
**Preparation of steel substrates before
application of paints and related
products — Tests for the assessment
of surface cleanliness —**

**Part 9:
Field method for the conductometric
determination of water-soluble salts**

*Préparation des subjectiles d'acier avant application de peintures
et de produits assimilés — Essais pour apprécier la propreté d'une
surface —*

*Partie 9: Méthode in situ pour la détermination des sels solubles dans
l'eau par conductimétrie*



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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 12, *Preparation of steel substrates before application of paints and related products*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, *Paints and varnishes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 8502-9:1998), which has been technically revised.

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

- inclusion of new measurement methods according to the direct sample method;
- improved connection to ISO 8502-6, and all extraction types;
- dedication to water soluble salts to avoid confusion with other analysis methods;
- improvement to [Figure 1](#) to clarify the use of other volumes for analysis.

A list of all parts in the ISO 8502 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 performance of protective coatings of paint and related products applied to steel is significantly affected by the state of the steel surface immediately prior to painting. The principal factors that are known to influence this performance are:

- a) the presence of rust and mill scale;
- b) the presence of surface contaminants, including salts, dust, oils and greases; and
- c) the surface profiles.

ISO 8501, ISO 8502 and ISO 8503 have been prepared to provide methods of assessing these factors, while ISO 8504 provides guidance on the preparation methods that are available for cleaning steel substrates, indicating the capabilities of each in attaining specified levels of cleanliness.

These International Standards do not contain recommendations for the protective coating systems to be applied to the steel surface. Neither do they contain recommendations for the surface quality requirements for specific situations even though surface quality can have a direct influence on the choice of protective coating to be applied and on its performance. Such recommendations are found in other documents such as national standards and codes of practice. It is necessary for the users of these International Standards to ensure that the qualities specified are:

- compatible and appropriate both for the environmental conditions to which the steel is exposed and for the protective coating system to be used, and
- within the capability of the cleaning procedure specified.

The four International Standards referred to above deal with the following aspects of preparation of steel substrates before application of paints and related products:

- ISO 8501, *Visual assessment of surface cleanliness*;
- ISO 8502, *Tests for the assessment of surface cleanliness*;
- ISO 8503, *Surface roughness characteristics of blast-cleaned steel substrates*;
- ISO 8504, *Surface preparation methods*.

Each of these International Standards is in turn divided into separate parts.

This document describes a field method for the assessment of the total amount of water-soluble salts, the salts being reported as one value. The more aggressive contaminants causing corrosion and blistering (the ionic species) can easily be dissolved off and determined by this method. Consequently, the less aggressive and not so easily dissolved minor part of contaminant remains un-assessed. For additional information on the test method, its potential and its limitations, see Bresle Å, Conductometric determination of salts on steel surfaces^[1] and Frankhuizen N, Measuring NaCl, Salt and Soluble Contaminants with Bresle Patches — Part 1 & 2^[2].

Rusty steel substrates, particularly those of rust grades C or D (see ISO 8501-1), even when blast-cleaned to preparation grade Sa 3 (see ISO 8501-1 and ISO 8501-2), might still be contaminated by water-soluble salts and corrosion products. These compounds are almost colourless and are localized at the lowest point of the rust pits. If they are not removed prior to painting, chemical reactions can result in blister formation and accumulations of rust that destroy the adhesion between the substrate and the applied protective coating.

Even if the salt is readily soluble in water, it is often impossible to remove it completely from the surface by a simple washing or extracting. The method described does not, therefore, determine the total amount of soluble materials on the surface but gives an indication of the cleanliness level of the surface. Prolonging the extractions time, or repeating the extraction procedure, should remove a larger proportion of the salt.

Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness —

Part 9:

Field method for the conductometric determination of water-soluble salts

1 Scope

This document specifies a field method for the assessment of the surface density of various water-soluble salts on steel surfaces, before and/or after surface preparation, by conductometric determination. The individual surface densities of the salt composition like chlorides, sulphates, sodium, etc, cannot be determined by this method.

This method assesses only contaminants that forms an electrolyte (ions) when in contact with water. These represent the greater part of the contaminants.

2 Normative references

The following documents are referred to in the text in such a way that some or all 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 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 8502-6, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminants for analysis using adhesive cells, The Bresle method*

3 Terms and definitions

No terms and definitions are listed in this document.

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 <https://www.electropedia.org/>

4 Principle

The salts on the given area of the steel surface are dissolved by using adhesive cells, one of which is in accordance with the original Bresle method (see ISO 8502-6), using water as solvent. The conductivity of the solution thus obtained is measured. Finally, the total surface density of the salts in this area is calculated and expressed as total soluble salts, determined by the calculation by an empirical constant as stated in [Clause 8](#). This method gives a value for all salts present on the surface and is not ion specific for sodium and/or chloride. The unit as total soluble salts refers to the calculation method used based on analytical principles, and is the value for salts on the surface.

5 Apparatus and materials

5.1 Conductometer

Conductometer with temperature compensation and the most accurate range possible, from 0 mS/m (0 μ S/cm) to 20 mS/m (200 μ S/cm) with a resolution of 0,01 mS/m (0,1 μ S/cm), 20 mS/m (200 μ S/cm) to 200 mS/m (2 000 μ S/cm) with a resolution of 0,1 mS/m (1 μ S/cm) and an accuracy of 2 %. Either being an immersion type instrument, where the electrode is submerged in the liquid under test, or a direct measuring type instrument where the liquid under test is injected in the measurement cell of the instrument. The conductometer shall be compensated to 25 °C.

NOTE The official SI-unit for conductivity is mS/m, but since most commercially available instruments use the unit μ S/cm, this unit is given within brackets within this document. 1 mS/m is equivalent to 10 μ S/cm.

5.2 Beaker

Beaker of sufficient size and shape for the solvent and, if relevant, for housing the electrode end of an immersion type conductometer (6.1) during measurement.

NOTE When using immersion type instruments, use of a glass beaker is advisable for avoiding electrostatic interference.

5.3 Equipment for sampling

Adhesive cell and other equipment as specified in ISO 8502-6.

The cell should not cause any noticeable variation in the contamination of the extraction liquid. To confirm accuracy, an initial cell blank test shall be required as described in ISO 8502-6.

5.4 Syringe

If a syringe is used in the extraction procedure as specified in ISO 8502-6, this is the syringe referred to in the following, see 7.2 and 7.3. The same syringe shall be used for the extraction, analysis and blank test.

5.5 Solvent

Water of at least grade 3 purity in accordance with ISO 3696.

NOTE Usually, distilled or de-ionized water of conductivity less than 0,5 mS/m (5 μ S/cm) meets this requirement.

6 Procedure

6.1 Calibration

Calibrate the conductometer according to the manufacturer's instructions and in the range to be used for the measurements. Calibration shall be performed before each test sequence or at least daily.

6.2 Preparation of water and equipment blank test

6.2.1 Pour into the beaker (5.2) an amount of water (5.5). For instruments with a sensor to be immersed, the beaker shall be just large enough for the operation of the conductometer (5.1). Usually a volume between 10 ml and 15 ml is needed. For direct measurement type instruments, the volume shall be sufficient for rinsing and filling the cell of the instrument and, if a syringe is used in the sampling procedure, sufficient to fill the syringe (5.4). To prevent foreign matter inside the beaker and syringe, and on the conductometer probe, from influencing the result, carry out the following blank test (checking cleanliness of the syringe, beaker, water and conductometer zero reading).

6.2.2 In case a syringe is to be used in the extraction procedure (ISO 8502-6), completely fill the syringe (5.4) with water from the beaker.

6.2.3 For immersion type conductometers, empty the syringe back into the beaker and immerse the electrodes fully in the water in the beaker and agitate gently. For direct measurement type conductometers, apply the required volume of solution from the syringe on the sensor surface. Record the conductivity (γ_1) and the units in which it is expressed, for example mS/m or $\mu\text{S}/\text{cm}$.

6.3 Sampling of salts from the steel surface

Perform extraction of salts as stated in ISO 8502-6. Record the sampling area and the amount of water used for extraction according to ISO 8502-6 (V_e).

6.4 Conductometric measurement

For immersion type instruments, immerse the electrodes of the conductometer fully in the contaminated water from the sampling. If a dilution is required, use solvent of at least grade 3 purity in accordance with ISO 3696. Record the volume of sampled water (V_s with salts) and the amount of water added (V_a). Record the conductivity (γ_2) expressed in the same units as in 6.2.3.

For direct measuring type instruments, rinse the sensor surface several times with the solution and apply a suitable volume of solution in the cell of the instrument. Record the conductivity (γ_2) expressed in the same units as in 6.2.3.

Rinse the sensor, beaker, etc. between readings making sure that contamination from previous tests does not influence the measurement.

7 Calculations

7.1 Calculation of corrected volume

If dilution is performed, the volume V , to be used for the calculations of the amount of salt on the surface in 7.2, is calculated according to

$$V = V_e \left(1 + \frac{V_a}{V_s} \right)$$

where

V_e is the amount of water used for the extraction of salts from the surface (see ISO 8502-6);

V_s is the amount of water sampled from the extracted water i.e. sampled from V_e ;

V_a is the amount of water added to the sample i.e. added to V_s .

7.2 Calculation of total amount of salt on the surface

The total surface density ρ_A of the soluble salts is given by the Formula

$$\rho_A = \frac{m}{A} \quad (1)$$

where

m is the mass of salts dissolved from the sampling area i.e. the part of the surface exposed to water in the adhesive cell during the extraction procedure;

A is the area of that part of the surface.

the relationship between mass of salts and conductivity can be expressed as

$$m = c \cdot V \cdot \Delta\gamma \quad (2)$$

where

c is a constant for the salts on the surface, approximately equal to $5 \text{ kg} \cdot \text{m}^{-2} \cdot \text{S}^{-1}$ at $25 \text{ }^{\circ}\text{C}$ (see [Clause 8](#)); the value is based on the conductivity constant stated by Bresle in [Clause 8](#);

V is the volume of water used for extraction, see [6.3](#), if dilution is performed corrected according to [7.1](#).

$\Delta\gamma$ is the change in conductivity, i.e. the difference between the conductivity measured in [6.4](#) (γ_2) and the conductivity measured in [6.2.3](#) (γ_1).

From [Formulae \(1\)](#) and [\(2\)](#), it follows that

$$\rho_A = \frac{c \cdot V \cdot \Delta\gamma}{A}$$

With the SI-units in mg/m^2 (soluble salts), V in ml, $\Delta\gamma$ in mS/m , A in mm^2 and c expressed in $\text{kg} \cdot \text{m}^{-2} \cdot \text{S}^{-1}$, the formula is written as

$$\rho_A = \frac{c \cdot 10^3 \cdot V \cdot \Delta\gamma}{A} \quad (3)$$

For $\Delta\gamma$ in $\mu\text{S}/\text{cm}$ the formula is

$$\rho_A = \frac{c \cdot 10^2 \cdot V \cdot \Delta\gamma}{A}$$

where c is approximately equal to $5 \cdot \text{kg} \cdot \text{m}^{-2} \cdot \text{S}^{-1}$ at $25 \text{ }^{\circ}\text{C}$.

7.3 Examples: Standard patch A-1250 and flexible sleeve S-1000 acc. to ISO 8502-6

With the standard patch (Bresle patch) A-1250 the area is $1\,250 \text{ mm}^2$ and with the standard sleeve S-1000 the area is $1\,000 \text{ mm}^2$ (see Table 1 in ISO 8502-6).

Graphical representations of [Formula \(3\)](#) for different sampling volumes for the adhesive patch A-1250 and for 10 ml sampling volume for the flexible sleeve S-1000, and $c = 5 \text{ kg} \cdot \text{m}^{-2} \cdot \text{S}^{-1}$, are given in [Figure 1](#).

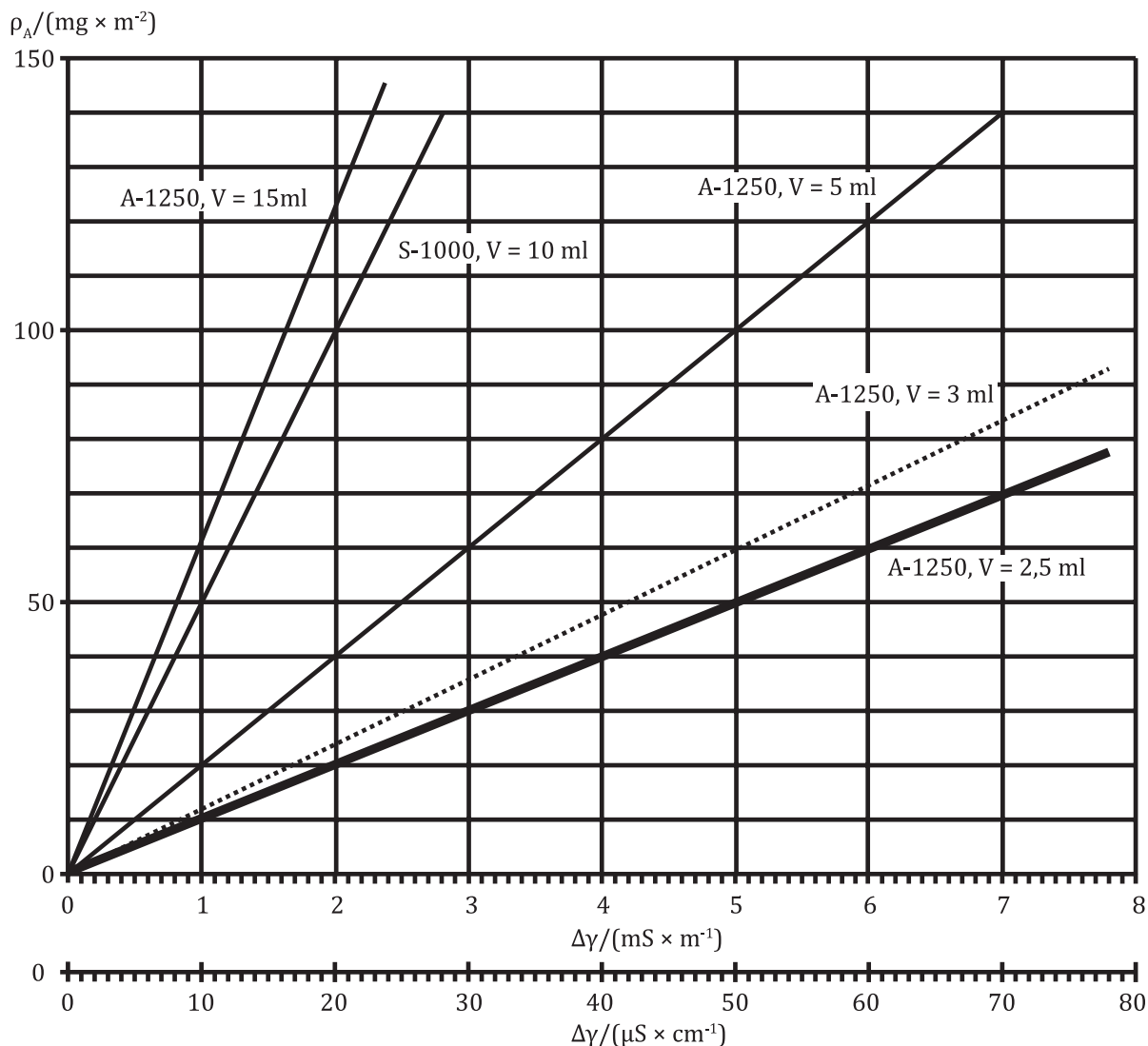


Figure 1 — Conductivity vs. surface concentration

NOTE The total surface density ρ_A (mg/m^2) of salts as a function of the change in conductivity $\Delta\gamma$ (normalized to 25 °C) for the A-1250 patch and for the S-1000 flexible sleeve in accordance with ISO 8502-6. Each line corresponds to a different volume of water for sampling the salts, conductivity $\Delta\gamma$ expressed in mS/m and in $\mu\text{S}/\text{cm}$.

8 Accuracy

The accuracy of the method depends on the accuracy of the constant c in [Formula \(2\)](#), and on the accuracy to which the variables in that formula can be determined. But other factors, such as variations in temperature, also have an influence on the accuracy. Very little has been published on these matters. Practical experience has shown, however, that most variations relating the analysis have negligible influence on the overall accuracy, except that in the constant c , which is dependent upon the types of salts dissolved in the water.

In the majority of cases, the following types of ion are pre-dominant in the water: Cl^- , SO_4^{2-} , HCO_3^- , Na^+ , Ca^{2+} and Fe^{2+} . Other types of ion might also be present. Usually, however, their contribution to the variation in the constant c is only marginal. This composition is based on natural contamination by environmental exposure. When material is deposited from other sources such as blast media, containing carbonates or bicarbonates, the composition of the contaminants might be different. These

different elements will also be detectable by conductivity measurement. but do not by default contain corrosive salts.

The constant c used in [Clause 7](#) is the inverse of the ionic conductivity for a salt solution at 25 °C; conductivity expressed per unit weight of the salt. The value of the constant c ($5 \text{ kg}\cdot\text{m}^{-2}\cdot\text{S}^{-1}$) given in [Clause 8](#) represents a mix of salts considered representative to normal conditions, as evaluated by Bresle, see Bresle Å, Conductometric determination of salts on steel surfaces^[1].

The value of constant c ($5\cdot\text{kg}\cdot\text{m}^{-2}\cdot\text{S}^{-1}$), is derived by Bresle, see Bresle Å, Conductometric determination of salts on steel surfaces^[1] as average of the individual constants for ions expected on slightly rusty steel surfaces: sodium, calcium, ferrous chloride and sodium, calcium, ferrous sulphate, resulting in $(5 \pm 1) \text{ kg}\cdot\text{m}^{-2}\cdot\text{S}^{-1}$. Bresle reports either low or very low bicarbonate concentrations in extracts from steel substrates. The contribution of carbonates to the constant c is estimated at maximum 5 % for carbonates constituting as much as 10 % of the salt content. A second source of error is deviations from linearity between conductivity and salt concentration, estimated as maximum 5 % for salt concentrations of up to 300 mg/l–400 mg/l. The total error in the constant c is estimated at about ± 12 % when adding the accuracy of the conductometer. Further information on measurement errors, etc. can be obtained from Frankhuizen N.H., Measuring NaCl, Salt and Soluble Contaminants with Bresle patches^[2].

Major factors influencing the accuracy of the method are related to the dissolution of salts from the surface, such as state of the surface (roughness, cleanliness), temperature, agitation and extraction time. These values are affected by, for example, abrasives, cleaning solutions and passivation methods.

9 Test report

The test report, covering both sampling and conductometric analyses, shall contain at least the following information:

- a) a reference to relevant parts of ISO 8502 (i.e. ISO 8502-9 and ISO 8502-6);
- b) measurement range for the conductometer ([5.1](#));
- c) the conductivities measured in [6.2.3](#) and [6.4](#);
- d) the type of adhesive patch or sleeve tested and its size;
- e) the manufacturer's batch number (ISO 8502-6);
- f) temperature of the sampled surface (ISO 8502-6);
- g) the type of water used as solvent (ISO 8502-6);
- h) the volume of water injected for extraction (ISO 8502-6);
- i) the total time of contact between the solvent and substrate (ISO 8502-6);
- j) the volume sampled, and volume added for dilution (if diluted);
- k) the calculated total surface density of the salts;
- l) temperature during conductivity measurements;
- m) any deviations from the procedure specified in [Clause 6](#);
- n) any unusual features (anomalies) observed during the test;
- o) the date of the test.

Bibliography

- [1] BRESLE Å., Conductometric determination of salts on steel surfaces, *MP (Materials Performance)*, June 1995, Vol. 34, No. 6, pp. 35-37, NACE International, Houston TX, USA
- [2] FRANKHUIZEN N.H., Measuring NaCl, Salt and Soluble Contaminants with Bresle Patches — Part 1 & 2, *Materials Performance* December 2009 pp. 34-36, NACE International, Houston TX, USA. (General information on salts given Part 1, *Materials Performance*, November 2009 pp. 36)

