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**Corrosion of metals and alloys — Basic
terms and definitions**

**Corrosion des métaux et alliages —
Termes principaux et définitions**

**Korrosion von Metallen und
Legierungen — Grundbegriffe**

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 156, *Corrosion of metals and alloys*.

This fourth edition cancels and replaces the third edition (ISO 8044:1999), which has been revised to include additional terms and definitions.

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Introduction

The definitions in this International Standard have been drawn up with the objective of achieving a proper balance between precision and simplicity. The main objective of this International Standard is to provide definitions that can be understood to have the same meaning by all concerned. Some corrosion terms in present use have developed through common usage and are not always logical. It has not, therefore, been possible to define certain terms in the form they are used in some countries. Because of the occasional conflicts between tradition and logic some definitions inevitably represent a compromise.

An example of this kind of conflict is the term “corrosion”. This has been used to mean the process, results of the process and damage caused by the process. In this International Standard corrosion is understood to mean the process. Any detectable result of corrosion in any part of a corrosion system is termed “corrosion effect”. The term “corrosion damage” covers any impairment of the function of the technical system of which the metal and the environment form a part. Consequently the term “corrosion protection” implies that the important thing is to avoid corrosion damage rather than to prevent corrosion, which in many cases is impossible and sometimes not necessary.

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Corrosion of metals and alloys — Basic terms and definitions

1 Scope

This International Standard defines terms relating to corrosion that are widely used in modern science and technology. In addition, some definitions are supplemented with short explanations.

NOTE 1 Throughout the document IUPAC rules for electrode potential signs are applied. The term “metal” is also used to include alloys and other metallic materials.

NOTE 2 Terms and definitions related to inorganic surface treatment of metals are given in ISO 2080.

NOTE 3 See also the ISO online browsing platform (OBP): www.iso.org/obp/ui/

2 General terms

2.1

corrosion

physicochemical interaction between a metal and its environment that results in changes in the properties of the metal, and which may lead to significant impairment of the function of the metal, the environment, or the technical system, of which these form a part

Note 1 to entry: This interaction is often of an electrochemical nature.

2.2

corrosive agent

corrodent

substance which when in contact with a given metal will cause *corrosion* (2.1)

2.3

corrosive environment

environment that contains one or more *corrosive agents* (2.2)

2.4

corrosion system

system consisting of one or more metals and those parts of the environment that influence *corrosion* (2.1)

Note 1 to entry: Parts of the environment may be, for example, coatings, surface layers or additional *electrodes* (6.1.2).

2.5

corrosion effect

change in any part of the *corrosion system* (2.4) caused by *corrosion* (2.1)

2.6

corrosion damage

corrosion effect (2.5) that causes impairment of the function of the metal, the environment or the technical system, of which these form a part

2.7

corrosion failure

corrosion damage (2.6) characterized by the total loss of function of the technical system

**2.8
corrosion product**

substance formed as a result of *corrosion* (2.1)

**2.9
scale**

solid layer of *corrosion products* (2.8) formed on a metal at high temperature

Note 1 to entry: The term “scale” is also used in some countries for deposits from supersaturated water.

**2.10
rust**

visible *corrosion products* (2.8) consisting mainly of hydrated iron oxides

**2.11
corrosion depth**

distance between a point on the surface of a metal affected by *corrosion* (2.1) and the original surface of the metal

**2.12
corrosion rate**

corrosion effect (2.5) on a metal per time

Note 1 to entry: The unit used to express the corrosion rate depends on the technical system and on the type of corrosion effect. Thus corrosion rate may be expressed as an increase in *corrosion depth* (2.11) per time, or the mass of metal turned into *corrosion products* (2.8) per area of surface and per time, etc. The corrosion effect may vary with time and may not be the same at all points of the corroding surface. Therefore, reports of corrosion rates should be accompanied by information on the type, time dependency and location of the corrosion effect.

**2.13
corrosion resistance**

ability of a metal to maintain *serviceability* (2.16) in a given *corrosion system* (2.4)

**2.14
corrosivity**

ability of an environment to cause *corrosion* (2.1) of a metal in a given *corrosion system* (2.4)

**2.15
corrosion likelihood**

qualitative and/or quantitative expression of the expected *corrosion effects* (2.5) in a defined *corrosion system* (2.4)

**2.16
serviceability** (with respect to corrosion)

ability of a *corrosion system* (2.4) to perform its specified functions without impairment due to *corrosion* (2.1)

**2.17
durability** (with respect to corrosion)

ability of a *corrosion system* (2.4) to maintain *serviceability* (2.16) over a specified time when the specified requirements for use and maintenance have been fulfilled

**2.18
service life** (with respect to corrosion)

time during which a *corrosion system* (2.4) meets the requirements for *serviceability* (2.16)

**2.19
critical humidity**

value of the relative humidity of an atmosphere above which there is a sharp increase in the *corrosion rate* (2.12) of a given metal

2.20**corrosion attack**

corrosion effect (2.5) that is detrimental but has not progressed to the point of impairment of the function of the metal, the environment, or the technical system of which they form a part

2.21**pickling**

removal of oxides or other compounds from a metal surface by chemical or electrochemical action

2.22**pitting resistance equivalent number****PREN**

indication of the resistance of stainless steels and nickel-based alloys to pitting in the presence of chloride-containing water

Note 1 to entry: A widely accepted formula for PREN is given by

$$\text{PREN} = \% \text{Cr} + 3,3 \left[(\% \text{Mo}) + 0,5 (\% \text{W}) \right] + 16 (\% \text{N}) .$$

Note 2 to entry: The higher the PREN, the higher is the resistance to pitting corrosion.

2.23**trap**

micro structural site at which the residence time for a hydrogen atom is long compared to the residence time in an interstitial lattice site

2.24**time of wetness**

period when a metallic surface is covered by adsorptive and/or liquid films of electrolyte to be capable of causing atmospheric corrosion

2.25**threshold stress** (for stress corrosion cracking)

tensile stress above which stress corrosion cracks initiate and grow, for the specified test conditions

2.26**threshold stress intensity factor for stress corrosion cracking** K_{ISCC}

stress intensity factor above which stress corrosion crack propagation is sustained

Note 1 to entry: The threshold stress intensity factor is a concept of linear elastic fracture mechanics (LEFM) and is applicable when the plastic zone size is large compared with the microstructure, the crack is sufficiently long, and a high constraint to plastic deformation prevails, i.e. under plane strain predominant conditions. For growing stress corrosion cracks, LEFM is not necessarily applicable in all detail but is adopted as a pragmatic tool that is commonly used.

Note 2 to entry: Stress corrosion cracks may initiate at a surface or a surface defect and grow in the “short crack” regime at stress intensity factor levels below the apparent threshold stress intensity factor. Therefore, LEFM is not applicable in the “short crack” regime.

3 Types of corrosion**3.1****electrochemical corrosion**

corrosion (2.1) involving at least one *anodic reaction* (6.1.9) and one *cathodic reaction* (6.1.6)

3.2**chemical corrosion**

corrosion (2.1) not involving electrochemical reaction

**3.3
gaseous corrosion**

corrosion (2.1) with dry gas as the only *corrosive environment* (2.3) and without any liquid phase on the surface of the metal

**3.4
atmospheric corrosion**

corrosion (2.1) with the earth's atmosphere at ambient temperature as the *corrosive environment* (2.3)

**3.5
marine corrosion**

corrosion (2.1) with sea water as the main agent of the *corrosive environment* (2.3)

Note 1 to entry: This definition includes both immersed and splash zone conditions.

**3.6
underground corrosion**

corrosion (2.1) of buried metals, soil being the *corrosive environment* (2.3)

Note 1 to entry: The term soil includes not only the naturally occurring material but also any other material, such as ballast and backfill, used to cover a structure.

**3.7
microbial corrosion**

corrosion (2.1) associated with the action of micro-organisms present in the *corrosion system* (2.4)

**3.8
bacterial corrosion**

microbial corrosion (3.7) due to the action of bacteria

**3.9
general corrosion**

corrosion (2.1) proceeding over the whole surface of the metal exposed to the *corrosive environment* (2.3)

**3.10
localized corrosion**

corrosion (2.1) preferentially concentrated on discrete sites of the metal surface exposed to the *corrosive environment* (2.3)

Note 1 to entry: Localized corrosion can result in, for example, pits, cracks, or grooves.

**3.11
uniform corrosion**

general corrosion (3.9) proceeding at almost the same rate over the whole surface

**3.12
galvanic corrosion**

corrosion (2.1) due to the action of a *corrosion cell* (6.1.13)

Note 1 to entry: The term has often been restricted to the action of bimetallic corrosion cells, i.e. to *bimetallic corrosion* (3.13).

**3.13
bimetallic corrosion**

DEPRECATED: contact corrosion

galvanic corrosion (3.12), where the *electrodes* (6.1.2) are formed by dissimilar metals

**3.14
impressed current corrosion**

electrochemical corrosion (3.1) due to the action of an external source of electric current

3.15**stray-current corrosion**

impressed current corrosion (3.14) caused by current flowing through paths other than the intended circuits

3.16**pitting corrosion**

localized corrosion (3.10) resulting in pits, i.e. cavities extending from the surface into the metal

3.17**crevice corrosion**

localized corrosion (3.10) associated with, and taking place in, or immediately around, a narrow aperture or clearance formed between the metal surface and another surface (metallic or non-metallic)

3.18**deposit corrosion**

localized corrosion (3.10) associated with, and taking place under, or immediately around, a deposit of *corrosion products* (2.8) or other substance

3.19**water-line corrosion**

corrosion (2.1) along, and as a consequence of the presence of, a gas/liquid boundary

3.20**selective corrosion**

corrosion (2.1) of an alloy whereby the components react in proportions that differ from their proportions in the alloy

3.21**dezincification of brass**

selective corrosion (3.20) of brass resulting in preferential removal of zinc

3.22**graphitic corrosion**

selective corrosion (3.20) of grey cast iron, resulting in partial removal of metallic constituents, leaving graphite

3.23**intergranular corrosion**

corrosion (2.1) in or adjacent to the grain boundaries of a metal

3.24**weld corrosion**

corrosion (2.1) associated with the presence of a welded joint and taking place in the weld or its vicinity

3.25**knife-line corrosion**

corrosion (2.1) resulting in a narrow slit in or adjacent to the filler/parent boundary of a welded or brazed joint

3.26**layer corrosion**

corrosion (2.1) of internal layers of wrought metal, occasionally resulting in exfoliation, i.e. detachment of unattacked layers

Note 1 to entry: Exfoliation is generally oriented in the direction of rolling, extrusion or principal deformation.

3.27

erosion corrosion

process involving conjoint *corrosion* (2.1) and erosion

Note 1 to entry: Erosion corrosion can occur in, for example, pipes with high fluid flow velocity and pumps and pipe lines carrying fluid containing abrasive particles in suspension or entrained in a gas flow.

3.28

cavitation corrosion

process involving conjoint *corrosion* (2.1) and cavitation

Note 1 to entry: Cavitation corrosion can occur, for example, in rotary pumps and on ships' propellers.

3.29

fretting corrosion

process involving conjoint *corrosion* (2.1) and oscillatory slip between two vibrating surfaces in contact

Note 1 to entry: Fretting corrosion can occur, for example, at mechanical joints in vibrating structures.

3.30

wear corrosion

process involving conjoint *corrosion* (2.1) and friction between two sliding surfaces in contact

3.31

corrosion fatigue

process involving conjoint *corrosion* (2.1) and alternating straining of the metal, often leading to cracking

Note 1 to entry: Corrosion fatigue can occur when a metal is subjected to cyclic straining in a *corrosive environment* (2.3).

3.32

stress corrosion

process involving conjoint *corrosion* (2.1) and straining of the metal due to applied or residual stress

3.33

stress corrosion cracking

cracking due to *stress corrosion* (3.32)

3.34

hydrogen embrittlement

process resulting in a decrease of the toughness or ductility of a metal due to absorption of hydrogen

Note 1 to entry: Hydrogen embrittlement often accompanies hydrogen formation, for example by *corrosion* (2.1) or electrolysis, and can lead to cracking.

3.35

blistering

process resulting in dome-shaped defect visible on the surface of an object and arising from localized loss of cohesion below the surface

Note 1 to entry: For example, blistering can occur on coated metal due to loss of adhesion between coating and substrate, caused by accumulation of products from *localized corrosion* (3.10). On uncoated metal, blistering can occur due to excessive internal hydrogen pressure.

3.36

spalling

fragmentation and detachment of portions of the surface layer or scale

3.37

tarnishing

dulling, staining or discoloration of a metal surface, due to the formation of a thin layer of *corrosion products* (2.8)

3.38**aqueous corrosion**

corrosion with water or a water-based solution as the corrosive environment

3.39**microbiologically influenced corrosion****MIC**

corrosion influenced by the action of microorganisms

Note 1 to entry: Compare with *microbial corrosion* ([3.7](#)).

3.40**dealloying**

see *selective corrosion* ([3.20](#))

3.41**environmentally assisted cracking**

cracking of a susceptible metal or alloy due to the conjoint action of an environment and mechanical stress

3.42**hydrogen induced cracking****HIC**

planar cracking that occurs in metals due to induced stresses when atomic hydrogen diffuses into the metal and then combines to form molecular hydrogen at trap sites

3.43**hydrogen stress cracking****HSC**

cracking that results from the presence of hydrogen in a metal and tensile stress (residual or applied or both)

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Note 1 to entry: HSC describes cracking in metals that are not sensitive to *sulphide stress corrosion cracking (SSCC)* ([3.46](#)) but which may be embrittled by hydrogen when galvanically coupled, as the cathode, to another metal that is corroding actively as an anode. The term “galvanically induced HSC” has been used for this mechanism of cracking.

3.44**irradiation assisted stress corrosion cracking**

intergranular cracking of austenitic stainless steels resulting from a reduction in the chromium concentration in a very narrow band at the grain boundaries following exposure to high neutron irradiation doses exceeding one displacement per atom (which causes the migration of point defects to the grain boundaries)

3.45**stepwise cracking****SWC**

cracking that connects hydrogen induced cracks (HICs) on adjacent planes in a metal

Note 1 to entry: This term describes the crack appearance. The linking of hydrogen induced cracks to produce stepwise cracking is dependent upon local strain between the cracks and embrittlement of the surrounding steel by dissolved hydrogen. HIC/SWC is usually associated with low-strength plate steels used in the production of pipes and vessels.

3.46

sulfide stress corrosion cracking

SSCC

cracking of metal involving corrosion and tensile stress (residual and/or applied) in the presence of water and hydrogen sulfide

Note 1 to entry: SSCC is a form of hydrogen stress cracking (HSC) and involves embrittlement of the metal by atomic hydrogen that is produced by acid corrosion on the metal surface. Hydrogen uptake is promoted in the presence of sulfides. The atomic hydrogen can diffuse into the metal, reduce ductility and increase susceptibility to cracking. High strength metallic materials and hard weld zones are prone to SSCC.

3.47

stress oriented hydrogen induced cracking

SOHIC

staggered small cracks formed approximately perpendicular to the principal stress (residual or applied) resulting in a “ladder-like” crack array linking (sometimes small) pre-existing HIC cracks

Note 1 to entry: The mode of cracking can be categorised as SSCC caused by a combination of external stress and the local strain around hydrogen induced cracks. SOHIC is related to SSCC and HIC/SWC. It has been observed in parent material of longitudinally welded pipe and in the heat affected zone of welds in pressure vessels. SOHIC is a relatively uncommon phenomenon usually associated with low-strength ferritic pipe and pressure vessel steels.

Note 2 to entry: cf. *hydrogen embrittlement* ([3.34](#)).

[SOURCE: ISO 15156-1:2009, 3.22; modified — In Note 1, SSC has been replaced with SSCC and Note 2 has been added]

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3.48

exfoliation corrosion

stratified form of subsurface stress corrosion of susceptible primary wrought alloy mill products materials having a highly directional grain structure, accompanied by detachment of separate layers from the body of the material, formation of cracks and finally usually complete layer-by-layer disintegration of metal

Note 1 to entry: Exfoliation generally proceeds along grain boundaries, but with certain alloys and tempering it may develop along transgranular paths or a mixed intergranular/transgranular path.

Note 2 to entry: *Layer corrosion* ([3.26](#)) can be developed on the first stage.

3.49

filiform corrosion

type of corrosion proceeding under coating materials on metals in the form of threads, generally starting from bare edges or from local damage to the coating

Note 1 to entry: Usually the threads are irregular in length and direction of growth, but they may also be nearly parallel and of approximately equal length. It should be noted that filiform corrosion can occur under different protective coatings.

3.50

tribo-corrosion

any form of corrosion that involves constant removal of the passive layer due to fluid or particles impact on the corroding surface or the friction between the corroding surface and another surface

Note 1 to entry: Tribo-corrosion includes but is not restricted to: *wear corrosion* ([3.30](#)), *fretting corrosion* ([3.29](#)) and *erosion corrosion* ([3.27](#)).

Note 2 to entry: This process may result in an increase in friction of bearing surfaces in addition to causing material loss.

3.51**impingement attack**

form of erosion corrosion in aqueous liquids under high velocity or turbulent flow conditions associated on the metal surface causing repetitive disruption of protective films leading to accelerated localised corrosion

3.52**high temperature corrosion**

corrosion by gases or deposits or both gases and deposits occurring at elevated temperatures under conditions where aqueous electrolytes no longer exist

Note 1 to entry: High temperature corrosion can become significant at temperatures above 170 °C depending on material and environment.

3.53**hot corrosion**

corrosion by gases or deposits or both gases and deposits forming a liquid phase during a *high temperature corrosion* (3.52) reaction

Note 1 to entry: Hot corrosion is a sub-term of *high temperature corrosion* (3.52).

Note 2 to entry: The most common liquid phases in which hot corrosion occurs are metal sulfates, metal vanadates and metal chlorides.

3.54**sulfidation**

reaction of a metal or alloy with a sulfur-containing species to produce metal sulfides on or beneath the surface of the metal or alloy

3.55**metal dusting**

carburation of metallic materials in process gases containing carbon oxides and hydrocarbons and with extremely low oxygen partial pressures leading to disintegration of the metal into dust of graphite, metal or carbides, or combinations

Note 1 to entry: The temperature range for metal dusting lies between 400 °C and 900 °C. For the mechanism to happen, a carbon activity higher than 1 in the process gas is required.

3.56**rebar corrosion**

corrosion of reinforcement bars in concrete

4 Corrosion protection**4.1****corrosion protection**

modification of a *corrosion system* (2.4) so that *corrosion damage* (2.6) is reduced

4.2**degree of protection**

(percentage) reduction in *corrosion damage* (2.6) achieved by *corrosion protection* (4.1)

Note 1 to entry: All types of *corrosion* (2.1) present have to be considered.

4.3**temporary protection**

corrosion protection (4.1) intended to last for a limited time only

Note 1 to entry: Temporary protection is used, for example, during storage and transportation of metal products or during shut-down of equipment.