix test panels on the coating rack as agreed. Afterwards, carry out the application in the spray booth under the specified conditions.

Weigh the coated test panels after the process step of examination (m_p).

Subsequently, dry the test panels in a horizontal position in a laboratory drying box in accordance with the agreed drying conditions. Cool down to room temperature in a dust-free environment.

Weigh the test panels with the dried paint film (m_T).

8 Evaluation

Calculate the content of non-volatile matter after the application and the defined process step (NV_p) as a mass fraction, in per cent, in accordance with [Formula \(1\)](#):

$$NV_p = \frac{m_T - m_0}{m_p - m_0} \times 100 \quad (1)$$

where

m_0 is the mass of the uncoated aluminium foil or of the prepared test panel, in grams;

m_p is the mass of the coated aluminium foil or of the test panel after the process step of examination, in grams;

m_T is the mass of the coated aluminium foil or of the test panel after defined drying, in grams.

Calculate the content of volatile matter after the application and the defined process step (VM_p) as a mass fraction, in per cent, in accordance with [Formula \(2\)](#):

$$VM_p = 100 - NV_p \quad (2)$$

9 Precision

9.1 Repeatability limit (r)

The repeatability limit r is the value below which the absolute difference between two test results (each the mean of valid duplicates) can be expected to lie when this method is used under repeatability conditions. In this case, the test results are obtained on identical material by one operator in one

laboratory within a short interval of time using the standardized test method. In this document, the repeatability limit r with a probability of 95 % is given in [Table 1](#).

Table 1 — Repeatability limit

Non-volatile matter (NV _p)	Total mean value of results	Repeatability limit (r)	
		% (absolute)	% (relative)
Directly after application	24,9	1,7	6,8
After pre-drying	86,9	1,7	2,0

9.2 Reproducibility limit (R)

The reproducibility limit R is the value below which the absolute difference between two single test results (each the mean of valid duplicates) can be expected to lie when this method is used under reproducibility conditions. In this case, the test results are obtained on identical material by operators in different laboratories using the standardized test method. In this standard, the reproducibility limit R with a probability of 95 % is given in [Table 2](#).

Table 2 — Reproducibility limit

Non-volatile matter (NV _p)	Total mean value of results	Reproducibility limit (R)	
		% (absolute)	% (relative)
Directly after application	24,9	2,4	9,8
After pre-drying	86,9	1,9	2,2

For details on how to obtain precision data, see [Annex A](#).

10 Test report

The test report shall contain at least the following information:

- a) any details necessary to identify the tested product (manufacturer, product designation, batch number etc.);
- b) a reference to this document (ISO 22516:2019);
- c) the method applied;
- d) a description of the coating device, the process steps, and process parameters;
- e) the information on temperature, relative humidity, and air falling speed during coating;
- f) the type and design of the laboratory drying box used;
- g) the agreed drying conditions;
- h) the test result (single values and mean value);
- i) any deviation from the test methods specified;
- j) any unusual features (anomalies) observed during the test;
- k) the date of the test.

Annex A (informative)

Comments on precision

A.1 Parameters of the round-robin test

The precision data were determined in accordance with method A (see 7.2) on a water-thinnable base coat with a coating machine with electrostatic high-efficiency rotary atomizer and pneumatic air atomizer unit on five successive days during shift operation.

Application conditions and climatic conditions were constant during application.

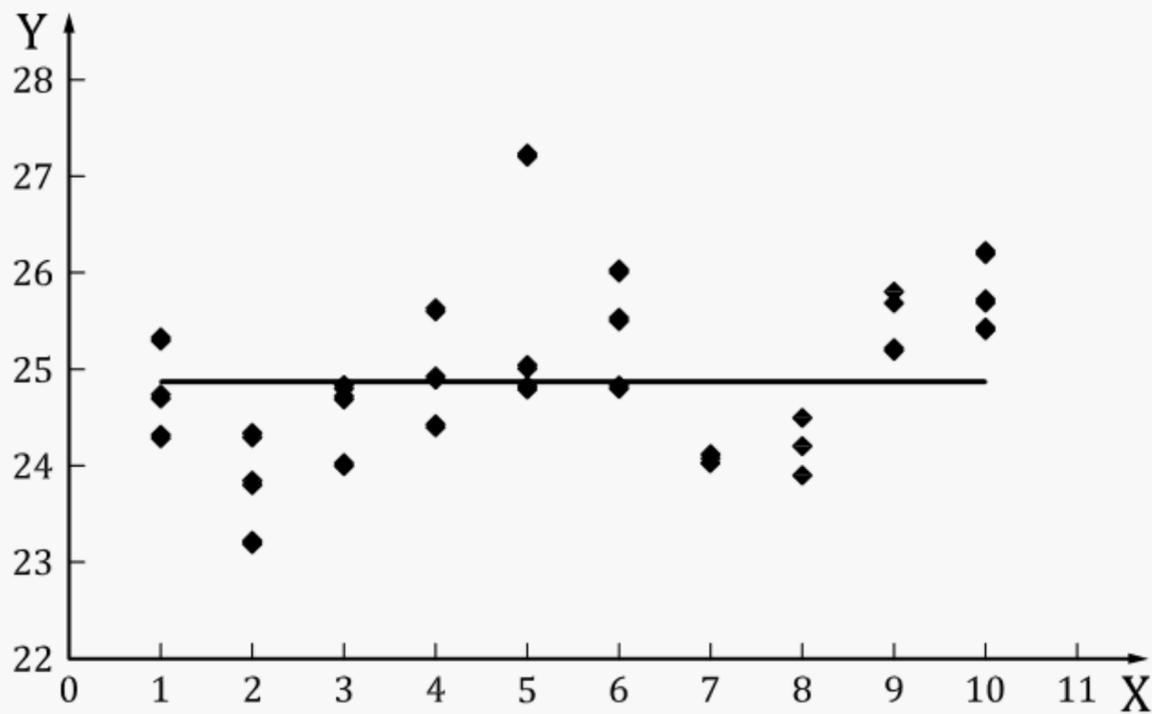
Procedure and evaluation of the round-robin test were in accordance with ISO 5725-2 and ISO/TR 22971.

The non-volatile matter was obtained directly after application and after intermediate drying.

For the graphic presentation of the raw data of the round-robin test directly after application see [Figure A.1](#). The results are given in [Table A.1](#).

For the graphic presentation of the raw data of the round-robin test after intermediate drying see [Figure A.2](#). The results are given in [Table A.2](#).

A.2 Determination of non-volatile matter, NV_p , directly after application



Key

X designation of facility carrying out the test

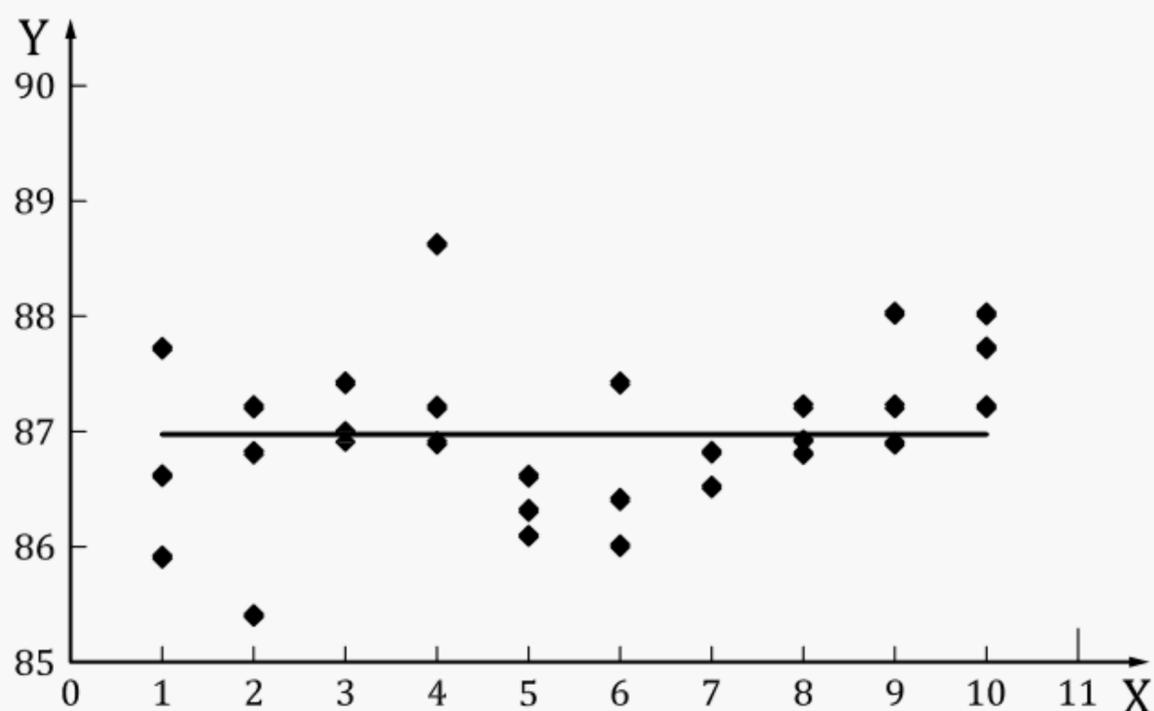
Y non-volatile matter NV_p , as a percentage

The continuous line illustrates the total mean value of the results of 24,9 %.

Figure A.1 — Graphic presentation of raw data of round-robin test, determination of non-volatile matter, NV_p , directly after application

Table A.1 — Results of round-robin test Determination of non-volatile matter, NV_p , directly after application

Number of participants taking part in round-robin test (P)	10
Number of participants after elimination of outliers (p)	10
Number of determinations (n)	30
Total mean value of results (m), as a percentage (absolute)	24,9
Standard deviation of repeatability (s_r)	0,6
Coefficient of variation (CV_r)	2,4
Repeatability limit (r), as a percentage (absolute)	1,7
Repeatability limit (r), as a percentage (relative)	6,8
Standard deviation of reproducibility (s_R)	0,9
Coefficient of variation (CV_R)	3,5
Reproducibility limit (R), as a percentage (absolute)	2,4
Reproducibility limit (R), as a percentage (relative)	9,8

A.3 Determination of non-volatile matter, NV_p , after pre-drying**Key**

X designation of facility carrying out the test

Y non-volatile matter NV_p , as a percentage

The continuous line illustrates the total mean value of the results of 86,9 %.

Figure A.2 — Graphic presentation of raw data of round-robin test, determination of non-volatile matter, NV_p , after pre-drying

Table A.2 — Results of round-robin test Determination of non-volatile matter NV_p directly after pre-drying

Number of participants taking part in round-robin test (P)	10
Number of participants after elimination of outliers (p)	10
Number of determinations (n)	30
Total mean value of results (m), as a percentage (absolute)	86,9
Standard deviation of repeatability (s_r)	0,6
Coefficient of variation (CV_r)	0,7
Repeatability limit (r), as a percentage (absolute)	1,7
Repeatability limit (r), as a percentage (relative)	2,0
Standard deviation of reproducibility (s_R)	0,7
Coefficient of variation (CV_R)	0,8
Reproducibility limit (R), as a percentage (absolute)	1,9
Reproducibility limit (R), as a percentage (relative)	2,2

Bibliography

- [1] 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*
- [2] ISO/TR 22971, *Accuracy (trueness and precision) of measurement methods and results — Practical guidance for the use of ISO 5725-2:1994 in designing, implementing and statistically analysing interlaboratory repeatability and reproducibility results*

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