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Metallic and other inorganic coatings — Electropolishing as a means of smoothing and passivating stainless steel

Revêtements métalliques et autres revêtements inorganiques — Polissage électrolytique: procédé de brillantage (ou nivellement) et de passivation des aciers inoxydables

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Contents

Page

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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 8, *Chemical conversion coatings,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 15730:2000), of which it constitutes a minor revision.

The main changes are as follows:

— the normative references, and the terms and definitions have been updated;

— editorial errors have been corrected.

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.

Introduction

Electropolishing removes a small but finite amount of metal from the surface that, in addition to smoothing and brightening, produces a hygienically clean surface desirable for use by manufacturers of food processing and medical equipment.

In addition to improved passivation, electropolishing provides many other benefits. Some examples are surface stress relief, removal of surface carbon and oxides and reduction of friction. Hydrogen embrittlement of articles is not produced during the electropolishing process, which takes minutes to perform.

The quality of passivation depends on the type of stainless steel, the formulation of the electropolishing solution and the conditions of operation. Free iron on the surface of the stainless steel is removed resulting in improved corrosion resistance. No further chemical treatment is necessary in order to passivate the stainless steel surface. Surface smoothing obtained by electropolishing also improves passivation.

Metallic and other inorganic coatings — Electropolishing as a means of smoothing and passivating stainless steel

WARNING — The use of this document may involve hazardous materials, operations and equipment. This document does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices, and to determine the applicability of regulatory limitations prior to use. Large quantities of hydrogen and oxygen gases are evolved at the electrodes during the electropolishing process. Proper ventilation procedures should be used to ensure their removal. Ignition of hydrogen gas can result in dangerous explosions.

1 Scope

This document specifies the information to be supplied by the purchaser to the finisher, requirements and test methods for electropolishing as a means of smoothing and passivating stainless steel alloys in the S2XXXX, S3XXXX and S4XXXX series, and the precipitation hardened alloys (see ISO 15510 for information on composition).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2064:1996, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

ISO 2080:2022, *Metallic and other inorganic coatings — Surface treatment, metallic and other inorganic coatings — Vocabulary*

ISO 4519:1980, *Electrodeposited metallic coatings and related finishes — Sampling procedures for inspection by attributes*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 16348, *Metallic and other inorganic coatings — Definitions and conventions concerning appearance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064, ISO 2080 and ISO 4519 and the following 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
passivation
rendering of a stainless steel surface into a lower state of chemical reactivity

Note 1 to entry: Passivated surfaces are characterized by the absence of free iron and the formation of a thin coherent oxide film.

3.2
electropolishing
improvement in surface smoothness and brightness of a metal surface by making it anodic in an appropriate solution

[SOURCE: ISO 2080:2022, 3.2.114]

3.3
inspection lot
collection of coated articles that are of the same kind, that have been produced to the same specifications, that have been coated by a single supplier at one time, or at approximately the same time, under essentially identical conditions and that are submitted for acceptance or rejection as a group

[SOURCE: ISO 4519:1980, 3.7]

3.4
significant surface
part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance and where the coating must meet all of the specified requirements

[SOURCE: ISO 2064:1996, 3.1]

4 Information to be supplied by the purchaser to the finisher

When ordering articles smoothed and passivated in accordance with this document, the purchaser shall provide the following information:

a) the number of this International Standard, i.e. ISO 15730, the alloy designation number and the test method(s) to be used to evaluate the article (see Clause 7);

b) the appearance required; alternatively, a sample showing the required finish shall be supplied or approved by the purchaser in accordance with ISO 16348 (see NOTE 1);

c) those areas on the article where electrical contact is acceptable;

d) the dimensional tolerances, if any, to be stated in the ordering document (see NOTE 2);

e) any requirements for passivation testing (see 5.3 and Clause 7);

f) any requirements for the provision of a test report (see 5.4 and Clause 8).

NOTE 1 When required, the basis material can be subjected, prior to electropolishing, to such mechanical polishing as can be required to yield the desired final surface characteristics.

NOTE 2 Typically, 5 µm to 10 µm of metal are removed from the surface during electropolishing; however, up to 50 µm can be removed for additional smoothing. Greater amounts will be removed from corners and edges, i.e. areas of high current density, unless either shields or auxiliary cathodes, or both, are used.

5 Requirements

5.1 Visual defects

Where specified the significant surfaces of the article to be smoothed and passivated by electropolishing shall be free of clearly visible defects such as pits, roughness, striations or discoloration when examined with 20/20 eyesight at a distance of approximately 0,5 m.

NOTE Defects in the surface of the basis material such as scratches, porosity and inclusions can adversely affect the appearance and performance of the article.

5.2 Process

5.2.1 General

The basis material may have to be subjected to preparatory operations, for example, polishing and cleaning in order to remove surface soil such as polishing compounds, oils, etc.

5.2.2 Electropolishing

Following any preparatory operations, the article(s) shall be introduced into the electropolishing solution for a period of time at the current density and temperature required to produce the surface finish specified by the purchaser [see Clause 4 b)].

NOTE 1 Annex A describes a typical electropolishing solution and operating conditions suitable for many stainless steel alloys.

NOTE 2 Proprietary electropolishing solutions are available offering special features such as low sludging, better bright throwing power, longer life or better performance with specific stainless steel alloys.

NOTE 3 Intricately shaped articles can possibly not receive the same degree of passivation in recessed areas due to low current densities. By increasing the time and/or overall current density, or by using auxiliary cathodes, the electropolishing can be improved in such areas and subsequent passivation tests can be passed.

5.2.3 Post treatment and rinsing

The electropolishing process produces a residual surface film when withdrawn from the electropolishing solution that can adversely affect appearance or performance.

The film shall be removed either by:

— immersing the article in nitric acid solution of 10 % volume fraction to 30 % volume fraction (relative density 1,42; 70 % mass fraction) at room temperature; or

— using several rinse stages.

Neutralization procedures such as immersion in alkaline solutions shall not be used as they have a tendency to “set” the residual surface film and detract from appearance and performance.

The article shall be rinsed subsequently to remove all traces of acidified water that can affect the appearance and performance of the passive part.

NOTE De-ionized or distilled water can be used to avoid water spots.

5.3 Passivation testing

— When tested in accordance with 7.1, there shall be no evidence on the article of red rust or other visible products resulting from the test.

— When tested in accordance with 7.2, there shall be no evidence on the article of red rust or other visible products resulting from the test.

— When tested in accordance with 7.3, there shall be no evidence on the article of red rust or other visible products resulting from the test.

— Stainless steel alloys in the austenitic 200 series, austenitic 300 series and martensitic 400 series containing more than 16 % chromium shall provide no evidence of either a copper-coloured deposit or copper-coloured spots, or both, when tested in accordance with 7.4.

— Stainless steel alloys in the austenitic 200 series, austenitic 300 series and martensitic 400 series containing more than 16 % chromium shall provide no evidence of the formation of a dark blue colour within 30 s when tested in accordance with 7.5.

5.4 Test report

When specified in the purchase order [see Clause 4 f)], a report of the passivation test used (see Clause 7) shall be supplied to the purchaser in accordance with Clause 8.

6 Sampling

6.1 A random sample shall be selected from the inspection lot in accordance with ISO 4519.

The items in the lot shall be inspected for conformity to the requirements of this specification and the lot shall be classified as conforming or non-conforming to each requirement in accordance with the sampling plans given in ISO 4519.

NOTE ISO 4519 describes four sampling plans for the original inspection of coated articles. Three are used where the test methods are non-destructive (i.e. the test method does not make the items non-conforming). The fourth plan is used where the test method is destructive.

The purchaser should identify which test methods are destructive and which are non-destructive. Where both destructive and non-destructive test methods exist to test the conformity of a finish to a particular requirement the purchaser should state which test method is to be used.

6.2 If separate test specimens are used to represent the items in a test, the specimens shall be of the nature, size and number, and be processed, as required in accordance with the test methods of this document.

Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for non-destructive tests and visual examination.

NOTE For destructive tests, separately prepared specimens can be used.

7 Test methods

7.1 Water immersion test

The article(s) shall be alternately immersed in distilled water for 1 h then allowed to dry for 2 h for eight wet-dry cycles (24 h total).

7.2 Humidity test

The article(s) shall be subjected to 100 % humidity at 38 °C ± 2 °C in a suitable humidity cabinet for a period of 24 h.

7.3 Neutral salt spray test

The article(s) shall be tested for a minimum of 2 h in accordance with the neutral salt spray (NSS) test described in ISO 9227.

7.4 Copper sulfate test

The article(s) shall be tested for a minimum of 2 h in accordance with the NSS test described in ISO 9227.

7.4.1 Principle

The article is swabbed with an acidified solution of copper sulfate and inspected for evidence of either a copper-coloured deposit or copper-coloured spots, or both, indicating the presence of free iron.