



SLOVENSKI STANDARD
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**Korozijski preskusi v umetnih atmosferah - Korozijski preskusi v slani komori
(ISO/DIS 9227:2021)**

Corrosion tests in artificial atmospheres - Salt spray tests (ISO/DIS 9227:2021)

Korrosionsprüfungen in künstlichen Atmosphären - Salzsprühnebelprüfungen (ISO/DIS 9227:2021)

Essais de corrosion en atmosphères artificielles - Essais aux brouillards salins (ISO/DIS 9227:2021)

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Essais de corrosion en atmosphères artificielles — Essais aux brouillards salins

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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 156, *Corrosion of metals and alloys*.

This fifth edition cancels and replaces the fourth edition (ISO 9227:2017), which has been technically revised.

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

- arrangement of collecting devices has been changed;
- examples of arrangement of collecting devices have been added as [Annex E](#).

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

There is seldom a direct relation between resistance to the action of salt spray and resistance to corrosion in other media, because several factors influencing the progress of corrosion, such as the formation of protective films, vary greatly with the conditions encountered. Therefore, the test results should not be regarded as a direct guide to the corrosion resistance of the tested metallic materials in all environments where these materials might be used. Also, the performance of different materials during the test should not be taken as a direct guide to the corrosion resistance of these materials in service.

Nevertheless, the method described gives a means of checking that the comparative quality of a metallic material, with or without corrosion protection, is maintained.

Different metallic substrates (metals) cannot be tested in direct comparison in accordance to their corrosion resistances in salt spray tests. Comparative testing is only applicable for the same kind of substrate.

Salt spray tests are generally suitable as corrosion protection tests for rapid analysis for discontinuities, pores and damage in organic and inorganic coatings. In addition, for quality control purposes, comparison can be made between specimens coated with the same coating. As comparative tests, however, salt spray tests are only suitable if the coatings are sufficiently similar in nature.

When interpreting test results, e.g. minimum time until appearance defects or protection defects, for product quality control or acceptance specifications, it is important to recognize that the salt spray test may be a low level of reproducibility, especially with production parts tested in different laboratories.

It is often not possible to use results gained from salt spray testing as a comparative guide to the long-term behaviour of different coating systems, since the corrosion stress during these tests differs significantly from the corrosion stresses encountered in practice.

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Corrosion tests in artificial atmospheres — Salt spray tests

1 Scope

This document specifies the apparatus, the reagents and the procedure to be used in conducting the neutral salt spray (NSS), acetic acid salt spray (AASS) and copper-accelerated acetic acid salt spray (CASS) tests for assessment of the corrosion resistance of metallic materials, with or without permanent or temporary corrosion protection.

It also describes the method employed to evaluate the corrosivity of the test cabinet environment.

It does not specify the dimensions or types of test specimens, the exposure period to be used for a particular product, or the interpretation of results. Such details are provided in the appropriate product specifications.

The salt spray tests are particularly useful for detecting discontinuities, such as pores and other defects, in certain metallic, organic, anodic oxide and conversion coatings.

The neutral salt spray (NSS) test particularly applies to

- metals and their alloys,
- metallic coatings (anodic and cathodic),
- conversion coatings,
- anodic oxide coatings, and
- organic coatings on metallic materials.

The acetic acid salt spray (AASS) test is especially useful for testing decorative coatings of copper + nickel + chromium, or nickel + chromium. It has also been found suitable for testing anodic and organic coatings on aluminium.

The copper-accelerated acetic acid salt spray (CASS) test is useful for testing decorative coatings of copper + nickel + chromium, or nickel + chromium. It has also been found suitable for testing anodic and organic coatings on aluminium.

The salt spray methods are all suitable for checking that the quality of a metallic material, with or without corrosion protection, is maintained. They are not intended to be used for comparative testing as a means of ranking different materials relative to each other with respect to corrosion resistance or as means of predicting long-term corrosion resistance of the tested material.

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 2808, *Paints and varnishes — Determination of film thickness*

ISO 3574, *Cold-reduced carbon steel sheet of commercial and drawing qualities*

ISO 4623-2:2016, *Paints and varnishes — Determination of resistance to filiform corrosion — Part 2: Aluminium substrates*

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ISO 8044, *Corrosion of metals and alloys — Vocabulary*

ISO 8407, *Corrosion of metals and alloys — Removal of corrosion products from corrosion test specimens*

ISO 17872, *Paints and varnishes — Guidelines for the introduction of scribe marks through coatings on metallic panels for corrosion testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8044 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 <https://www.electropedia.org/>

3.1 reference material

material with known test performance

3.2 reference specimen

portion of the *reference material* (3.1) that is to be exposed with the intention to check the reproducibility and repeatability of the test results for the test cabinet in use

3.3 test specimen

specific portion of the samples upon which the testing is to be performed

3.4 substitute specimen

specimen made of inert materials (such as plastic or glass) used for the substitute of a *test specimen* (3.3)

4 Principle

WARNING — This document may involve hazardous materials, operations and equipment. This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

The neutral salt spray (NSS) test is the test method in which a neutral approximate 5 % sodium chloride solution is atomized under a controlled environment.

The acetic acid salt spray (AASS) test is the test method in which an approximate 5 % sodium chloride solution acidified by the addition of glacial acetic acid is atomized under a controlled environment.

The copper-accelerated acetic acid salt spray (CASS) test is the test method in which an approximate 5 % sodium chloride solution acidified by the addition glacial acetic acid and with the addition of copper(II) chloride is atomized under a controlled environment.

5 Test solutions

5.1 Preparation of the sodium chloride solution

Dissolve a sufficient mass of sodium chloride in distilled or deionized water with a conductivity not higher than 20 $\mu\text{S}/\text{cm}$ at $25\text{ }^\circ\text{C} \pm 2\text{ }^\circ\text{C}$ to produce a concentration in a range between 45 g/l and 55 g/l.

The sodium chloride concentration of the sprayed solution collected shall be $50 \text{ g/l} \pm 5 \text{ g/l}$. The specific gravity range for a $50 \text{ g/l} \pm 5 \text{ g/l}$ solution is 1,029 to 1,036 at $25 \text{ }^\circ\text{C}$.

The sodium chloride shall not contain a mass fraction of the heavy metals copper (Cu), nickel (Ni) and lead (Pb) in total more than 0,005 %. It shall not contain a mass fraction of sodium iodide more than 0,1 % and a mass fraction of total impurities more than 0,5 %, calculated for dry salt.

NOTE Anti-caking agents added to the sodium chloride can act as corrosion inhibitors or accelerators. A useful sodium chloride salt grade is a grade named Ph. Eur/USP or JIS, ACS.

5.2 Preparation of each test solution with pH adjustment

5.2.1 pH of the salt solution

Adjust the pH of the salt solution to the desired value on the basis of the pH of the sprayed solution collected.

5.2.2 Neutral salt spray (NSS) test

Adjust the pH of the salt solution (5.1) so that the pH of the sprayed solution collected within the test cabinet (6.2 and 6.5) is 6,5 to 7,2 at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$. Check the pH using electrometric measurement. Measurements of pH shall be done using electrodes suitable for measuring in weakly buffered sodium chloride solutions in distilled or deionized water. Make any necessary corrections by adding hydrochloric acid, sodium hydroxide or sodium bicarbonate solution of analytical grade.

WARNING — Hydrochloric acid (CAS no. 7647-01-0) solution is toxic, corrosive, irritating and very toxic to aquatic life. Refer to Safety Data Sheet for details. Handling of hydrochloric acid solution shall be restricted to skilled personnel or conducted under their control. Care shall be taken in the disposal of this solution.

WARNING — Sodium hydroxide (CAS no. 1310-73-2) solution is toxic, corrosive and irritating. Refer to Safety Data Sheet for details. Handling of sodium hydroxide solution shall be restricted to skilled personnel or conducted under their control. Care shall be taken in the disposal of this solution.

NOTE Possible changes in pH can result from loss of carbon dioxide in the solution when it is sprayed. Such changes can be avoided by reducing the carbon dioxide content of the solution by, for example, heating it to a temperature above $35 \text{ }^\circ\text{C}$ before it is placed in the apparatus, or by making the solution using freshly boiled water.

5.2.3 Acetic acid salt spray (AASS) test

Add a sufficient amount of glacial acetic acid not less than 99,7 % of mass fraction to the salt solution (5.1) to ensure that the pH of samples of sprayed solution collected in the test cabinet (6.2 and 6.5) is between 3,1 and 3,3 at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$. If the pH of the solution initially prepared is 3,0 to 3,1, the pH of the sprayed solution is likely to be within the specified limits. Check the pH using electrometric measurement. Measurements of pH shall be done using electrodes suitable for measuring in weakly buffered sodium chloride solutions in distilled or deionized water. Make any necessary corrections by adding glacial acetic acid, sodium hydroxide, or sodium bicarbonate of analytical grade.

WARNING — Glacial acetic acid (CAS no. 64-19-7) is flammable liquids, toxic, corrosive and irritating. Refer to Safety Data Sheet for details. Handling of glacial acetic acid shall be restricted to skilled personnel or conducted under their control. Care shall be taken in the disposal of this solution.

5.2.4 Copper-accelerated acetic acid salt spray (CASS) test

Dissolve a sufficient mass of copper(II) chloride dihydrate ($\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$) not less than 99,0 % of mass fraction in the salt solution (5.1) to produce a concentration of $0,26 \text{ g/l} \pm 0,02 \text{ g/l}$ [equivalent to $(0,205 \pm 0,015) \text{ g}$ of CuCl_2 per litre].

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WARNING — Copper(II) chloride dihydrate (CAS no. 10125-13-0) is toxic, corrosive, irritating and very toxic to aquatic life. Refer to Safety Data Sheet for details. Handling of copper(II) chloride dihydrate shall be restricted to skilled personnel or conducted under their control. Care shall be taken in the disposal of this solution.

Adjust the pH using the procedures described in [5.2.3](#).

5.3 Filtration

If necessary, filter the solution before placing it in the reservoir of the apparatus, to remove any solid matter which might block the apertures of the spraying device.

6 Apparatus

6.1 Component protection

All components in contact with the spray or the test solution shall be made of, or lined with, materials resistant to corrosion by the sprayed solution and which do not influence the corrosivity of the sprayed test solutions.

The supports for the test specimen shall be constructed such that different substrate types do not influence each other. It shall also be constructed so that the supports themselves do not influence the test specimens.

6.2 Spray cabinet

The cabinet shall be such that the conditions of homogeneity and distribution of the spray are met. Due to the limited capacity of cabinets smaller than 0,4 m³, the effect of the loading of the cabinet on the distribution of the spray and temperature shall be carefully considered. The solution shall not be sprayed directly onto test specimens but rather spread throughout the cabinet so that it falls naturally down to them. The upper parts of the cabinet shall be designed so that drops of sprayed solution formed on its surface do not fall on the test specimens being tested.

The size and shape of the cabinet shall be such that the collection rate of solution in the cabinet is within the limits specified in [10.3](#).

Preference shall be given to apparatus that has a means for properly dealing with fog after the test, prior to releasing it from the building for environmental conservation, and for drawing water prior to discharging it to the drainage system.

NOTE A schematic diagram of one possible design of spray cabinet is shown in [Annex A](#) (see [Figure A.1](#) and [Figure A.2](#)).

6.3 Heater and temperature control

The test cabinet shall be maintained at the specified temperature (see [10.1](#)) in the zone where the test specimens are placed by the appropriate system.

6.4 Spraying device

The device for spraying the salt solution comprises a supply of clean air, of controlled pressure and humidity, a reservoir to contain the solution to be sprayed, and one or more atomizers.

The compressed air supplied to the atomizers shall be passed through a filter to remove all traces of oil or solid matter, and the atomizing pressure shall be at an overpressure of 70 kPa¹⁾ to 170 kPa. The pressure is typically 98 kPa ± 10 kPa but can vary depending on the type of cabinet and atomizer used.

1) 1 kPa = 1 kN/m² = 0,01 atm = 0,01 bar = 0,145 psi.