INTERNATIONAL
STANDARD

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Corrosion of metals and alloys — Corrosivity of atmospheres — Determination of corrosion rate of standard specimens for the evaluation of corrosivity

Corrosion des métaux et alliages — Corrosivité des atmosphères — Détermination de la vitesse de corrosion d'éprouvettes de référence pour l'évaluation de la corrosivité

Reference number
ISO 9226:1992(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 9226 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

The characterization of an atmospheric corrosion test site or of a service location with respect to its corrosivity can be accomplished by determining the corrosion rate of standard specimens exposed for one year to the atmosphere at the respective location (direct corrosivity evaluation). The standard specimens are flat plate or open helix specimens of the four standard structural materials: aluminium, copper, steel and zinc. These methods represent an economical way for corrosivity evaluation, taking into account all local environmental influences.

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Corrosion of metals and alloys — Corrosivity of atmospheres — Determination of corrosion rate of standard specimens for the evaluation of corrosivity

WARNING — Some of the procedures included in this International Standard entail the use of potentially hazardous chemicals. It is emphasised that all appropriate safety precautions should be taken.

1 Scope

This International Standard specifies methods which can be used for the determination of corrosion rate with standard specimens.

The values obtained from the measurements (corrosion rates for the first year of exposure) are to be used as classification criteria for the evaluation of atmospheric corrosivity according to ISO 9223.

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 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 9223:1992, *Corrosion of metals and alloys — Corrosivity of atmospheres — Classification*.

3 Principle

The corrosivity of the exposure locations or of industrial installation sites is deduced from the corrosion rate, calculated from the loss of mass per unit area of standard specimens following the descaling of corrosion products from the specimens after exposure periods of one year.

In the case of alloys of iron, zinc and copper, mass loss is a proven measure of corrosion damage. In the case of aluminium alloys, mass loss is a valid measure of corrosion. This is the aim of this International Standard, however it does not measure the corrosion penetration.

4 Standard specimens

Two types of standard specimens may be used.

Helix specimens often give results which are significantly different from those obtained with flat specimens; therefore, comparisons of results should be based on specimens of the same type.

The materials used to prepare the standard specimens are of current fabrication, i.e.:

Steel:	unalloyed carbon steel (Cu 0,03 % to 0,10 %, P < 0,07 %)
Zinc:	98,5 % min.
Copper:	99,5 % min.
Aluminium:	99,5 % min.

Prior to exposure, all specimens shall be solvent degreased. Steel specimens with visable rust stains or corrosion products on their surfaces shall be polished with 120 grit abrasive paper prior to degreasing to remove these visible corrosion products. Copper, zinc and aluminium specimens shall not be used if visable corrosion products are present before exposure.

4.1 Flat plate specimens

The specimens are rectangular plates with dimensions of preferably 100 mm × 150 mm but at least 50 mm × 100 mm, and a thickness of approximately 1 mm.

4.2 Open helix specimens

The materials used to prepare the standard specimens are wires intended for thermal spraying.

Wires with a diameter, d, of 2 mm to 3 mm are cut to a length of approximately 1 000 mm. They are then rolled into a helix using a rod with a diameter of 24 mm.

5 Exposure of standard specimens

The preparation and the exposure of the weighed and marked standard specimens shall be done according to the specifications of ISO 8565.

Three specimens of each metal should be exposed for one year, starting at the beginning of the worst corrosive period of the year. Helix specimens must be exposed in upright position (see figure 1).

After exposure, the corrosion products formed on specimens shall be removed in accordance with the specifications of ISO 8407 and reweighed to the nearest 0,1 mg. Procedures suitable for chemical cleaning are given in annex A. The cleaning procedure should be repeated several times in equal cleaning cycles.

6 Expression of results

The corrosion rate, r_{corr}, for each metal, expressed in grams per square metre year [g/(m^2·a)], is given by the equation

$$r_{\mathrm{corr}} = \frac{\Delta m}{A \cdot t} \qquad \ldots (1)$$

where

Δm is the mass loss, in grams;

A is the surface area, in square metres;

t is the exposure time, in years.

The corrosion rate, r_{corr}, can also be expressed in micrometres per year (µm/a), and is given by the equation

$$r_{\mathrm{corr}} = \frac{\Delta m}{A \cdot \varrho \cdot t} \qquad \ldots (2)$$

where

ϱ is the density, in grams per cubic centimetre, of the metal:

$\varrho_{\mathrm{Fe}} = 7,86\ \mathrm{g/cm^3}$
$\varrho_{\mathrm{Zn}} = 7,14\ \mathrm{g/cm^3}$
$\varrho_{\mathrm{Cu}} = 8,96\ \mathrm{g/cm^3}$
$\varrho_{\mathrm{Al}} = 2,70\ \mathrm{g/cm^3}$

Δm, A and t have the same meaning as the symbols in equation (1).

The corrosion rate for open helix specimens, r_{corr}, expressed in micrometres per year (µm/a), is given by the equation

$$r_{\mathrm{corr}} = 0,25 \times \frac{\Delta m \cdot d}{m \cdot t} \qquad \ldots (3)$$

where

Δm is the mass loss, in milligrams;

d is the wire diameter, in millimetres;

m is the original mass, in grams;

t is the exposure time, in years.

All single values and their mean values shall be represented in the test report.

Dimensions in millimetres

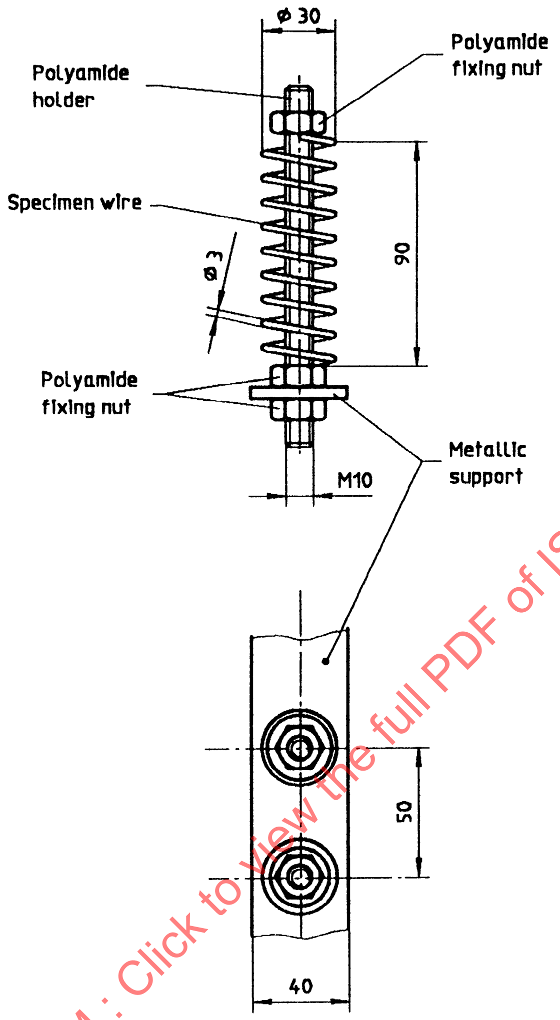

Figure 1 — Open helix specimen assembly

Annex A
(informative)

Chemical cleaning procedures for removal of corrosion products

Material	**Chemical**	**Time** min	**Temperature** °C	**Remarks**
Steel	500 ml of hydrochloric acid (HCl, ϱ = 1,19 g/ml) 3,5 g of hexamethylene tetramine Distilled water to make up to 1 000 ml	10	20 to 25	—
Zinc	200 g of chromium trioxide (CrO_3) Distilled water to make up to 1 000 ml	1	80	Chloride contamination of the chromic acid from corrosion products formed in salt environments should be avoided to prevent attack of the zinc base metal.
Copper	54 ml of sulfuric acid (H_2SO_4, ϱ = 1,84 g/ml) Distilled water to make up to 1 000 ml	30 to 60	40 to 50	Deaerate solution with nitrogen. Brushing of test specimens to remove corrosion products followed by re-immersion for 3 s to 4 s is recommended.
Aluminium	50 ml of phosphoric acid (H_3PO_4, ϱ = 1,69 g/ml) 20 g of chromium trioxide (CrO_3) Distilled water to make up to 1 000 ml	5 to 10	90 to 95	If corrosion product films remain, then follow with the nitric acid procedure below.
	Nitric acid (HNO_3, ϱ = 1,42 g/ml)	1 to 5	20 to 25	Remove extraneous deposits and bulky corrosion products to avoid reactions that may result in excessive removal of base metal.

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