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Corrosion of metals and alloys — Guidelines for galvanic corrosion control

Corrosion des métaux et alliages — Lignes directrices pour le contrôle de la corrosion galvanique

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Foreword

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

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Use of multi-materials (i.e. use of metal materials as well as ceramics, semiconductors, carbon fibre and resins in structures) is advancing rapidly in industrial fields like electronic components, automobiles, aircraft, plant systems and infrastructure, among others. This has increased the possibility of galvanic corrosion, heightening the necessity of a comprehensive, cross-sectorial guideline for galvanic corrosion suppression that includes materials and their environments. However, there are no clear provisions concerning galvanic corrosion or standards other than bolting of dissimilar materials. The boundary element method (BEM) and the finite element method (FEM) enable modelling and numerical calculation of galvanic corrosion. Simulations by these methods have progressed and are already used in practical applications. Moreover, accompanying the application of multi-materials such as carbon and other non-metallic materials eluted from ceramics, carbon fibre reinforced plastic (CFRP) or resins is related to galvanic corrosion. This galvanic corrosion has become a critical issue in automobiles, aircraft, etc.

Under these circumstances, a cross-sectorial guideline on galvanic corrosion, with its many inherent issues, is necessary.

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Corrosion of metals and alloys — Guidelines for galvanic corrosion control

1 Scope

This document specifies standard methods for avoiding galvanic corrosion in the design stage and for determining whether actual corrosion damage was caused by galvanic corrosion. It also specifies guideline for standard methods for suppressing galvanic corrosion.

This document also provides guidance for predicting galvanic corrosion in different environments (e.g. in water and in atmospheric and soil environments) by numerical calculation based on polarization data.

This document does not establish the grounds for indexes related to safety or the loss of functions of materials in actual use. However, this document can be used to estimate the function maintenance life and safety maintenance life of these materials in advance. The responsibility for using the guideline rests with the reader.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
corrosion potential
potential measured when materials A and B are immersed individually in the environmental *electrolyte* (3.3) concerned

Note 1 to entry: Corrosion potential is given as either noble or base potential. Noble potential indicates a potential on the positive side. Base potential indicates a potential on the negative side.

3.2
coupling potential
potential measured when an electrical short circuit is established between materials A and B which are in contact with the *electrolyte* (3.3) concerned

3.3
electrolyte
ionically conductive liquid or solid medium covering the surfaces of material A and material B

3.4
area ratio
ratio of the area of material A with a base *corrosion potential* (3.1) and material B with a noble corrosion potential

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3.5
corrosion accelerate structure
structures where galvanic corrosion increases the corrosion (corrosion mass loss on the base side due to anodic reaction)

Note 1 to entry: The usual unit of corrosion is g/m^2.

EXAMPLE When the potential difference between metals is large or the anode area is small compared to the cathode.

4 General principles

4.1 General

This document provides guidance to minimise galvanic corrosion.

Galvanic corrosion is caused by an electric current flow from a material A (anode) with a base potential to a material B (cathode) with a noble potential via an electrolyte and then returned to the base material A through conductive wiring, a conducting body or the material itself (see Annex A). This current causes galvanic corrosion and, as the current increases, the anodic current density on the surface of material A increases and the galvanic corrosion rate correspondingly rises. Galvanic corrosion is accelerated by electrical contact between materials with different electric potentials.

The method of preventing galvanic corrosion involves reviewing the process and mitigation using a flowchart that includes one or more of the following:

a) materials designed for avoiding galvanic corrosion;

b) evaluation method for determining whether actual corrosion damage was caused by galvanic corrosion;

c) corrosion protection method for suppressing galvanic corrosion.

4.2 Material design

4.2.1 General

Figure 1 shows a material design flowchart for avoiding galvanic corrosion. It shows when material selection or, if possible, removal or change in electrolyte should be considered as a design change. It can also be used as an evaluation method for determining whether actual corrosion damage was caused by galvanic corrosion. The process is described in 4.2.2 to 4.2.5.

4.2.2 Conductive dissimilar materials

It may be verified whether conductive dissimilar materials are in electrical contact. In addition to direct contact, “electrical contact” also includes electrical continuity (conduction) by way of wiring, etc. In the absence of electrical continuity, galvanic corrosion does not take place between those materials.

4.2.3 Contact with a common electrolyte

It may be verified whether the dissimilar materials are in electrical contact and whether they are also in contact with a common electrolyte. This means verifying whether electrical continuity exists between the two materials and whether the two materials have also formed an external circuit that has electrical conduction by the electrolyte. If an electrolyte is not present, galvanic corrosion is avoided. In case of condensation which can lead to the presence of electrolyte, it is possible that the presence is only cyclical and therefore not permanently observable. It can be ascertained whether or not there is a risk of condensation.

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