INTERNATIONAL STANDARD

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Corrosion of metals and alloys — Corrosivity of atmospheres — Guiding values for the corrosivity categories

Corrosion des métaux et alliages — Corrosivité des atmosphères — Valeurs directrices relatives aux catégories de corrosivité

Reference number
ISO 9224:1992(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 9224 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

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Introduction

The "corrosivity category" established in ISO 9223 is a general term suitable for engineering purposes, which describes the corrosion properties of atmospheres based on current knowledge of atmospheric corrosion.

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Corrosion of metals and alloys — Corrosivity of atmospheres — Guiding values for the corrosivity categories

1 Scope

This International Standard specifies guiding corrosion values and the characteristics of corrosion for the corrosivity categories defined in ISO 9223.

Guiding corrosion values give corrosion rates for standard structural materials and can be used for engineering calculations. The guiding corrosion values specify the technical content of each of the individual corrosivity categories for these standard metals.

This International Standard can be used to predict the service life for metals, alloys and, in some cases, for metallic coatings used in atmospheres corresponding to different corrosivity categories (see table 1). The guiding corrosion values also provide a technical basis for determining the need for protective measures and other engineering purposes.

The guiding corrosion values are based on experience obtained from a large number of site exposures and service performances. Corrosion rates expected for a given corrosivity category may be exceeded in the vicinity of special design features which cause localized or galvanic corrosion.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 guiding corrosion value: Corrosion rates (average and steady state), mass loss, penetration or other corrosion characteristics expressing the expected corrosive action of the atmospheric environment of a given corrosivity category towards standard materials.

3.2 average corrosion rate, r_{av}: The corrosion rate during the first 10 years of atmospheric exposure of a metal, given by the equation

$$r_{av} = \frac{\Delta h_1}{t_1 - t_0} \qquad \ldots (1)$$

where

Δh_1 is the corrosion depth, in micrometres, after the first 10 years of exposure;

t_0 is the time at which the exposure starts;

t_1 is the time at which the exposure ends.

3.3 steady state corrosion rate, r_{lin}: The corrosion rate derived from a long term atmospheric exposure of a metal, not including the initial period. For the purpose of this International Standard, the corrosion rate after 10 years of exposure is considered as constant.

The steady state corrosion rate, r_{lin}, is given by the equation

$$r_{lin} = \frac{\Delta h_2}{t_2 - t_1} \qquad \ldots (2)$$

where

Δh_2 is the corrosion depth, in micrometres, for the considered time interval;

t_1 and t_2 are the times (longer than 10 years) in the linear region of the curve of uniform corrosion as a function of time.

4 Long term corrosive action of atmospheres belonging to different corrosivity categories

4.1 The long term corrosive action of atmospheres belonging to different corrosivity categories is characterized for different metals and their groups by

a) the average corrosion rate for the first 10 years of exposure;

b) the steady state corrosion rate;

c) the form of corrosion attack.

4.2 For most metals, the initial corrosion rate exceeds the steady state corrosion rate. The total extent of corrosion must therefore be calculated by multiplying the average corrosion rate for the first 10 years by 10 and adding the product of the remaining service life and the steady state corrosion rate in subsequent years.

4.3 Average corrosion rates for the first 10 years of exposure, and steady state corrosion rates of carbon steel, zinc, copper, aluminium and weathering steels are given in table 1.

Table 1 — Guiding corrosion values for corrosion rates (r_{av}, r_{lin}) of carbon steel, weathering steels, zinc, copper and aluminium in atmospheres of various corrosivity categories

Values in micrometres per year

Metal	Average corrosion rate (r_{av}) during the first 10 years for the following corrosivity categories				
	C 1	C 2	C 3	C 4	C 5
Carbon steel	$r_{av} \leqslant 0,5$	$0,5 < r_{av} \leqslant 5$	$5 < r_{av} \leqslant 12$	$12 < r_{av} \leqslant 30$	$30 < r_{av} \leqslant 100$
Weathering steel	$r_{av} \leqslant 0,1$	$0,1 < r_{av} \leqslant 2$	$2 < r_{av} \leqslant 8$	$8 < r_{av} \leqslant 15$	$15 < r_{av} \leqslant 80$
Zinc	$r_{av} \leqslant 0,1$	$0,1 < r_{av} \leqslant 0,5$	$0,5 < r_{av} \leqslant 2$	$2 < r_{av} \leqslant 4$	$4 < r_{av} \leqslant 10$
Copper	$r_{av} \leqslant 0,01$	$0,01 < r_{av} \leqslant 0,1$	$0,1 < r_{av} \leqslant 1,5$	$1,5 < r_{av} \leqslant 3$	$3 < r_{av} \leqslant 5$
Aluminium	$r_{av} \approx 0,01$	$r_{av} \leqslant 0,025$	$0,025 < r_{av} \leqslant 0,2$	See note 5	See note 5
Metal	**Steady state corrosion rate (r_{lin}) for the following corrosovity categories**				
	C1	C2	C3	C4	C5
Carbon steel	$r_{lin} \leqslant 0,1$	$0,1 < r_{lin} \leqslant 1,5$	$1,5 < r_{lin} \leqslant 6$	$6 < r_{lin} \leqslant 20$	$20 < r_{lin} \leqslant 90$
Weathering steel	$r_{lin} \leqslant 0,1$	$0,1 < r_{lin} \leqslant 1$	$1 < r_{lin} \leqslant 5$	$5 < r_{lin} \leqslant 10$	$10 < r_{lin} \leqslant 80$
Zinc	$r_{lin} \leqslant 0,05$	$0,05 < r_{lin} \leqslant 0,5$	$0,5 < r_{lin} \leqslant 2$	$2 < r_{lin} \leqslant 4$	$4 < r_{lin} \leqslant 10$
Copper	$r_{lin} \leqslant 0,01$	$0,01 < r_{lin} \leqslant 0,1$	$0,1 < r_{lin} \leqslant 1$	$1 < r_{lin} \leqslant 3$	$3 < r_{lin} \leqslant 5$
Aluminium	Negligible	$0,01 < r_{lin} \leqslant 0,02$	$0,02 < r_{lin} \leqslant 0,2$	See note 5	See note 5

NOTES

1 The corrosion rate of carbon steel is not constant during the first 10 years.

2 The corrosion rate of weathering steel is strongly dependent on the combination of various influencing factors (alternation between wet and dry periods). In atmospheres with sulphur dioxide (SO_2) pollution, a more protective rust layer is formed. Rain protected surfaces in marine atmospheres heavily polluted with chlorides may have much higher corrosion rates than freely exposed surfaces.

3 Applies also to the copper-zinc, copper-tin and similar alloys with a copper content of at least 60 %.

4 The rates shown are based on commercially pure aluminium (purity > 99,5 %) which, like most aluminium alloys, corrodes in the atmosphere at a rate that decreases with time. However, these rates are based on average mass loss results while the corrosion attack is usually manifested as pitting. Consequently, the rates shown do not represent rates of penetration. Penetration rates for pitting also decrease with exposure time. Commercially pure aluminium, aluminium alloys containing magnesium, manganese and/or silicon as the major alloying elements, and Alclad products generally have better corrosion resistance than aluminium alloys containing significant quantities of copper, zinc and/or iron. Alloys with significant quantities of magnesium, zinc, copper and/or iron may also be subject to other forms of localized corrosion such as stress corrosion cracking, exfoliation and intergranular attack.

5 In atmospheres defined by corrosivity categories C 4 and C 5, a marked increase in corrosion rate may be expected and local corrosion effects become important. For these two corrosivity categories, the data concerning general corrosion may be misleading.

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Descriptors: metals, alloys, atmospheres, corrosion, atmospheric corrosion, corrosion rate, computation.

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