INTERNATIONAL STANDARD

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Corrosion of metals and alloys — Corrosion tests in artificial atmosphere — Accelerated outdoor test by intermittent spraying of a salt solution (Scab test)

Corrosion des métaux et alliages — Essais de corrosion en atmosphère artificielle — Essai de corrosion accéléré en extérieur par vaporisation intermittente d'un brouillard salin («Scab test»)

Reference number
ISO 11474:1998(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11474 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys.*

Annex A of this International Standard is for information only.

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Introduction

Corrosion testing under atmospheric exposure conditions is most commonly executed as field tests. As the corrosion rate depends on the environment of the test site, the latter should ideally be selected to best represent the environments in which the material is likely to be used. The results of field tests cannot therefore be used to predict service performance exactly but they do provide the best guidance to service performance. Field tests, however, may require exposure periods corresponding to the expected service life of a material.

To promote corrosion and accelerate the degradation process, test sites with a high atmospheric corrosivity can be used. Such test sites may be located in marine environments or in highly polluted industrial areas. To increase the corrosion rate at other test sites, artificial measures need to be adopted. In the method described, the corrosion process during outdoor exposure is accelerated by intermittently spraying a solution of sodium chloride (mass fraction 3 %) on to the test surface thus simulating and enhancing the environmental stress prevailing at marine test sites. The method is mainly intended for comparative testing and one or more reference materials are therefore always necessary. The results obtained do not permit any more far-reaching conclusions on the corrosion resistance of the tested metal in all environments in which it may be used. The method described can nevertheless give valuable information on the relative performance of materials in service.

NOTE — The title of this International Standard presents (within parentheses) a common name for this kind of test. Hitherto, “scab test” has been used mainly in a narrower sense to denote similar test methods developed within the car industry for the study of underfilm corrosion, particularly where painted steel surfaces have been locally damaged by stone shots. The word “scab” is no acronym. It simply refers to a well-known but not very pleasant disease and its symptom, i.e. a kind of crusty spots on the skin. In this International Standard, the same name is used in a wider sense to denote a test method which is applicable to all kinds of metallic substrate with or without coating. Some of these substrates will show a scab-like appearance after being tested. Others will not.

Corrosion of metals and alloys — Corrosion tests in artificial atmosphere — Accelerated outdoor test by intermittent spraying of a salt solution (Scab test)

1 Scope

The purpose of this International Standard is to define a method of assessing the corrosion resistance of metals by an accelerated outdoor corrosion test.

In this International Standard, the term “metal” includes metallic materials with or without corrosion protection.

The accelerated outdoor corrosion test applies to

— organic coatings on metals;

— metallic coatings (anodic and cathodic);

— chemical conversion coatings;

— metals and their alloys.

The method is especially suitable for comparative testing in the optimization of surface treatment systems.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2810:—[1], *Paints and varnishes — Notes for guidance on the conduct of natural weathering tests.*

ISO 8407:1991, *Corrosion of metals and alloys — Removal of corrosion products from corrosion test specimens*.

ISO 8565:1992, *Metals and alloys — Atmospheric corrosion testing — General requirements for field tests*.

ISO 9226:1992, *Corrosion of metals and alloys — Corrosivity of atmospheres — Determination of corrosion rate of standard specimens for the evaluation of corrosivity.*

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[1] To be published. (Revision of ISO 2810:1974)

3 Reagents

Salt solution, prepared by dissolving a sufficient mass of sodium chloride in distilled or deionized water to a concentration of 30 g/l ± 1 g/l. The distilled or deionized water used shall have a conductivity not higher than 2 mS/m at 25 °C ± 2 °C.

The maximum permissible amounts of impurities in the sodium chloride are given in table 1.

Prior to use, check the pH of the salt solution by using electrometric measurement at 25 °C ± 2 °C or in routine checks, with a short range pH paper which can be read in increments of 0,3 pH units or less. If the pH value determined is outside the range 6,0 to 7,0 adjustments are to be made by adding to the alt solution diluted hydrochloric acid or sodium hydroxide of analytical grade.

Table 1

Impurity by	Max mass fraction of impurity %	Method
Copper	0,001	Determined by spectrophotometry or other method of similar accuracy
Nickel	0,001	Determined by spectrophotometry or other method of similar accuracy
Sodium iodide	0,1	Calculated for dry salt
Total	0,5	Calculated for dry salt

4 Apparatus

4.1 Spray bottle, capable of producing a finely distributed mist.

4.2 Exposure frames, for holding the test specimens in an appropriate position.

The frames shall be designed in accordance with the requirements of ISO 8565. They shall normally hold the test specimens at an angle 45° to the horizontal plane and face the equator. Other exposure angles and orientations may also be agreed upon. The frames shall be located so that the test specimens are neither protected nor shaded by nearby objects.

The frames shall be positioned so that the reverse sides of the test specimens are freely exposed to air and so that no water runs off from one test specimen to another. During exposure, the test specimens shall not be in direct contact with metallic parts and, if possible, not in contact with wood or other porous materials. If the test specimens are set in tracks, suitable drainage holes shall be made to prevent water collection.

The frames shall be positioned so that all test specimens are at least 0,75 m above ground level.

5 Test specimens

Test specimens (of the material to be tested for corrosion resistance) shall be prepared according to the general requirements given in ISO 8565. The simplest and most common type of test specimen is a flat panel, but valuable information can also be obtained by carrying out tests on structures. Structures which encase water may show early damage.

For each series of test specimens, data records shall be kept including the following information.

a) Specification of material to be tested. For surface treated materials: type of base material, its pretreatment, type of coating, method of application and dry coat thickness.

b) If the test specimen is subjected to intentional damage in the coating the shape and the location of the damage should be described, as well as how the damage was achieved.

c) Any special requirements concerning the exposure site.

d) Information on reference material or materials with which the test specimen is to be compared.

e) Testing period.

f) How the test specimen is to be examined and which properties are to be assessed.

6 Procedure

Perform the test with three equally prepared test specimens.

If the test specimens consist of rectangular panels, mount them with their short sides parallel to the horizontal plane.

After mounting the test specimens, spray a salt solution (see clause 3) from above and downwards on to the entire test surface of each test specimen. When the solution begins to drip from the lower part of the test specimen, stop spraying. Repeat the spraying twice a week, 3 d – 4 d apart.

NOTE — When spraying, be careful that the salt mist does not affect other testing in the vicinity.

If there is any snow on the test specimens remove it gently before spraying. If the outdoor temperature is below – 10 °C, do not perform the salt spraying as the salt solution will freeze on the surface of test specimens.

At regular intervals, examine the test specimens visually and note the appearance of any possible corrosion damage. Adapt length of intervals to the rate of degradation.

Unless it is unavoidable, do not touch or move the test specimens as long as testing continues.

Normally, the testing should continue for 6 months. If no significant corrosion effects appear the testing may continue for a suitable number of subsequent 3 month periods.

Final evaluation of the corrosion resistance shall be made after exposure has been completed. If examination of the base material with regard to corrosion damage is required, any coating shall be removed using a suitable method. In the case of uniform corrosion, the evaluation can also be based on the mass loss of each test specimen during the test after removal of the corrosion products in accordance with ISO 8407.

7 Characterization of the exposure site

Since the test result depends on the location of the exposure site and on the exposure conditions, it is necessary to characterize the corrosivity of the atmosphere at the exposure site. This can be accomplished by the direct measurement of the corrosion rate of standard test specimens, (see clause 8) or by measuring atmospheric data, or both methods may be used. If the atmospheric data are valid for some site other than the exposure site, this other site and its distance from the exposure site shall be specified.

The environmental data required for characterizing the corrosivity of the atmosphere are

- air temperature in degrees Celsius;
- relative humidity in percent;
- calculated time of wetness, i.e. the time with temperature above 0 °C and relative humidity above 80 %, in hours;
- amount of precipitation in millimetres per day;

— SO_2 deposition in milligrams per square metre per day, or concentration in milligrams per cubic metre;

— Cl^- deposition in milligrams per square metre per day, usually for marine exposure sites only.

The recommended frequency of monitoring these factors can be found in annex A of ISO 8565:1992.

When specimens of organic coatings on metals are tested, degradation of the organic coating may occur by action of UV light or by other ageing agents in the environment of the test site. This may cause changes in the colour and gloss of the coating. This may also initiate cracking of the coating or other coating defects and therefore affect the corrosion resistance of test specimens determined by the method described in this International Standard. When testing organic coatings on metals by the method described in this International Standard, characterization of the exposure site, according to the list of climatic variables given above, may therefore be complemented by climatic variables as described in ISO 2810.

8 Measurement of corrosivity at exposure site

The corrosivity of the atmosphere at an exposure site over a certain time period can be evaluated by determining the corrosion rate of standard test specimens as is described in ISO 9226. This means that the standard test specimens shall be made of the following materials:

— steel unalloyed carbon steel (Cu 0,03 % to 10 %, P < 0,07 %);

— zinc 98,5 % min purity;

— copper 99,5 % min purity;

— aluminium 99,5 % min purity.

The standard test specimens shall be rectangular metal sheets of at least 50 mm × 100 mm and a thickness of approximately 1 mm.

Prior to exposure, the standard test specimens shall be marked and thoroughly cleaned according to one of the following methods.

a) Manual cleaning using a soft, clean brush or ultrasound in a vessel filled with suitable organic solvent (e.g. hydrocarbon with a boiling point of 60 °C — 120 °C). After cleaning, the standard test specimens shall be rinsed with clean solvent and dried.

b) Other cleaning methods may be used, provided their results are comparable to those of a).

After cleaning, weigh the standard test specimens to an accuracy of ± 1 mg.

Expose three standard test specimens of each metal as long as the testing continues.

After exposure is completed, remove the corrosion products from the standard test specimens in accordance with ISO 8407. Suitable procedures are given in annex A. Reweigh the standard test specimens to an accuracy of ± 1 mg.

A numerical value for the corrosion rate of each metal, r_{corr}, expressed in micrometres per year is calculated as follows:

$$r_{\mathrm{corr}} = \frac{\Delta m}{A \times \rho \times t}$$

where

Δm is the metal loss in grams;

A is the exposed area of the standard test specimen in square metres;

ρ is the density in grams per cubic centimetre;

t is the time of exposure in years.

9 Test report

The test report shall give the following information:

a) reference to this International Standard;

b) the type and designation of the tested product;

c) supplementary data in accordance with clause 5;

d) test results after final evaluation in accordance with clause 6;

e) place and time of exposure and date of start;

f) the exposure conditions defined by the environmental data, (see clause 7) or by the corrosion rate of standard test specimens (see clause 8);

g) any deviations from the prescribed testing method.

Annex A
(informative)

Procedures for the removal of corrosion products

Material	Chemicals	Time min	Temperature °C	Remarks
Steel	500 ml hydrochloric acid (HCl, density 1,19 g/ml) 3,5 g hexa-methylene-tetramine, distilled water to make 1 000 ml	10	20 to 25	
Copper	54 ml sulphuric acid (H_2SO_4, density 1,84 g/ml), distilled water to make 1 000 ml	30 to 60	45 to 50	Deaerate the solution with nitrogen. To remove corrosion products from the standard specimens, brushing followed by further immersion for 3 s – 4 s is recommended.
Aluminium	50 ml phosphoric acid (H_3PO_4, density 1,69 g/ml) 20 g chromium trioxide (CrO_3), distilled water to make 1 000 ml	5 to 10	90 to 95	If corrosion products remain, then follow with the nitric acid procedure below.
	Nitric acid (HNO_3, density 1,42 g/ml)	1 to 5	20 to 25	Remove foreign deposits and voluminous corrosion products in order to avoid reactions that may result in strong attacks on the base metal.
Zinc	200 g chromium trioxide (CrO_3), distilled water to make 1 000 ml	1	80	Chloride contamination in the chromic acid from corrosion products formed in salt-rich environments should be avoided to protect the zinc base metal from attack.

ICS 77.060

Descriptors: corrosion, atmospheric corrosion, metals, alloys, tests, corrosion tests, atmospheric corrosion tests, accelerated corrosion tests, field corrosion tests, salt spray tests, determination, corrosion resistance.

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