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Corrosion of metals and alloys — Procedures to determine and estimate runoff rates of metals from materials as a result of atmospheric corrosion

Corrosion des métaux et alliages — Modes opératoires pour déterminer et évaluer le taux d'entraînement par les eaux de ruissellement des métaux présents dans des matériaux soumis à la corrosion atmosphérique

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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 17752 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

Introduction

Runoff testing is carried out in order to obtain data on the release rates of metals of different materials under atmospheric exposure conditions. It involves exposure of specimens at a test site and, in addition, continuous collection of runoff water samples and is therefore more demanding than standardized corrosion tests.

Standardized corrosion tests cannot be used for obtaining these data since, on a long-term perspective, the runoff rate is always less than or equal to, and frequently much less than, the corrosion rate. The difference is the metal incorporated in the corrosion products. In contrast to standardized corrosion tests, runoff testing can be performed on real product surfaces or on any kind of surface-treated material, e.g. pure metals, alloys or different coatings (i.e. metallic coatings, metal-including organic coatings), as long as the history and surface finish and characteristics of the specimen are documented.

The result of this field test is the metal release rate to the collected rain water that has impinged the material surface. Further possible transformations of the metal in its different chemical forms and interactions with the environment are beyond the scope of this International Standard.

Procedures to establish runoff rates can be carried out either by determination (normative) based on exposure of specimens or by estimation (informative), taking into account the conditions in a particular application.

Corrosion of metals and alloys — Procedures to determine and estimate runoff rates of metals from materials as a result of atmospheric corrosion

1 Scope

This International Standard specifies procedures to determine and estimate runoff rates of metals from metals, alloys and coatings under atmospheric conditions carried out in the open air.

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 4221, *Air quality — Determination of mass concentration of sulphur dioxide in ambient air — Thorin spectrophotometric method*

ISO 4226, *Air quality — General aspects — Units of measurement*

ISO 4543, *Metallic and other non-organic coatings — General rules for corrosion tests applicable for storage conditions*

ISO 8565, *Metals and alloys — Atmospheric corrosion testing — General requirements*

ISO 9169, *Air quality — Definition and determination of performance characteristics of an automatic measuring system*

ISO 9225, *Corrosion of metals and alloys — Corrosivity of atmospheres — Measurement of environmental parameters affecting corrosivity of atmospheres*

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

3 Requirements for test specimens

3.1 Types of specimen

The exposed surface area of the specimen should be of such a magnitude that it provides sufficient water runoff volumes to enable reproducible results to be determined from the test, minimizing edge effects and any loss of runoff water. Rectangular specimens in the form of flat sheets shall be sized at least 100 mm × 300 mm (300 cm^2). The surface area of the specimens can be larger, provided that they can be accurately evaluated and all runoff water continuously collected. The specimen thickness shall be adequate to ensure that the specimens will endure the intended test period. A useful thickness is between 1 mm and 3 mm. The surface of the specimen tested should represent real products as closely as possible.

3.2 Specimen preparation and handling

Because atmospheric corrosion and metal runoff tests may extend over many years, it is important to ensure that specimens are clearly identified and records of data (collected total runoff water volumes, pH, and measured total metal concentrations) are carefully kept.

Surface damage shall be avoided. All specimens, in particular coated materials, shall be free from surface damage. To minimize surface contamination and to ensure surface uniformity, the uncoated specimens should

be cleaned prior to exposure, if possible, depending on the material. A convenient procedure is degreasing in acetone and isopropylic alcohol. Abrasion is not recommended since such a surface is not representative for real product conditions and can largely influence the extent of released metals. Fingerprints during specimen handling can influence the results and shall be avoided by using cotton gloves and by handling the specimens at the edges.

The reverse side of each specimen shall be covered by an adhesive tape and the cut-edges shall be sealed with lacquer (metal-free) or wax in order to avoid metal release from these parts of the specimen. Sealing of cut-edges is primarily essential for coated materials.

A specimen holder without a metal specimen made of an inert material with the same area should be exposed in parallel to continuously collect impinging rainwater for background deposition rates of the metals of interest.

3.3 Marking of specimens

Mark the specimens in such a way that no confusion during the exposure is possible. It is recommended to mark both the sample holder and the specimen.

This can be accomplished by notching (which shall be on the back side of the specimen). Other marking procedures may be used, provided that the requirements of legibility and durability are met. The area affected by marking shall be minimized. Any method of identification used on the specimens shall not influence, or otherwise interfere with, the results of the test; this is particularly important where notching is used to identify coated specimens. All notching on coated specimens shall be made prior to coating.

3.4 Number of specimens

For each type of material, one specimen is sufficient as long as the surface area is equal to or exceeds 300 cm^2 (see 3.1).

3.5 Storage

The time period between specimen preparation and start of exposure should be kept as short as possible to minimize any corrosive effects induced on the specimen during storage. Such effects can influence runoff results, in particular for specimens releasing very low concentrations of metals. The recommended time between specimen preparation and start of exposure is one week, in particular for bare metal and alloy surfaces.

Since runoff tests can be conducted on any kind of surface, it is essential to document the storage time and storage conditions prior to testing. If the specimens are to be analysed for corrosion products and surface morphology after exposure termination, the recommended maximum time between the end of exposure and surface evaluation is two weeks to ensure no changes in surface characteristics and to avoid further oxidation. Naturally this period shall be kept as short as possible, in particular for short-term exposures.

During storage of the test specimens before exposure, care shall be taken to avoid mechanical damage and contact with other specimens. A room with controlled temperature and relative humidity of 50 % or less shall be used for storage purposes. Particularly sensitive specimens shall be stored in a desiccator or sealed in plastic bags with a desiccant. (See ISO 4543.)

3.6 Specimen data records

For each series of test specimens, record the data that are needed for the assessment of the runoff effects (see Clause 8). These records shall include the following:

a) in the case of bare metals or alloys:

- chemical composition including main and minor alloying elements;
- exposure geometry and surface area;
- surface finish characteristics (e.g. surface roughness profile, etc.);

— specimen history (e.g. storage conditions, pretreatments, surface ageing).

b) in the case of coatings or other product surfaces, in addition:

— specification of the basis metal (substrate), if available;

— specification of the coating application method(s);

— specification of the coating material(s), chemical composition;

— coating thickness.

NOTE 1 The composition can vary from point to point on the specimen, as can the morphology of coating exposed to the test.

NOTE 2 Visual and photographic records of the specimen conditions prior to and during testing can be made.

4 Atmospheric-corrosion test sites

4.1 Test site requirements

The atmospheric-corrosion test site shall provide facilities for open-air exposure, i.e. direct exposure to all atmospheric conditions and atmospheric contaminants (see ISO 8565).

Test sites shall be selected so that the testing area will normally be exposed to the full effects of the weather. The presence of buildings, structures, trees and certain geographical features (rivers, lakes, hills or hollows) might cause unintended shelter of exposure to wind, sources of pollution or sunlight.

Unless the effects from man-made or natural features are to be an intended part of the exposure programme, such features in the vicinity of the test site, that could influence the results of the test, should be avoided; otherwise their presence shall be reported. Similarly, the presence of low-growing shrubs and other plants may affect the temperature and humidity distribution over a given test site. Therefore these shall be absent or controlled to a maximum height of 0,2 m or by placing test frames on well-drained ground or on gravel, concrete or paved foundations.

4.2 Test site locations and security

The exposure site shall be selected so that it represents uniform conditions of some atmospheric site with specific characteristics, for example, a rural, urban, marine or industrial environment. If possible, it shall be located at or near a site where on-going meteorological and environmental measurements of temperature, humidity, rainfall characteristics (rainfall quantity, rain intensity), gaseous and/or particle contaminants are performed, for instance by environmental or health organizations. Near-point sources of emission of corrosive substances shall be avoided. Ideally, the test site shall be fenced or in other ways protected from damage caused by the public or by animals and from growing plants reaching the specimens.

4.3 Exposure frames

The function of the exposure frames is to maintain the test specimen securely in position without undergoing significant deterioration or influencing the corrosion or runoff of the test specimens attached to them. Metal sections or wood may be used, provided that they have adequate strength and durability. If necessary, additional protection can be provided by paint coatings over suitably prepared and primed metal surfaces. Frames may also be constructed from suitably protected and maintained wood. The choice of materials and design of the supporting framework shall not influence or otherwise interfere with the results of the tests.

The test frames shall also be designed to enable specimens to be exposed at an angle of 45° from the horizontal. The design of the frame shall be such that test specimens are not affected by water that runs off the test frame or other specimens, or by splash water from the ground. The minimum height shall be chosen to prevent both splashing by rainwater and burial in snow-drifts and should be not less than 0,5 m.

