
**Corrosion of metals and alloys —
Corrosivity of atmospheres —
Measurement of environmental
parameters affecting corrosivity of
atmospheres**

*Corrosion des métaux et alliages — Corrosivité des atmosphères —
Mesurage des paramètres environnementaux affectant la corrosivité
des atmosphères*
(standards.iteh.ai)

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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 9225 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

This second edition cancels and replaces the first edition (ISO 9225:1992), which has been technically revised.

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Introduction

The ability of an atmosphere to cause corrosion of metals and alloys is controlled by the following factors: the temperature-humidity complex and pollution. A basic requirement for the estimation of the corrosivity of atmospheres is standardized measurement of the important parameters describing the correlation between the corrosion and the environmental characteristics.

The methods included in this International Standard have been chosen for their easy applicability and good comparability of results. It is important to stress that the methods for estimation of the atmospheric corrosivity given in ISO 9223 are based on the measurement methods described in this International Standard.

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Corrosion of metals and alloys — Corrosivity of atmospheres — Measurement of environmental parameters affecting corrosivity of atmospheres

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

1 Scope

This International Standard specifies methods for measuring the parameters needed for corrosivity estimation used for classification of the corrosivity of atmospheres in ISO 9223.

This International Standard specifies methods for the measurement of environmental parameters for

- normative corrosivity estimation based on calculated first-year corrosion rates of standard metals, and
- informative corrosivity estimation based on characterization of the exposure environment.

This International Standard does not describe the usual analytical techniques for the measured parameters since this depends on the available analytical techniques used in laboratories. Specific methods for deposition measurement of SO₂ and Cl⁻ deposition rates and conversional factors for comparison of different measuring methods are presented in Annexes A, B, C, D, E and F.

For methods pertaining to the characterization of the atmospheric exposure site in general, see ISO 8565.

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 9223, *Corrosion of metals and alloys — Corrosivity of atmospheres — Classification, determination and estimation*

ISO 11844-3, *Corrosion of metals and alloys — Classification of low corrosivity of indoor atmospheres — Part 3: Measurement of environmental parameters affecting indoor corrosivity*

3 Principle

Different environmental parameters and their combinations affect the corrosivity of the atmosphere. Two methods for corrosivity estimation (normative and informative) are specified in ISO 9223.

In general, two groups of parameters are obtained or measured for standardized procedures of corrosivity estimation:

- humidity and temperature;
- airborne contaminants.

Standardized corrosivity estimation is based on information on levels of the dominating environmental parameters: the temperature-humidity complex, and pollution with SO₂ and airborne chlorides. Measurements of these parameters are mandatory for the purpose of corrosivity estimation.

Contaminants other than SO₂ and Cl⁻, such as NO_x, O₃, H₂S, HNO₃, can also exert an effect on the corrosion rate. Corrosion active components of dust deposits (SO₄²⁻, NO₃⁻, Cl⁻) react with metals in the presence of humidity. These factors are considered as accompanying factors (see ISO 9223). These environmental parameters, which contribute to the effect on corrosion of standard metals in multi-pollutant situations, are not included as mandatory parameters for corrosivity estimation in ISO 9223. Information on levels of these parameters can help in informative corrosivity estimation.

Methods for the measurement of environmental parameters to be used specifically for the estimation of low corrosivity of indoor atmospheres (IC) are given in ISO 11844-3.

4 Humidity and temperature parameters

4.1 Relative humidity

Reliable long-term average values for relative humidity can often be obtained from the meteorological authorities in the country. Several types of measuring devices can be used if collection of new data for the locality is needed. There are several continuous measuring devices, such as hygrographs, thermohygrographs or logging hygrometers, available on the market.

The period of measurement is preferably one year in order to cover seasonal variations and because the classification system is based on yearly average values. The data shall be expressed as yearly mean values.

4.2 Temperature

Reliable long-term average values for temperature can often be obtained from the meteorological authorities in the country. Several types of measuring devices can be used if collection of new data for the locality is needed. There are several continuous measuring devices, such as thermohygrographs or logging thermometers, available on the market.

The period of measurement is preferably one year in order to cover seasonal variations and because the classification system is based on yearly average values. The data shall be expressed as yearly mean values.

5 Airborne contaminants

5.1 Principle

The gas concentration or deposition rate may be measured using several techniques:

- continuous gas concentration measuring instruments;
- average gas concentration with active sampler and air pump;
- average gas concentration with diffusive (passive) sampler;
- average deposition rate equipment.

The results from concentration measurements are typically given in micrograms per cubic metre (µg/m³) and, for deposition measurements, in milligrams per square metre per day [mg/(m²·d)].

5.2 Placement of measurement equipment

5.2.1 Continuous gas concentration measurement instruments

The instrument shall be located in a place that is sheltered from the rain and protected from unauthorized people. Preferably, the instrument should be placed indoors with a tube leading out to the ambient air. Polyethylene or PTFE tubing is recommended and the length of the tubing should not exceed 2 m. The inlet shall be facing down with a wider hood at the inlet to reduce the risk of sucking particulates into the tube.

5.2.2 Measurement instruments with active sampler

The active sampler equipment shall be placed according to the same rules as the continuous gas-measuring instrument.

5.2.3 Measurement instruments with diffusive sampler

The sampling device shall be placed with the open end facing downward under appropriate shelter. The air flow influences the gas diffusion in the sampler.

5.2.4 Deposition rate equipment

The equipment shall be sheltered from setting particles and from washing out by rain for outdoor deposition measurements. The air flow influences the deposition rate.

5.3 Measurement methods and duration

5.3.1 Continuous measurement

The measurements shall preferably be carried out for one year in order to record the seasonal variation of the gas pollutants. The data from continuous measuring instruments shall be recorded as monthly average values. For the corrosivity estimation, the data shall be expressed as yearly mean values.

Standard instruments have detection limits in a range from 4×10^{-5} volume fractions to 1×10^{-6} volume fractions.

5.3.2 Measurement with active sampler

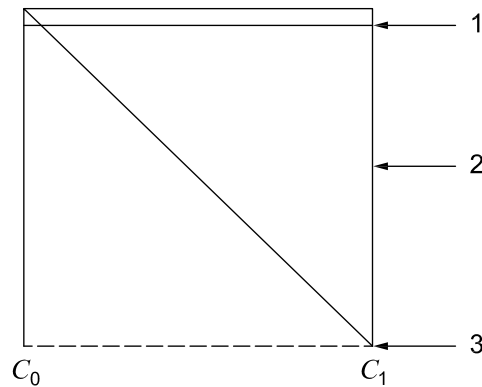
The methods are based on pumping air through an absorption unit with a reactive surface or liquid, with subsequent laboratory analysis of the amount absorbed. The sampling period shall be one week. The data shall be collected over the sampling periods and summarized to monthly average values. The result is given as an average concentration for the measuring period.

The measuring period is preferably one year or at least one month for each season of the year. For the corrosivity estimation, the data shall be expressed as yearly mean values.

NOTE The detection limits for air concentrations depend on the sensitivity of the analysing instruments and the duration of the sampling. For an analytical instrument with normal sensitivity, it is possible to obtain weekly average values with a detection limit better than $0,1 \mu\text{g}/\text{m}^3$.

5.3.3 Measurement with diffusive sampler

Mean gas concentrations can be calculated using diffusive sampling devices. The principle used for diffusive sampling is shown in Figure 1. The recommended sampling period is one month, but can be extended to three months, corresponding to one measurement for each season of the year. The measurement period is preferably one year.



Key

- 1 absorbent
- 2 tube
- 3 permeable screen for gases
- C_1 ambient concentration of gas
- C_0 concentration of gas at the absorbent equal zero

Figure 1 — Principle of concentration calculation for a diffusive sampler

NOTE Normal sensitivity for weekly mean values is down to 0,1 $\mu\text{g}/\text{m}^3$ for SO_2 , but higher for other gases. Generally the detection limit decreases with increasing sampling time.

The general calculation model is specified in ISO 11844-3.

The data shall be expressed as yearly mean values.

5.3.4 Measurement of deposition rate of pollution

The deposition takes place on an absorbing or collecting surface similar to the surfaces used for diffusive sampling devices. In the deposition method standardized for SO_2 deposition measurements, the gas reacts when it reaches the lead dioxide surface or alkaline surface (see Annexes A, B and C). In the methods standardized for airborne salinity measurements, particles (aerosol) are deposited on a wet or dry surface designed to collect this pollutant (see Annexes D and E). Since the collecting system is open, the deposition rate depends on the movement of the air.

NOTE The use of lead compounds can be restricted in some countries.

SO_2 deposition measurements performed by the lead dioxide plates and by the lead dioxide cylinder differ with regard to the kind and shape of the deposition surface. Both measurements give values with low correlation for monthly sampling periods due to the greater variation in weather characteristics. A high correlation exists for annual average values (see Annex F). Capture of sulfuric acid aerosols and sulfur-bearing species from precipitation and sea salt deposition can occur.

The SO_2 deposition values used for the derivation of the dose-response functions given in ISO 9223 are either based on deposition measurements on alkaline surfaces or converted values based on concentration measurements.

Chloride deposition rates determined by the dry plate method and by the wet candle method differ because the kind and shape of deposition surface are different (wet/dry surfaces, cylindrical/plate format of the deposition surface). There is little difference in the deposition rates determined by the two methods at locations with very low deposition rates, i.e. $<10 \text{ mg}/(\text{m}^2\cdot\text{d})$. On the other hand, at higher chloride deposition rates, the wet candle method gives deposition rates that are approximately twice as high as those given by the dry plate method. Both these measurements give values with low correlation for monthly sampling periods due to the great variation in weather characteristics. A high correlation exists for annual average values (see Annex F).

The chloride deposition values used for the derivation of the dose-response functions given in ISO 9223 are based on measurements with the wet candle method. If the chloride deposition is measured with the dry plate method (see Annex E), it is necessary that the transformation factor given in Annex F be applied before using the dose-response functions.

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Annex A (normative)

Determination of sulfur dioxide deposition rate on lead dioxide sulfation plates

A.1 Principle

Atmospheric sulfur dioxide (SO_2) reacts with the lead dioxide (PbO_2) to form lead sulfate (PbSO_4). The plates are withdrawn after exposure and sulfate analysis is performed on the contents to determine the extent of sulfur dioxide capture. The deposition rate of sulfur dioxide is expressed in milligrams per square metre per day [$\text{mg}/(\text{m}^2\cdot\text{d})$].

The lead dioxide reagent used in this method can also convert other sulfur-bearing compounds, such as hydrogen sulfide (H_2S) and mercaptans ($\text{C}_2\text{H}_5\text{SH}$), to sulfate.

The inverted position of the disc is intended to minimize sulfur capture from acid precipitation or sulfuric acid (H_2SO_4) aerosols.

A.2 Sampling apparatus

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A.2.1 Sulfation plate

Sulfation plates may be purchased ready for exposure or may be prepared. The following method is recommended for the preparation of sulfation plates.

Bond filter paper circles to the bottom of polystyrene Petri dishes. The circle diameters may be 50 mm or 60 mm. Bonding is carried out by placing a filter paper rough side up, in the bottom of the dish. The filter paper should fit inside the dish without wrinkling. Carefully squirt acetone into the dish so that the filter becomes just saturated. Press the filter paper firmly with a glass rod so that it adheres completely to the dish. Allow the acetone to evaporate.

Place a batch of bonded plates (several tens of either 50 mm plates or 60 mm plates) in a rack and rinse with distilled or demineralized water. Fill the plates with water again and allow to stand for 1 h. Pour the water out of the plates and refill to between one quarter and one half with distilled or deionized water.

Add 3,5 g of tragacanth gum and 900 ml of distilled or deionized water to a high-speed blender. Set at a low speed and blend for 2 h.

Pour the contents of the blender into a 1 l beaker and pour 350 ml of the solution back into the blender. Pulp 3,5 g of filter paper, add them to the 350 ml of gum solution and set the blender at a moderate speed until the mixture appears smooth and uniform.

Pour 400 ml of the previously prepared gum solution into the blender and blend at a moderate speed for 1 min.

Set the blender at a high speed and add 112 g of lead dioxide. Blend for 2 min and then turn the blender back to a low speed.

Carefully pipette 10 ml of the mixture into each 50 mm plate or 15 ml into each 60 mm plate. Make sure that the mixture spreads uniformly to the edge of each plate.