
**Paints and varnishes — Electro-
deposition coatings —**

**Part 9:
Stoving loss**

*Peintures et vernis — Peintures d'électrodéposition —
Partie 9: Perte par d'étuvage*

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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*.

A list of all parts in the ISO 22553 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

The stoving loss of an electro-deposition coating is not an absolute parameter but instead depends on the temperature used during testing and the test duration. As a result, relative values alone and not the true values for the stoving loss are obtained when using this method.

The relative mass loss factor, the relative reaction loss factor, and the relative total stoving loss factor can be calculated relative to the coated and vented, pre-dried and stoved test panel. The calculation is specified in [Annex A](#).

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Paints and varnishes — Electro-deposition coatings —

Part 9: Stoving loss

1 Scope

This document specifies a method for determining the volatile-matter content of electro-deposition coatings (e-coats) during stoving (stoving loss) used for automotive industries and other general industrial applications, e.g. chiller units, consumer products, radiators, aerospace, agriculture.

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

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

ISO 22553-1, *Paints and varnishes — Electro-deposition coatings — Part 1: Vocabulary*

ISO 23321, *Solvents for paints and varnishes — Demineralized water for industrial applications — Specification and test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and ISO 22553-1 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/>

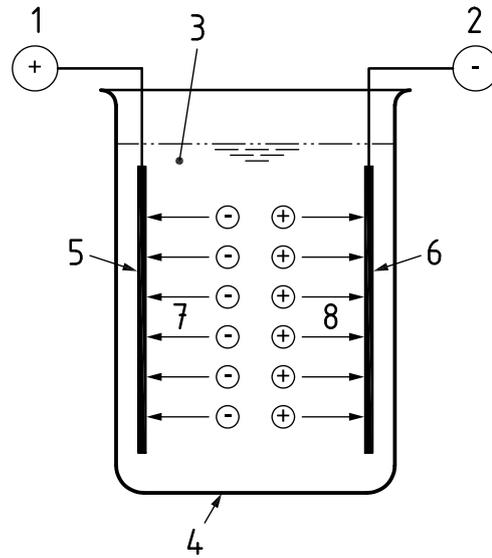
4 Principle

The non-volatile matter is determined after stoving of the electro-deposition coating and the stoving loss is calculated from this.

5 Apparatus and materials

Typical laboratory apparatus, together with the following:

5.1 **Laboratory deposition system**, which consists of a deposition tank with tank recirculation and DC voltage equipment — see [Figure 1](#).



Key

- | | |
|---------------------------------------|---|
| 1 anode | 5 anode (counter electrode for cathodic e-coat) |
| 2 cathode | 6 cathode (test panel for cathodic e-coat) |
| 3 electro-deposition coating material | 7 acid |
| 4 deposition tank | 8 electro-deposition coating material |

Figure 1 — Schematic diagram of a laboratory deposition system with cathodic e-coat material as an example

The container of the deposition system shall be filled with the electro-deposition coating material and the tank circulation (stirrer or pump) is initiated. Subsequently, the test panels shall be immersed in the container. The deposition conditions shall be adjusted according to the specification and the deposition process is initiated. Upon completion of the deposition process, the test panels shall be removed from the container and thoroughly rinsed using demineralized water specified in ISO 23321, so that any excess of the electro-deposition coating material (cream coat) is removed.

5.2 **Ampere meter.**

5.3 **Thermometer**, with a reading accuracy of 0,1 °C.

5.4 **Analytical balance**, with a weighing accuracy of 0,000 1 g.

5.5 **Oven**, in which the test can be carried out reliably and using which the specified or agreed test temperature can be held to within ±2 °C (for temperatures up to 150 °C) or ±3,5 °C (for temperatures between 150 °C and 200 °C).

5.6 **Timer**, with a reading accuracy of 1 s.

6 Test panels

Use electrically conductive test panels with pre-treatment as specified in ISO 1514 with dimensions of approximately 190 mm × 105 mm × 0,75 mm.

7 Number of determinations

Carry out each determination in triplicate.

8 Procedure

Fill the tank with the electro-deposition coating material up to about 1 cm below the edge and homogenize the coating material, e.g. using a stirring machine with paddle stirrer (diameter min. 50 mm) at 500 min^{-1} , so that sufficient tank circulation is visually detectable.

Weigh each of the three test panels on an analytical balance to within 1 mg (m_0).

Put the test panel in the laboratory deposition system and connect the anode and cathode to the current source. Maintain stirring the electro-deposition coating material with a stirring machine or a magnet stirrer.

Set the bath temperature to the temperature as specifically required for the product, to $\pm 0,5 \text{ }^\circ\text{C}$.

NOTE 1 Usually, the temperature is in the range of $25 \text{ }^\circ\text{C}$ to $35 \text{ }^\circ\text{C}$.

Select the deposition voltage and deposition time so that the expected dry-film thickness of the electro-deposition coating on the test panel corresponds to the nominal dry-film thickness.

Increase the voltage to the selected coating voltage (if necessary, without series resistor). Maintain this voltage over the selected time.

Remove the test panel after coating, rinse with demineralized water and pre-dry for approx. 60 min at approx. $110 \text{ }^\circ\text{C}$ in an oven.

Weigh the test panels on an analytical balance to within 1 mg, m_1 .

Calculate the mass of the applied electro-deposition coating, $m_{\text{e-coat}}$ in grams, using [Formula \(1\)](#):

$$m_{\text{e-coat}} = m_1 - m_0 \quad (1)$$

where

m_0 is the mass, in grams, of the uncoated test panel;

m_1 is the mass, in grams, of the coated, pre-dried test panel.

Stove/cure the coated, pre-dried test panels in the oven as specifically required for the product. The stoving temperature shall be the object temperature, not the displayed oven temperature.

NOTE 2 The stoving temperature is usually between $100 \text{ }^\circ\text{C}$ and $180 \text{ }^\circ\text{C}$.

After the test panels have cooled down, weigh them to within 1 mg, m_2 .

Calculate the mass loss of stoved electro-deposition coating material, m_t in grams, using [Formula \(2\)](#):

$$m_t = m_1 - m_2 \quad (2)$$

where

m_1 is the mass, in grams, of the coated, pre-dried test panel;

m_2 is the mass, in grams, of the coated, stoved test panel.

Repeat this procedure with the two other test panels.

Calculate the mean value of the values for the three test panels.

NOTE 3 An alternative to the calculation of the mean value is to take the median of the mass loss values. The median is the middle value of the three mass loss values. The other two mass values are then no longer considered.

9 Evaluation

Calculate the stoving loss, s_l , as a mass fraction in per cent, using [Formula \(3\)](#):

$$s_l = \frac{m_t}{m_{e\text{-coat}}} \cdot 100 \quad (3)$$

where

m_t is the mass loss, in grams, of the stoved electro-deposition coating material;

$m_{e\text{-coat}}$ is the mass, in grams, of the applied electro-deposition coating material.

10 Precision

No precision data is currently available.

11 Test report

The test report shall contain at least the following information:

- a) all details necessary for the identification of the tested product (manufacturer, product labelling, batch number etc.);
- b) a reference to this document (i.e. ISO 22553-9:2020);
- c) the tank voltage;
- d) the tank temperature;
- e) the application time: adjustment time and holding time, in seconds;
- f) the stoving temperature (object temperature) and time;
- g) the result of the test in accordance with [Clause 9](#);
- h) every agreed or other deviation from the specified test method;
- i) every unusual observation (anomaly) during the test;
- j) the date of the test.

Annex A (informative)

Calculation of the relative mass loss factors, the relative reaction loss factor and the relative total stoving loss factor

A.1 Calculation of the intermediate mass losses

The relative mass loss factor, $s_{l,m}$, the relative reaction loss factor, $s_{l,r}$, and the relative total stoving loss factor, $s_{l,total,A}$, can be calculated relative to the coated and vented, pre-dried and stoved test panel.

To do this, additional weighings shall be carried out to determine the intermediate mass losses.

Weigh each of the three test panels on an analytical balance to within 1 mg (m_0).

Coat the test panels as described in [Clause 8](#).

Remove the test panel after coating, rinse with demineralized water and allow to vent for approximately 20 min to 30 min in air.

Weigh the test panels on an analytical balance to within 1 mg ($m_{1,air}$).

Calculate the mass loss of the vented electro-deposition coating material, $m_{2,l,air}$ in grams, using [Formula \(A.1\)](#):

$$m_{2,l,air} = m_{1,air} - m_0 \quad (A.1)$$

where

m_0 is the mass of the uncoated test panel, in grams;

$m_{1,air}$ is the mass of the vented test panel, in grams.

Then dry these test panels for approximately 60 min at approximately 110 °C in an oven.

After the test panels have cooled down, weigh them on an analytical balance to within 1 mg ($m_{3,dry}$).

Calculate the mass loss of the electro-deposition coating material dried at 110 °C, $m_{4,l,110}$, in grams, using [Formula \(A.2\)](#):

$$m_{4,l,110} = m_{1,air} - m_{3,dry} \quad (A.2)$$

where

$m_{1,air}$ is the mass of the vented test panel, in grams;

$m_{3,dry}$ is the mass of the test panel dried at 110 °C, in grams.

After this, the actual stoving of the coated, vented and pre-dried test panels is carried out in the oven in line with the product-specific specifications. The stoving temperature shall be the object temperature, not the displayed oven temperature.

NOTE The stoving temperature is usually between 150 °C and 180 °C.