SIS - Standardiseringskommissionen i Sverige

Handläggande organ

MATERIALNORMCENTRALEN

SVENSK STANDARD SS-ISO 9223

Fastställd	Utgåva	Sida
1994-06-03	1	1 (1 + 13)

Korrosion hos metaller och legeringar — Atmosfärers korrosivitet — Klassificering

Denna standard utgörs av den engelska versionen av den internationella standarden ISO 9223:1992, Corrosions of metals and alloys – Corrosivity of atmospheres – Classification

Standarden definierar på två likvärdiga sätt fem olika korrosivitetskategorier betecknade C1 till C5 för klassificering av atmosfärer

- först, genom atmosfärens korrosionseffekter på standardprov enligt ISO 9226,
- sedan, genom eskalerande kombinationer av de tre dominerande faktorerna för den atmosfäriska korrosionen, dvs våttiden, förorening med svavelhaltiga ämnen, samt förorening med luftburna salter.

De fem korrosivitetskategorierna ger ett underlag för materialval och/eller skyddsåtgärder.

I standarden hänvisas till:

- ISO 8044 (2:a utgåvan), som utkom 1989 och ännu inte överförts till svensk standard. Däremot har ISO 8044: 1986 (1:a utgåvan) oförändrad överförts till svensk standard SS-ISO 8044, Korrosion hos metaller och legeringar – Termer och definitioner
- ISO 9224, som oförändrad överförts till svensk standard SS-ISO 9224, Korrosion hos metaller och legeringar – Atmosfärers korrosivitet – Riktvärden för korrosivitetskategorierna,
- ISO 9225, som oförändrad överförts till svensk standard SS-ISO 9225, Korrosion hos metaller och legeringar – Atmosfärers korrosivitet – Mätning av föroreningar,
- ISO 9226, som oförändrad överförts till svensk standard SS-ISO 9226, Korrosion hos metaller och legeringar – Atmosfärers korrosion – Bestämning av korrosionshastighet hos standardprov för utvärdering av korrosivitet.

Corrosion of metals and alloys — Corrosivity of atmospheres — Classification

This standard consists of the English version of the international standards ISO 9223:1992, Corrosion of metals and alloys – Corrosivity of atmospheres – Classification

The standard defines in two equivalent ways five different corrosivity categories designated C1 to C5, for the classification of atmospheres

- first, by the corrosion effects of the atmosphere on standard test specimens according to ISO 9226,
- second, by escalating combinations of the three dominant factors of atmospheric corrosion, i.e time of wetness, pollution by sulfurcontaining substances, and pollution by airborne salinity.

The five corrosivity categories provide a basis for the selection of materials and/or taking protective measures.

In the standard, reference is made to:

- ISO 8044:1989, (2nd edition) Corrosion of metals and alloys – Vocabulary, which has not yet been adopted as Swedish standard. However, ISO 8044:1986 (1st edition) is fully adopted as Swedish standard SS-ISO 8044,
- ISO 9224:1992, Corrosion of metals and alloys, Corrosivity of atmospheres – Guiding values for the corrosivity categories, which is fully adopted as Swedish standard SS-ISO 9224,
- ISO 9225:1992, Corrosion of metals and alloys – Corrosivity of atmospheres – Measurement of pollution, which is fully adopted as Swedish standard SS-ISO 9225,
- ISO 9226:1992, Corrosion of metals and alloys – Corrosivity of atmospheres – Determination of corrosion rate of standard specimens for the evaluation of corrosivity, which is fully adopted as Swedish standard SS-ISO 9226.

Standarder kan beställas hos SIS som även lämnar allmänna upplysningar om svensk och utländsk standard.
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Prisgrupp N

Tryckt i juli 1994

Corrosion of metals and alloys — Corrosivity of atmospheres — Classification

1 Scope

1.1 This International Standard specifies the key factors in the atmospheric corrosion of metals and alloys. These are the time of wetness (τ), pollution by sulfur dioxide (SO_2) (P) and air-borne salinity (S). Corrosivity categories (C), which are defined on the basis of these three factors, are used for the classification of atmospheres.

1.2 The classification given in this International Standard can be used directly to evaluate the corrosivity of atmospheres for metals and alloys under known conditions of time of wetness, pollution by sulfur dioxide (SO_2) and/or airborne salinity.

This International Standard does not characterize the corrosivity of specific service atmospheres, e.g. atmospheres in the chemical or metallurgical industries. The pollution and time of wetness characterization of these environments cannot be generalized.

The classified pollution and corrosivity categories can be directly used for technical and economical analyses of corrosion damage and for a rational choice of protection measures.

Annex A summarizes the technical content of this International Standard in an easily read form.

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 8044:1989, *Corrosion of metals and alloys — Vocabulary.*

ISO 9224:1992, *Corrosion of metals and alloys — Corrosivity of atmospheres — Guiding values for the corrosivity categories.*

ISO 9225:1992, *Corrosion of metals and alloys — Corrosivity of atmospheres — Measurement of pollution.*

ISO 9226:1992, *Corrosion of metals and alloys — Corrosivity of atmospheres — Determination of corrosion rate of standard specimens for the evaluation of corrosivity.*

3 Definitions

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

3.1 corrosivity[1] of the atmosphere: The ability of the atmosphere to cause corrosion in a given corrosion system (e.g. atmospheric corrosion of a given metal or alloy).

3.2 time of wetness: The period during which a metallic surface is covered by adsorptive and/or liquid films of electrolyte that are capable of causing atmospheric corrosion.

3.2.1 calculated time of wetness: The time of wetness estimated from the temperature-humidity complex (see 5.2).

3.2.2 experimental time of wetness: The time of wetness indicated directly by various measuring systems (see 5.3).

1) See ISO 8044:1989, subclause 2.18.

3.3 pollution category: A numbered rank based on quantitative measurements of specific chemically active substances, corrosive gases or suspended particles in the air (both natural and the result of human activity) that are different from the normal components of the air.

3.4 type of atmosphere: Characterization of the atmosphere on the basis of appropriate classification criteria other than corrosivity (industrial, marine, etc.) or of complementary operational factors (chemical, etc.).

3.5 temperature-humidity complex: The combined effect of temperature and relative humidity on the corrosivity of the atmosphere.

3.6 category of location: Conventionally defined typical exposure conditions of a component or structure, e.g. in the open air, under shelter, in a closed space etc.

4 Symbols and abbreviations

τ	Time of wetness
P	Pollution category with sulfur compounds based on sulfur dioxide (SO_2) levels
S	Pollution category based on airborne salinity contamination
C	Atmospheric corrosivity category
θ	Air temperature
h/a	Hours per year
r_{corr}	Corrosion rate for the first year of atmospheric exposure
r_{av}	Average corrosion rate for the first 10 years of atmospheric exposure
r_{lin}	Steady state corrosion rate derived from long term atmospheric exposure

5 Characterization of the atmosphere in relation to its corrosivity

5.1 For the purposes of this International Standard, the key corrosion factors of the atmosphere for metals and alloys are time of wetness, and sulfur dioxide (SO_2) and chloride pollution levels.

5.2 The wetting of surfaces is caused by many factors, for example, dew, rainfall, melting snow and a high humidity level. The length of time when the relative humidity is greater than 80 % at a temperature (θ) greater than 0 °C is used to estimate the calculated time of wetness (τ) of corroding surfaces (see note 1).

5.3 The experimental time of wetness can be determined directly by various measuring systems (see note 2).

5.4 The most important factor within a particular category of time of wetness is the pollution level caused by sulphur dioxide or airborne salinity.

5.5 The pollution level shall be measured in accordance with the specifications of ISO 9225.

5.6 Other kinds of pollution can also exert an effect [oxides of nitrogen, (NO_x) and industrial dust in populated and industrial zones] or the specific operational and technological pollution of microclimates [chloride, (Cl_2), hygrogen sulfide, (H_2S), organic acids and de-iceing agents). These types of pollution have not been used as classification criteria.

According to this International Standard, the other kinds of pollution should be considered as accompanying ones [for example: oxides of nitrogen (NO_x) in urban atmospheres] or specific operational ones (for example: vapours of acids in operational microclimates).

NOTES

1 The time of wetness calculated by this method does not necessarily correspond with the actual time of exposure to wetness, because wetness is influenced by: the type of metal, the shape, mass and orientation of the object, the quantity of corrosion product, the nature of pollutants on the surface and other factors. These considerations may increase or decrease the actual time of wetness. However, this criterion is usually sufficiently accurate for the characterization of atmospheres. The relevance of the time of wetness decreases with the degree of sheltering.

2 The indicated time may depend upon the type of instrument and the sensor used. The times of wetness indicated by various systems are not directly comparable and are convertible only within a limited extent of temperature-humidity characteristics.

6 Classification of time of wetness

6.1 The time of wetness (according to 5.2 and 5.3) depends upon the macroclimatic zone and the category of the location.

6.2 The classification of time of wetness for atmospheres is given in table 1. The classified values are based on the long term characteristics of macroclimatic zones for typical conditions of the location categories.

6.3 The calculated times of wetness and selected climatological characteristics of the macroclimatic zones of the Earth are shown in annex B as general guidelines.

6.4 For times of wetness τ_1, almost no condensation is expected. For τ_2, the probability of liquid forming on the metallic surface is low. Times τ_3 to τ_5 include periods of condensation and precipitation.

Table 1 — Classification of time of wetness

Category	Time of wetness		Example of occurrence
	h/a	%	
τ_1	$\tau \leqslant 10$	$\tau \leqslant 0{,}1$	Internal microclimates with climatic control
τ_2	$10 < \tau \leqslant 250$	$0{,}1 < \tau \leqslant 3$	Internal microclimates without climatic control except for internal non-air-conditioned spaces in damp climates
τ_3	$250 < \tau \leqslant 2\,500$	$3 < \tau \leqslant 30$	Outdoor atmospheres in dry, cold climates and part of temperate climates; properly ventilated sheds in temperate climates
τ_4	$2\,500 < \tau \leqslant 5\,500$	$30 < \tau \leqslant 60$	Outdoor atmospheres in all climates (except for the dry and cold climates); ventilated sheds in humid conditions; unventilated sheds in temperate climates
τ_5	$5\,500 < \tau$	$60 < \tau$	Part of damp climates; unventilated sheds in humid conditions

NOTES

1 The time of wetness of a given locality depends on the temperature-humidity complex of the open air atmosphere and the category of the location and is expressed in hours per year or as part of exposure time (in percentage).

2 The values of time of wetness in percentage are rounded and informative only.

3 The occurrence column does not include all the possibilities due to the degree of sheltering.

4 Sheltered surfaces in marine atmospheres where chlorides are deposited may experience substantially increased times of wetness, due to the presence of hygroscopic salts and should be classified in the category τ_5.

5 In indoor atmospheres without climatic control, the time of wetness categories τ_3 to τ_5 can occur when sources of water vapour are present.

6 For the times of wetness τ_1 and τ_2, the probability of corrosion is higher for dusty surfaces.

7 Classification of pollution categories

7.1 Atmospheric pollution is divided into two categories: pollution by sulfur dioxide (SO_2) and by airborne salinity. These two types of pollution are representative for rural, urban, industrial and marine atmospheres.

7.2 The classification of pollution by sulfur dioxide (SO_2) for standard outdoor atmospheres is given in table 2.

Table 2 — Classification of pollution by sulphur-containing substances represented by (SO_2)

Deposition rate of SO_2 $mg/(m^2 \cdot d)$	Concentration of SO_2 $\mu g/m^3$	Category
$P_d \leqslant 10$	$P_c \leqslant 12$	P_0
$10 < P_d \leqslant 35$	$12 < P_c \leqslant 40$	P_1
$35 < P_d \leqslant 80$	$40 < P_c \leqslant 90$	P_2
$80 < P_d \leqslant 200$	$90 < P_c \leqslant 250$	P_3

NOTES

1 Methods of determination of sulfur dioxide (SO_2) are specified in ISO 9225.

2 The sulfur dioxide (SO_2) values determined by the deposition (P_d) and volumetric (P_c) methods are equivalent for the purpose of classification. The relationship between measurements using both methods could be approximately expressed as: $P_d = 0{,}8\ P_c$.

3 For the purposes of this International Standard, the sulfur dioxide (SO_2) deposition rate and concentration are calculated from continuous measurements during at least one year and are expressed as the annual average. The result of short term measurements may differ considerably from long term averages. Such results are only used for guidance.

4 Any concentration of sulfur dioxide (SO_2) within category P_0 is considered to be the background concentration and is insignificant from the point of view of corrosive attack.

5 Pollution by sulfur dioxide (SO_2) within category P_3 is considered extreme and is typical of operational microclimates beyond the scope of this International Standard.

6 In shed-type atmospheres and, especially, in indoor atmospheres, the concentration of the pollutants is reduced in inverse proportion to the degree of sheltering.

Table 3 — Classification of pollution by airborne salinity represented by chloride

Deposite rate of chloride $mg/(m^2 \cdot d)$	Category
$S \leqslant 3$	S_0
$3 < S \leqslant 60$	S_1
$60 < S \leqslant 300$	S_2
$300 < S \leqslant 1\ 500$	S_3

NOTES

1 The classification of airborne salinity according to this International Standard is based on the wet candle method specified in ISO 9225.

2 The results obtained by the application of various methods for the determination of the salt content in the atmosphere are not always directly comparable and convertible.

3 For the purposes of this International Standard, the chloride deposition rate is expressed as an annual average. The results of short-term measurements are very variable and depend very strongly upon weather effects.

4 Any chloride deposition rate within category S_0 is taken as the background concentration and is insignificant from the point of view of corrosive attack.

5 Extreme pollution by chloride, which is typical of marine splash and spray, is beyond the scope of this International Standard.

6 The airborne salinity is strongly dependent on the variables influencing the transport inland of sea-salt, such as wind direction, wind velocity, local topography, distance of the exposure site from the sea, etc.

7.3 The classification of pollution by chlorides (Cl^-) refers to outdoor atmospheres which are polluted by airborne salinity in marine environments. The classification is given in table 3.

8 Categories of corrosivity of the atmosphere

The corrosivity of the atmosphere is divided into five categories (see table 4).

Table 4 — Categories of corrosivity of the atmosphere

Category	Corrosivity
C 1	Very low
C 2	Low
C 3	Medium
C 4	High
C 5	Very ligh

9 Classification of corrosivity based on corrosion rate measurements of standard specimens

Numerical values of the first year corrosion rates for standard metals (carbon steel, zinc, copper, aluminium) are given in table 5 for each of the corrosivity categories. The values cannot be extrapolated for the prediction of long-term corrosion behaviour. Guiding corrosion values and addtional information are given in ISO 9224.

Table 5 — Corrosion rates (r_{corr}) for the first year of exposure for the different corrosivity categories

Corrosivity category	Corrosion rates (r_{corr}) of metals				
	Units	Carbon steel	Zinc	Copper	Aluminium
C 1	$g/(m^2 \cdot a)$ µm/a	$r_{corr} \leqslant 10$ $r_{corr} \leqslant 1,3$	$r_{corr} \leqslant 0,7$ $r_{corr} \leqslant 0,1$	$r_{corr} \leqslant 0,9$ $r_{corr} \leqslant 0,1$	Negligible —
C 2	$g/(m^2 \cdot a)$ µm/a	$10 < r_{corr} \leqslant 200$ $1,3 < r_{corr} \leqslant 25$	$0,7 < r_{corr} \leqslant 5$ $0,1 < r_{corr} \leqslant 0,7$	$0,9 < r_{corr} \leqslant 5$ $0,1 < r_{corr} \leqslant 0,6$	$r_{corr} \leqslant 0,6$ —
C 3	$g/(m^2 \cdot a)$ µm/a	$200 < r_{corr} \leqslant 400$ $25 < r_{corr} \leqslant 50$	$5 < r_{corr} \leqslant 15$ $0,7 < r_{corr} \leqslant 2,1$	$5 < r_{corr} \leqslant 12$ $0,6 < r_{corr} \leqslant 1,3$	$0,6 < r_{corr} \leqslant 2$ —
C 4	$g/(m^2 \cdot a)$ µm/a	$400 < r_{corr} \leqslant 650$ $50 < r_{corr} \leqslant 80$	$15 < r_{corr} \leqslant 30$ $2,1 < r_{corr} \leqslant 4,2$	$12 < r_{corr} \leqslant 25$ $1,3 < r_{corr} \leqslant 2,8$	$2 < r_{corr} \leqslant 5$ —
C 5	$g/(m^2 \cdot a)$ µm/a	$650 < r_{corr} \leqslant 1\,500$ $80 < r_{corr} \leqslant 200$	$30 < r_{corr} \leqslant 60$ $4,2 < r_{corr} \leqslant 8,4$	$25 < r_{corr} \leqslant 50$ $2,8 < r_{corr} \leqslant 5,6$	$5 < r_{corr} \leqslant 10$ —

NOTES

1 The classification criterion is based on the methods of determination of corrosion rates of standard specimens (flat plate or helix) for the evaluation of corrosivity (see ISO 9226).

2 The corrosion rates expressed in grams per square metre year $[g/(m^2 \cdot a)]$ have been recalculated in micrometres per year (µm/a) and rounded.

3 The materials are characterized in ISO 9226.

4 Aluminium experiences localized corrosion but the corrosion rates shown in the table were calculated as uniform corrosion. Maximum pit depth is a better indicator of potential damage, but this characteristic cannot be evaluated after the first year of exposure.

5 Corrosion rates exceeding the upper limits in category C 5 represent environments beyond the scope of this International Standard.