INTERNATIONAL STANDARD

ISO 15730

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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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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15730 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 8, *Chemical conversion coatings*.

Annex A of this International Standard is for information only.

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 International Standard may involve hazardous materials, operations and equipment. This International Standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and 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 International Standard 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/TR 15510 for information on composition).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 2080:1981, *Electroplating and related processes — 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/TR 15510, *Stainless steels — Chemical composition*.

ISO 16348:—[1)], *Metallic and other inorganic coatings — Definitions and conventions concerning appearance*.

3 Terms and definitions

For the purposes of this International Standard, the definitions given in ISO 2064, ISO 2080 and ISO 4519 (some of which are repeated below for convenience) and the following apply.

1) To be published.

3.1
passivation
rendering of a stainless steel surface into a lower state of chemical reactivity

NOTE Passivated surfaces are characterized by the absence of free iron and the formation of a thin coherent oxide film.

3.2
electropolishing
smoothing and brightening of a metal surface by making it anodic in an appropriate solution

[ISO 2080:1981]

3.3
inspection lot
collection of treated items that are of the same kind, that have been produced to the same specifications, that have been treated 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

[Based on ISO 4519:1980, definition 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 has to meet all of the specified requirements

[ISO 2064:1996]

4 Information to be supplied by the purchaser to the finisher

When ordering articles smoothed and passivated in accordance with this International Standard, 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 requirement for the provision of a test report (see 5.4 and clause 8).

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

NOTE 2 Typically, 5 μm to10 μm of metal are removed from the surface during electropolishing; however, up to 50 μm may be removed for additional smoothing. Greater amounts will be removed from corners and edges, i.e. areas of high current density, unless shields and/or auxiliary cathodes 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, e.g. 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 b) of clause 4].

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 may 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 may be improved in such areas and subsequent passivation tests may 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 may be used to avoid water spots.

5.3 Passivation testing

5.3.1 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.

5.3.2 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.

5.3.3 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.

5.3.4 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 a copper-coloured deposit and/or copper-coloured spots when tested in accordance with 7.4.

5.3.5 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 f) of clause 4], 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 nonconforming 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 nondestructive (i.e. the test method does not make the items nonconforming). The fourth plan is used where the test method is destructive.

The purchaser should identify which test methods are destructive and which are nondestructive. Where both destructive and nondestructive 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 specification.

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

NOTE For destructive tests, separately prepared specimens may 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 (NSS) 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 Copper sulfate test

7.4.1 Principle

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

7.4.2 Reagents

Copper sulfate test solution, prepared by dissolving 1,6 g of analytical reagent grade copper sulfate ($CuSO_4 \cdot 5H_2O$) in 100 ml of distilled water and 0,4 ml of sulfuric acid of 96 % mass fraction.

A fresh test solution shall be prepared every two weeks.

7.4.3 Procedure

Using a cotton swab, apply the test solution to a clean area of the passivated surface to be tested, ensuring that the surface is kept wet for 6 min.

Inspect the surface for the formation of a copper-coloured deposit and/or copper-coloured spots.

Discard or reprocess parts used for testing.

7.5 Modified “ferroxyl” test

7.5.1 Principle

The article is swabbed with a solution of potassium ferricyanide and inspected for the formation of a dark blue colour indicating the presence of free iron.

7.5.2 Reagents

Potassium ferricyanide test solution, prepared by dissolving 1,0 g of analytical grade potassium ferricyanide [$K_3Fe(CN)_6$] in 70 ml of distilled water and 30 ml of reagent grade nitric acid of (70 ± 1) % mass fraction and relative density 1,415 to 1,420.

A fresh test solution shall be prepared daily.

7.5.3 Procedure

Using a cotton swab, apply the test solution to a clean area of the passivated surface to be tested. Note the time taken for a dark blue colour to form.

Discard or reprocess parts used for testing.

8 Test report

The test report shall include the following information:

a) reference to this International Standard, i.e. ISO 15730;

b) reference to the test method(s) used (see clause 7);

c) the location(s) of the test area(s) on each specimen;

d) the number of specimens used;

e) the name of the operator and the testing laboratory;

f) the date on which the test(s) was (were) performed;

g) any circumstances or conditions thought likely to affect the results or their validity;

h) any deviation from the test method specified;

i) the result(s) of the test(s) (see 5.3).

Annex A
(informative)

Typical electropolishing solution and operating conditions

A typical electropolishing solution consists of an equal volume mixture of 96 % mass fraction sulfuric acid and 85 % orthophosphoric acid. The operating conditions are as follows:

— current density: 5 A/dm^2 minimum;

— temperature: 75 °C;

— time: 2 min to 4 min;

— cathodes: stainless steel, copper, lead.

Bibliography

[1] ISO 8074, *Aerospace — Surface treatment of austenitic stainless steel parts*.

[2] ISO 8075, *Aerospace — Surface treatment of hardenable stainless steel parts*.

[3] TEGART, W. J. McG. *The electrolytic and chemical polishing of metals in research and industry*. 2nd ed. revised. London and New York: Pergamon Press, 1959.

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