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Corrosion tests in artificial atmosphere at very low concentrations of polluting gas(es)

Corrosion des métaux et alliages — Essais de corrosion en atmosphère artificielle à très faible concentration en gaz polluants

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 10062 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

This second edition cancels and replaces the first edition (ISO 10062:1991), which has been technically revised.

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Introduction

Products with, for example, sensitive electrical functions, may, during storage or operation in indoor locations, be affected by atmospheric corrosion dependent on climatic factors such as temperature, relative humidity, air velocity and rate of change caused by temperature and humidity. Additionally, gaseous pollutants may seriously affect the rate of corrosion, as well as the occurrence of different corrosion mechanisms. Contaminants on the surface, such as salt, dust, oil and compounds liberated from plastics, may also affect the rate and mechanism of corrosion.

Different corrosion-promoting gaseous pollutants dominate in different field environments:

- sulfur dioxide and nitrogen oxides in atmospheres influenced by combustion of fossil fuels and in traffic environments,
- hydrogen sulfide in atmospheres in the vicinity of petrochemical and steel industry, decaying organic matter, stagnant waters and animal shelters, and
- hydrogen sulfide and chlorine compounds in the vicinity of pulp and paper industry; if chlorine is used for bleaching

Those gaseous pollutants are known to act as single corrosion-promoting factors. However, in atmospheres where more than one gaseous pollutant is present, synergistic effects may be initiated. As a result, a considerable increase in the corrosion rate may occur, compared to the case when the different gaseous pollutants act as single corrosion-promoting factors.

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This International Standard is intended to

a) define a general method using atmospheres polluted by one or more gases at very low volume fractions $\leqslant 10^{-6}$ under specified conditions of temperature and relative humidity, so as to avoid condensation phenomena during the test,

b) define the test apparatus and procedure required to achieve the best possible reproducibility,

c) assess performance under test conditions which accelerate corrosion; as knowledge of operating conditions proceeds, more suitable pollutants or pollutant mixtures could be used.

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Corrosion tests in artificial atmosphere at very low concentrations of polluting gas(es)

WARNING — Safety rules for personnel: Handling of the gases used for testing can be hazardous and must be left to skilled chemists or conducted under their control. The test equipment must be used and maintained by skilled personnel, not only so that the tests can be performed correctly, but also because of the hazards to health and safety that are involved.

1 Scope

This International Standard specifies tests which are intended to determine the influence of one or more flowing polluting gas(es) at volume fractions less than or equal to 10^{-6} on test samples and/or articles of metals and alloys with or without corrosion protection under determined conditions of temperature and relative humidity.

These tests apply to

a) metals and their alloys,

b) metallic coatings (anodic and cathodic),

c) metals with conversion coatings,

d) metals with anodic oxide coatings, and

e) metals with organic coatings.

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2 Normative references

The following referenced documents are indispensable for the application 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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 558, *Conditioning and testing — Standard atmospheres — Definitions*

ISO 7384, *Corrosion tests in artificial atmosphere — General requirements*

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

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
exposure time
interval of time elapsed between the moment when the specimens are introduced into the test chamber and the end of the test

3.2
test duration
interval of time during which the specimens are exposed to polluting gases

4 Apparatus

Special attention shall be paid to equipment design and the choice of construction materials, in order that the conditions (less than ± 1 °C for temperature and less than ± 3 % for relative humidity) are uniformly consistent throughout the working space, able to ensure no condensation in the test chamber, and are repeatable.

The apparatus shall enable the use, singly or in mixtures, of polluting gas(es) such as SO_2, H_2S, Cl_2 and NO_2 up to at least the concentration required, for each gas, by the test method.

The important parameters are

a) the materials used for the test chamber and the gas handling system,

b) the geometry of the test chamber,

c) the rate and pattern of the gas flow,

d) the homogeneity of gas mixing,

e) the incident illumination (see A.1.6)

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The apparatus shall be constructed according to Annex A and shall meet its requirements.

A typical apparatus for polluting-gas corrosion tests is also shown in Annex B.

5 Test methods

5.1 Test severity

5.1.1 General

The test severity, to be given in the relevant specification, is defined by

— the type, concentration and flow rate of polluting gas,

— the temperature,

— the relative humidity, and

— the test duration.

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5.1.2 Suggested test methods

The method to be used depends upon the purposes of the test, the nature of the metals and alloys and the type of protection to be tested.

— **Method A**

Polluting gas	SO_2 at a volume fraction of $(0{,}5 \pm 0{,}1) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH
	or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

— **Method B**

Polluting gas	H_2S at a volume fraction of $(0{,}10 \pm 0{,}02) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH
	or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % RH is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

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— **Method C**

Polluting gas	Cl_2 at a volume fraction of $(0{,}02 \pm 0{,}005) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH
	or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % RH is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

— **Method D**

Mixture of polluting gases	SO_2 at a volume fraction of $(0{,}5 \pm 0{,}1) \times 10^{-6}$, and
	H_2S at a volume fraction of $(0{,}10 \pm 0{,}02) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH
	or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % RH is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

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— **Method E**

Mixture of polluting gases	SO_2 at a volume fraction of $(0,20 \pm 0,05) \times 10^{-6}$, and NO_2 at a volume fraction of $(0,5 \pm 0,1) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % RH is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

— **Method F**

Mixture of polluting gases	SO_2 at a volume fraction of $(0,5 \pm 0,1) \times 10^{-6}$, H_2S at a volume fraction of $(0,10 \pm 0,02) \times 10^{-6}$, and Cl_2 at a volume fraction of $(0,02 \pm 0,005) \times 10^{-6}$
Temperature and relative humidity	(40 ± 1) °C and (80 ± 5) % RH or (25 ± 1) °C and (75 ± 3) % RH

The condition of (40 ± 1) °C and (80 ± 5) % RH is more aggressive than the condition of (25 ± 1) °C and (75 ± 3) % RH. Either of them shall be optionally selected and be stated in the test report.

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NOTE 1 Since the corrosivity is different for methods A, B, C, D, E and F the result obtained by these methods are not comparable.

NOTE 2 Other methods may be added in the future if required (e.g. increase in the relative humidity).

5.1.3 Test duration

The test duration for each test method depends upon the purposes of the test, the nature of the metals and alloys and the means of protection tested.

5.2 Treatment of the specimens prior to testing (see Clause 6)

The relevant specification may require a preconditioning of specimens, for example chemical or mechanical cleaning of the surface.

5.3 Examination of the specimens prior to testing

Measurements shall be carried out as required by the relevant specification (see ISO 7384).

5.4 Filling of the test chamber

The filling of the chamber by the specimens shall satisfy the following conditions:

- the total surface of the test specimens shall not exceed the critical level at which the concentrations of polluting gases would decrease by more than 10 % during the passage through the working space;
- the specimens shall be placed in the working space, as defined in the relevant specification.

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Care shall be taken that the specimens are placed so that they do not come into contact with one another or with the walls of the chamber, and that they do not shield one another from the test atmosphere.

The specimens shall be distributed uniformly in the working space.

5.5 Procedure

Two procedures for the execution of the test may be adopted, the reference method and the simplified method.

5.5.1 Basis for calculation

5.5.1.1 Exposure time:

a) For the reference method, exposure time corresponds to t_1 to t_3 (see Figure 1).

b) For the simplified method, exposure time corresponds to t_2 to t_3 (see Figure 2).

5.5.1.2 Test duration:

a) For the reference method, test duration corresponds to t_2 to t_3 (see Figure 1).

b) For the simplified method, test duration corresponds to t_5 to t_3 (see Figure 2).

5.5.2 Reference method

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The conditions of the specimens and the test chamber shall be such that condensation does not occur on the specimens when they are introduced into the test chamber.

The temperature and relative humidity inside the chamber shall be adjusted according to the specified method (see 5.1.2 and A.1.4).

After introducing the specimens, a waiting period of 1 h should be allowed for the temperature and the relative humidity to stabilise before the polluting gas(es) is/are introduced into the test chamber.

The polluting gas(es) shall be introduced simultaneously into the damp air flow and their concentrations shall be adjusted to the value specified by the test method; during this adjustment, the maximum specified concentrations should not be exceeded (see 5.1).

The concentration of polluting gas(es) shall be stabilized in less than 1 h.

The test duration shall be measured as indicated in 5.5.1.2.

At the end of the test, the injection of polluting gas(es) shall be stopped and the specimens shall be maintained in the flow of the damp atmosphere without polluting gas(es) for 2 h.

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