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Corrosion of metals and alloys — Testing methods for corrosion of conducting alloys in AC electric current condition

Corrosion des métaux et alliages — Méthodes d'essai pour la corrosion des alliages conducteurs dans des conditions de courant alternatif

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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

As demonstrated in References [6] to [15], magnetic and electric fields influence corrosion behaviour in metallic materials. Depending on the composition and microstructure of the materials, magnetic and electric fields either increase or decrease the corrosion rate. In high-voltage power transmission systems (operating at voltage ≥10 kV), the alternative current (AC) and direct current (DC) flowing through the conducting materials (e.g. copper, aluminium and their alloys) generate intense magnetic and electric fields. These fields induce distinct corrosion behaviours in the materials. The global high-voltage transmission lines exceed 4,7 million km. Corrosion of conducting materials/alloys leads to localized overheating and mechanical failure, disrupting power supply reliability, accelerating equipment degradation and increasing costs.

A suitable testing method for conducting metals under an electric current is essential for selecting and evaluating the performance of materials. However, the conventional corrosion test methods (e.g. electrochemical test, salt spray test) do not take current-induced effects into consideration. This document therefore proposes a corrosion test method designed to simulate the operating conditions of conducting materials in high-voltage power transmission systems. Considering the global dominance of alternating current (AC) in power transmission infrastructure, this testing method focuses on AC-induced corrosion. This in turn provides comparative results that enable manufacturers to optimize material design, thereby enhancing the longevity and reliability of power transmission equipment.

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Corrosion of metals and alloys — Testing methods for corrosion of conducting alloys in AC electric current condition

1 Scope

This document specifies testing methods for alternative current (AC) influenced corrosion of conducting alloys. The methods are applicable for testing the corrosion rate of specific conducting metals and alloys for high-voltage AC electric power transmission systems exposed to atmosphere.

This document introduces corrosion testing methods for comparative study of corrosion rate of conducting materials such as aluminium, copper and their alloys.

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/

4 Principle

Electric and magnetic fields influence material corrosion mechanisms through three primary pathways (see References [6] to [15]):

— modification of redox reaction kinetics;

— altered mass transfer of corrosion products;

— changed formation of protective film.

During the operation of high-voltage power transmission systems, the current flowing through the conducting materials generate both magnetic fields and electric fields. These fields induce distinct corrosion behaviour in conducting materials compared to the same materials under normal operating conditions, such as structural applications.

The corrosion test method proposed in this document aims to test the corrosion rates of conducting metals and alloys for high-voltage electric power transmission systems by inducing AC into the salt spray test and the electrochemical polarization test. The tests are designed as comparative tests for corrosion evaluations. The density of applied currents can be determined by the load of conducting metals or alloys, such as overhead power transmission lines or connectors.

An AC current affects the corrosion of conducting materials by the current-induced magnetic field and electric field, as well as Joule heating due to electrical resistance. In this document, the salt spray test under AC current conditions considers all the impacting factors. The aim of the electrochemical test is to investigate the effect of the current-induced magnetic field and electric field on the corrosion of conducting materials.

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