INTERNATIONAL STANDARD

ISO 3651-2

Second edition
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Determination of resistance to intergranular corrosion of stainless steels —

Part 2:
Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid

Détermination de la résistance à la corrosion intergranulaire des aciers inoxydables —

Partie 2: Aciers inoxydables ferritiques, austénitiques et austéno-ferritiques (duplex) — Essais de corrosion en milieux contenant de l'acide sulfurique

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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.

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.

International Standard ISO 3651-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis)*.

This second edition cancels and replaces the first edition (ISO 3651-2:1976), which has been technically revised.

ISO 3651 consists of the following parts, under the general title *Determination of resistance to intergranular corrosion of stainless steels*:

— *Part 1: Austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in nitric acid medium by measurement of loss in mass (Huey test)*

— *Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid*

Annexes A and B of this part of ISO 3651 are for information only.

Introduction

The term "intergranular corrosion test" denotes the corrosion test carried out by means of preferential attack of the grain boundaries.

Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels may be subject to such an attack when they are held at a temperature between about 500 °C and 1 000 °C. This heat cycle, which may provoke sensitization to intergranular corrosion, may occur during hot-forming (forging, rolling) as the result of incorrect solution treatment or during a welding operation.

NOTE — In the field of application of this test, intergranular corrosion may be connected with the presence along the grain boundaries of a chromium-depleted region due to precipitation of chromium carbides, sigma phase or other intermetallic phases.

Determination of resistance to intergranular corrosion of stainless steels —

Part 2:
Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid

1 Scope

This part of ISO 3651 specifies methods for the determination of the resistance to intergranular corrosion of ferritic, austenitic and ferritic-austenitic (duplex) stainless steels in media containing sulfuric acid. It also specifies the purposes which may be assigned to the test. The test methods included are:

— **method A:** the 16 % sulfuric acid/copper sulfate test (Monypenny Strauss test);

— **method B**: the 35 % sulfuric acid/copper sulfate test;

— **method C**: the 40 % sulfuric acid/ferric sulfate test.

The methods are applicable to stainless steels supplied in the form of cast, rolled or forged products and tubes and intended for use in a mildly oxidizing acid medium (for example, sulfuric acid, phosphoric acid).

Unless specified in the product standard, the method to be used, A, B or C, shall form the subject of an agreement between the interested parties.

Annex A gives examples of application of the three methods on stainless steels.

NOTE — It is important to note that the result of the corrosion test is only strictly valid for the corrosive medium used in the test. It constitutes a basis for estimating the resistance to intergranular corrosion but may not be used to check resistance to other forms of corrosion (general corrosion, pitting, stress corrosion, etc.). It is necessary for the user to adapt the specified corrosion test to the use which will be made of the alloy. These test should, in no case, be considered as an absolute criterion of the quality of the metal.

2 Purpose of the test

This intergranular corrosion test may have either of the purposes given in 2.1 and 2.2.

2.1 Verification of the intrinsic resistance of the steel to intergranular corrosion

This verification applies only to low carbon steels ($C \leqslant 0{,}03$ %) and stabilized steels specified for resistance to intergranular corrosion. The metal is inspected after having undergone a heat treatment for sensitization which can be a heat treatment or welding for sensitization (see clause 3).

2.2 Inspection of the efficiency of the solution treatment

This inspection is only carried out on thin products for which the cooling speed may be made sufficiently rapid. It is only of interest for the steels which are not defined in 2.1. The metal is inspected in the state in which it is delivered to the user, without heat treatment for sensitization.

3 Sensitization treatment

3.1 Sensitization heat treatment

In order to verify the intrinsic resistance to intergranular corrosion (see 2.1), it is necessary to carry out a heat treatment for sensitization for stabilized steels and steels with low carbon content.

The sensitization heat treatment can be:

— T1: heating the specimen at 700 °C ± 10 °C for 30 minutes followed by water cooling;

— T2: heating the specimen at 650 °C ± 10 °C for 10 minutes followed by water cooling.

The above defined treatments only apply to austenitic and duplex steels.

The type of sensitization heat treatment shall be defined in the product standard or in the order. If not specified, heat treatment T1 shall be applied.

3.2 Sensitization by welding

Sensitization by the preparation of welded test pieces may be used as an alternative to 3.1, by agreement between the interested parties. Test pieces which are not solution annealed after welding shall be tested in the as-welded condition. No additional sensitization heat treatment shall be performed.

Sensitization by welding applies to all the stainless steels covered by this part of ISO 3651.

4 Corrosion test

4.1 Principle

A test piece, prepared as specified in 4.2 and 4.3, is immersed in a solution according to method A, B or C for a specified time. The test piece is then subjected to a bend test. The convex surface of the test piece is examined after bending in order to reveal any cracks caused by intergranular corrosion.

For small diameter tubes, up to 60 mm (tube diameter shall be compatible with the aperture of the flask containing the solution), a flattening test is used instead of the bend test.

4.2 Test pieces

4.2.1 Dimensions

The test piece shall have a total surface area of 15 cm² to 35 cm². In the case of sheets with a thickness greater than 6 mm, the test piece shall have a maximum thickness of 6 mm and one of the rolled surfaces shall be retained.