
International Standard



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Corrosion tests in artificial atmosphere — General requirements

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7384 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Corrosion tests in artificial atmosphere — General requirements

1 Scope and field of application

This International Standard specifies general requirements for the specimens, apparatus and procedure of corrosion tests in artificial atmospheres. It applies to metals and alloys with and without permanent corrosion protection or temporary corrosion protection.

The requirements specified in this International Standard are intended for application in other International Standards dealing with corrosion tests in artificial atmospheres as well as in accelerated methods of test and the construction of new chambers.

2 References

ISO 1456, *Metallic coatings — Electroplated coatings of nickel plus chromium.*

ISO 1458, *Metallic coatings — Electroplated coatings of nickel.*

ISO 1461, *Metallic coatings — Hot dip galvanized coatings on fabricated ferrous products — Requirements.*

ISO 1462, *Metallic coatings — Coatings other than those anodic to the basis metals — Accelerated corrosion tests — Method for the evaluation of the results.*

ISO 2081, *Metallic coatings — Electroplated coatings of zinc on iron or steel.*

ISO 2082, *Metallic coatings — Electroplated coatings of cadmium on iron or steel.*

ISO 3768, *Metallic coatings — Neutral salt spray test (NSS test).*

ISO 3769, *Metallic coatings — Acetic acid salt spray test (ASS test).*

ISO 3770, *Metallic coatings — Copper accelerated acetic acid salt spray test (CASS test).*

ISO 4536, *Metallic and non-organic coatings on metallic substrates — Saline droplets corrosion test (SD test).*

ISO 4540, *Metallic coatings — Coatings cathodic to the substrate — Rating of electroplated test specimens subjected to corrosion tests.*

ISO 4623, *Paints and varnishes — Filiform corrosion test on steel.*

ISO 8407, *Metals and alloys — Procedures for removal of corrosion products from corrosion test specimens.*¹⁾

3 Definition

For the purpose of this International Standard, the following definition applies.

corrosion tests in artificial atmospheres: Laboratory tests conducted in air, in the presence of intensifying factors influencing corrosion of metallic materials and alloys with and without permanent or temporary corrosion protection.

NOTE — Corrosion tests in artificial atmospheres attempt to reproduce corrosion effects under service conditions, such as atmospheric or other environments.

4 Principle

4.1 Acceleration of the processes is achieved by intensifying such factors as temperature, relative humidity, condensation of the moisture and corrosive agents (sulfur dioxide, chlorides, acids, ammonia, hydrogen sulfide, etc.).

4.2 The following shall be specified in the test programme:

- the purpose of the test;
- the nature of the tested metals, alloys or means of corrosion protection (chemical composition, thickness, state of the specimen surface);
- the method of test: operating conditions, total duration of the test, position and eventually permutation of the test specimens, frequency of removal and examination of specimens during the test, number of specimens removed and number of control specimens;
- the calibration of the corrosivity of the atmosphere of the test chamber regardless of specimen orientation in the chamber;
- the criteria and methods of evaluation of the test results.

1) At present at the stage of draft.

4.3 The tests can be classified as follows:

- a) enhanced environment tests in which the conditions are chosen to duplicate the corrosion mechanism in service conditions, but at an accelerated rate. Tests of this type allow the prediction of long-term corrosion of metals, alloys and means of corrosion protection;
- b) short-term corrosion tests in which the corrosive environment is chosen to produce accelerated corrosion. Tests of this type allow comparison of corrosion resistance of similar corrosion protection if this has been shown to be valid by practical experience for the specific environment;
- c) rapid quality control tests in which the corrosive environment is chosen to produce abnormally accelerated corrosion. Tests of this type allow rapid determination of defects and weak points in the corrosion protection.

The classification of a specific test is dependent on the material tested.

5 Requirements for test specimens

5.1 Irrespective of the method used, all tests shall be carried out using specimens treated or coated in the same way and having the same shape, dimensions and surface roughness.

5.2 The shape and dimensions of the test specimens shall be chosen according to the test method, criteria and methods of evaluation of the test results.

The thickness of the test specimens shall be preferably between 0,5 and 3 mm; and in any case, be such that they are not deformed during the test.

If necessary, production articles or their parts with shapes which do not cause difficulties in the evaluation of the test results, may be used as test specimens. In order to exclude, as far as possible, the effect of irregularities the total surface area of the test specimen shall be as large as possible and not less than 25 cm², except where smaller surface areas are specified in special test regulations.

5.3 The surface roughness of a test specimen shall be specified in the test programme.

5.4 The surface of test specimens of metals and alloys shall be free from visible defects, such as scratches, inclusions, cracks, pits and porosity. Cut edges should have no burrs.

5.5 The coatings of test specimens shall meet all the requirements of the appropriate International Standards, for example ISO 1456, ISO 1458, ISO 1461, ISO 2081, ISO 2082.

5.6 If test specimens are cut from a larger coated article, the cutting shall be carried out in such a way as to limit the amount of damage in the area adjacent to the cut.

5.7 While preparing test specimens in which there is a welded joint, the joint shall be placed in the centre of the test specimen parallel to its longest side.

5.8 The cut edges of the test specimens shall be protected with a suitable coating stable in the chosen corrosive environment; the coating used during testing may be, for example, paint, varnish, wax, tape or enamel.

Cut edges shall be left unprotected when the influence of unprotected edges on the corrosion is to be examined.

5.9 The test specimens should be identified. Marking shall be legible and durable over the whole period of testing and shall not have an effect on the test results.

5.10 Control specimens, intended for comparison with the specimens to be removed, shall be stored over the total period of testing under conditions which prevent corrosion. The conditions shall be specified in the test programme.

5.11 The number of test specimens required is governed by the total duration of the test, the frequency of removal and examination of specimens during the test, the number of test specimens tested and the number of control specimens specified in the test programme.

5.12 The number of replicate specimens shall be not fewer than three; there shall be at least one control specimen.

6 Requirements for apparatus

6.1 The tests are carried out in special chambers or cabinets which shall be large enough to assure homogeneous distribution and uniform conditions. The upper parts of the chambers shall be so shaped that drops of moisture or sprayed solution accumulated on them do not fall on the specimens being tested.

6.2 The apparatus shall maintain the specified operating conditions within the exposure zone of the chamber for the complete duration of the test.

6.3 The specified operating conditions shall be controlled. Values of temperature and relative humidity shall be recorded automatically, except in the case of condensation tests. The concentration of corrosive agents shall be recorded automatically or determined periodically.

6.4 It is not recommended to use the same chamber for testing different corrosive agents.

6.5 The testing of specimens protected with volatile inhibitors shall be carried out in special chambers intended for this purpose in which traces of volatile inhibitors from previous tests have been removed.

6.6 The inside surfaces of parts of chambers, gaskets for hatches and doors, communication equipment and apparatus, devices for testing the test specimens, which are in contact with corrosive agents shall be made of materials that are resistant to the corrosive test atmosphere.

6.7 If necessary, a system of air circulation shall be installed in order to provide uniform operating conditions throughout the chamber.

6.8 The temperature inside the chamber shall be capable of increasing at a rate of at least 1 °C/min upon startup.

6.9 The specified relative humidity inside the chamber shall be produced by means of a supply of humidified air.

For humidification purposes, only distilled or deionized water shall be used.

It is not permissible to produce the specified relative humidity inside the chamber by means of salt solutions, as these may influence the corrosion state of the test specimens.

6.10 The time required, from startup, to reach the specified relative humidity inside the chamber shall be not more than 1 h.

6.11 The temperature and relative humidity inside the chamber shall be controlled to an accuracy of ± 2 °C and ± 5 % respectively.

6.12 If the atmosphere is obtained by spraying a solution, as described in ISO 3768, ISO 3769, ISO 3770 and ISO 4536, the pressure, temperature and humidity conditions of the supply of air to be used shall be as specified in the appropriate International Standard.

The supply of air used for spraying shall be free from all traces of oil or solid matter. If necessary the composition of the sprayed solution should be determined.

The solution shall be uniformly distributed throughout the volume of the chamber.

The methods for checking the distribution of the solution and the corresponding tolerances shall be as specified in the appropriate International Standards.

6.13 When a gaseous corrosive agent is used (for example sulfur dioxide) the concentration and flux uniformity in the chamber shall be checked. The methods for checking and the tolerances shall be specified in the appropriate International Standards.

7 Preparation of test specimens

7.1 Treatment of the specimens prior to testing

Prior to testing the surface of the test specimens with and without metallic and other non-organic coatings shall be degreased using an inert product.

7.2 Examination of the specimens prior to testing

7.2.1 The specimens shall be examined prior to testing. Specimens intended for temporary corrosion protection shall be examined before application of the coating.

Test specimens that have been stored shall be checked for corrosion before testing.

7.2.2 Specimens, the corrosion behaviour of which is to be evaluated by a change in surface appearance, shall be examined in conformity with the requirements of 5.3 to 5.5.

The following changes in surface appearance shall be recorded: colour, tarnishing of surface, presence and distribution of visible corrosion defects which are acceptable to the interested parties. For determination of the number and distribution of the defects, a wire screen of flexible transparent material, for example, plastic in conformity with that described in ISO 1462, with lines, which divide the specimen surface into squares of 5 mm \times 5 mm, shall be put over the test specimen. Each square shall be numbered counting from the top left hand corner.

The results of the examinations shall be recorded for both sides of each specimen separately.

7.2.3 When corrosion behaviour is to be evaluated by a change in mass, the surface area of the specimen shall be measured, then the specimens shall be conditioned in a desiccator containing a suitable desiccant for at least 24 h and weighed:

- to an accuracy of 0,001 g for specimens with a mass up to 200 g;
- to an accuracy of 0,01 g for specimens with a mass over 200 g.

7.2.4 Other initial characteristics of the test specimens are determined depending on the chosen criteria for evaluation of test results.

7.3 Placing of the test specimens in the chamber

7.3.1 The test specimens shall be placed only in that zone of the chamber where the corrosive environment meets the requirement of all the specified parameters of the test conditions.

Condensate and test solution shall not be permitted to trickle down from the specimens or upper parts of the chamber on to the specimens placed below.

The samples should be arranged in such a way that they cannot protect each other against the influence of the environment.

The total area of the specimens shall not exceed 0,75 m² per cubic metre of the volume of the chamber.

7.3.2 The test specimens shall be placed vertically or at an angle of 15° to 30° to the vertical, depending on the test method. In the case of specimens in which there is a welded joint, the joint shall be placed perpendicular or at an angle of 15° to 30° to the bottom of the chamber.

There might also be an advantage in testing specimens where the welded joint is parallel to the bottom of the chamber. Staining from corrosion of the weld would then produce enhanced local corrosivity.

The distance between the specimens shall be not less than 20 mm; the distance from the lowest edges of the specimens to the bottom of the chamber being not less than 200 mm.

7.3.3 Devices for fastening the test specimens shall be made from an inert material and shall provide adequate immobilization of the specimens, taking account of the conditions of test.

The surface area of contact between the test specimens and their holders shall be as small as possible.

The fasteners shall not cause galvanic effects, or contamination of the specimens.

8 Procedure

8.1 Duration of tests

8.1.1 The total period of testing for each test method depends upon the purpose of the test, nature of the tested metals, alloys and means of protection and the chosen criterion and method for evaluation of their corrosion behaviour.

Recommended periods of exposure are 24 h — 48 h — 96 h — 240 h — 480 h — 720 h — 2 016 h.

8.1.2 The duration of the test shall be recorded from the moment specimens are introduced into the chamber when all the specified operating conditions are met.

8.1.3 The duration of forced interruptions as well as the duration of periodic examination and removal of the specimens shall not be included in the exposure period of the tests.

8.2 Frequency of removal and examination of specimens during the test

8.2.1 During the test and in accordance with the test programme, all specimens shall be examined and some of them removed.

8.2.2 During the periodic examinations, the test specimens shall be taken from the chamber, examined and replaced for further testing.

The examination of the specimens shall be carried out so as to prevent damage to the specimen.

8.2.3 Upon completion of the exposure the specimens tested shall be stored under conditions that exclude the beginning and further development of corrosion, in a desiccator containing a desiccant.

8.3 Surface treatment after testing

The treatment of the test specimen surfaces after testing shall be carried out in accordance with the chosen criteria for the evaluation of the test results as given in 9.1.

9 Evaluation of test results

9.1 There are many criteria for the evaluation of corrosion resistance of metals and alloys with and without corrosion protection, for example:

- a) change in the specimen appearance during the test;
- b) time elapsed before the first local site of corrosion of base metal or coating appears;
- c) number and distribution of corrosion defects;
- d) change in mass (see ISO 8407);
- e) change in dimensions (especially thickness);
- f) change in mechanical, electric, optical and other properties.

9.2 The evaluation of the test results shall be carried out in accordance with the criteria chosen, depending on the requirements for the tested metals, alloys and means of protection, as well as on the purpose and the method of test.

Use the methods of evaluation given either in appropriate International Standards, if any, for example ISO 1462, ISO 4540, ISO 4623, or in the test programme.

10 Test report

The test report shall contain the following information:

- a) the purpose of the test;
- b) the test method, with an indication of the chemical composition of the corrosive environment and the test operating conditions;
- c) designation and description of the test specimen (chemical composition, shape and dimensions, method of treatment: chemical, thermal and mechanical; type of coating and its thickness);
- d) known characteristics of the specimen tested;
- e) exposure period;
- f) duration of the tests and total number of test cycles;
- g) method of placing and material for fastening the test specimens during the test;
- h) the results of evaluation of corrosion changes for the tested specimen surfaces, including both descriptive and numerical assessment, possibly with photographs of the test specimens.

Other data may be included in the test report depending on the purpose and method of test as well as on the criteria chosen for evaluating the results.