TECHNICAL REPORT

ISO/TR 17671-3

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Welding — Recommendations for welding of metallic materials —

Part 3: Arc welding of stainless steels

Soudage — Recommandations pour le soudage des matériaux métalliques —

Partie 3: Soudage à l'arc 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.

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

The main task of technical committees is to prepare International Standards. 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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this part of ISO/TR 17671 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 17671-3 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

ISO/TR 17671 consists of the following parts, under the general title *Welding — Recommendations for welding of metallic materials*:

— *Part 1: General guidance for arc welding*

— *Part 2: Arc welding of ferritic steels*

— *Part 3: Arc welding of stainless steels*

— *Part 4: Arc welding of aluminium and aluminium alloys*

Introduction

This part of ISO/TR 17671 is being issued with several annexes in order that it may be extended to cover the different types of steel which will be produced to all the International steel standards for stainless steels.

When this part of ISO/TR 17671 is referenced for contractual purposes, the ordering authority should state the need for compliance with the document and such other annexes as are appropriate.

This part of ISO/TR 17671 gives general guidance for the satisfactory production and control of welding and details the possible detrimental phenomena that may occur with advice on methods by which they may be avoided. It is generally applicable to all stainless steels and is appropriate regardless of the type of fabrication involved, although the application standard may have additional requirements. Permissible design stresses in welds, methods of testing and acceptance levels are not included because they depend on the service conditions of fabrication. These details should be obtained from the design specification.

This part of ISO/TR 17671 contains additional details for fusion welding of stainless steels and should be read in conjunction with the general recommendations in ISO/TR 17671-1.

Welding — Recommendations for welding of metallic materials —

Part 3:
Arc welding of stainless steels

1 Scope

This part of ISO/TR 17671 gives general recommendations for the fusion welding of stainless steels. Specific details relevant to austenitic, austenitic-ferritic, ferritic and martensitic stainless steels are given in annexes A to D.

2 References

ISO 3581, *Welding consumables — Covered electrodes for manual metal arc welding of stainless and heat-resisting steels — Classification*

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 8249, *Welding — Determination of Ferrite Number (FN) in austenic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

ISO 9692-1, *Welding and allied processes — Recommendations for joint preparation — Part 1: Manual metal-arc welding, gas-shielded metal-arc welding and gas welding of steels*

ISO 9956-2, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*

ISO 14175, *Welding consumables — Shielding gases for arc welding and cutting*

ISO 14343, *Welding consumables — Wire electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification*

ISO/TR 15608:2000, *Welding — Guidelines for a metallic materials grouping system*

ISO/TR 17671-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*

EN 10088-1:1995, *Stainless steels — Part 1: List of stainless steels*

EN 12073, *Welding consumables — Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat resisting steels — Classification*

3 Terms and definitions

For the purposes of this part of ISO/TR 17671, the following terms and definitions apply.

3.1
passive layer
thin, transparent and tightly adherent film on the surface of stainless steels, which protects them from corrosive attack

3.2
stabilized steels
steels containing additions of strong carbide/nitride-forming elements (usually titanium or niobium), which limit the formation of chromium carbides/nitrides, allowing the stainless steel to retain its corrosion resistance, particularly around grain boundaries

3.3
non-stabilized steels
steels without the addition of strong carbide/nitride-forming elements (see 3.2)

3.4
ferrite number
FN
a number indicating magnetic attraction, relative to a series of reference samples and therefore, proportional to the ferro-magnetic phase content, approximately equal to ferrite (delta ferrite) content over the range 0 % to 10 % but more readily measured

[ISO 8249]

3.5
consumable insert
length of filler metal that is manufactured to conform to the shape and dimensions of the weld preparation and is melted to become an integral part of the joint during welding

3.6
proof strength
$R_{p0,2}$
tensile load which produces a plastic extension of 0,2 % of the original gauge length of the test specimen

4 Parent metal

This part of ISO/TR 17671 applies to stainless steels of the austenitic, ferritic, martensitic and austenitic/ferritic types, in accordance with groups 7 to 10 of ISO/TR 15608:2000.

5 Storage and handling

When storing, handling or fabricating stainless steel, the environment should be controlled to avoid permanent breakdown of the passive layer, which gives stainless steel its good corrosion resistance. Stainless steels should be protected from contamination and surface damage during all stages of storage, fabrication and transportation.

Contact between stainless steels and other materials, e.g. carbon steels, copper, paints, dyes and tapes, which cause a breakdown of the passive layer or other detrimental effects should be avoided. When contact is not avoidable, care should be taken that all residues are removed.

Racking for stainless steels should be strongly built and lined in a secure manner with materials that will not contaminate stainless steel, e.g. dry wood or stainless steel. Unlined or painted carbon steel racking should not be used. Lifting grabs should be made from or lined with a non-contaminating material.

Welding fixtures, earth clamps or manipulators should be either manufactured from or lined with non-contaminating materials.

6 Welding consumables

Filler materials should be selected with regard to the parent metals and the particular application and should comply with the relevant standards.

Where consumable inserts are used they should correspond with the relevant filler metal composition.

7 Fabrication

7.1 General

Facilities for fabrication of stainless steels should be segregated from other works and kept free of all possible contaminating materials such as lead, zinc, copper, copper alloys or carbon steels, etc.

Forming tools should be cleaned thoroughly before use to avoid cross contamination. All lubricants used in the forming operations should be removed from the workpiece.

Only tools dedicated to stainless steel should be employed. This particularly applies to grinding wheels and wire brushes.

Welding heats up the parent metal and this causes formation of oxide films both on the weld metal and on the surrounding areas of the weld. These oxides as well as slags produced by covered electrodes, flux cored wires and submerged arc welding, should be removed if the weld is to be exposed to a corrosive medium or for other reasons (see clause 10).

When preparing fusion faces, oxidation, hardening and general contamination from thermal cutting processes should be eliminated by mechanically machining to a sufficient depth from the cut face. During shearing, cracking can occur. Thise may also require to be removed prior to welding.

Where cut edges do not form fusion faces, care should be taken to ensure that the shearing or thermal cutting does not adversely affect the performance of the fabrication.

Hard stamping should be avoided, but when it has to be used attention is drawn to the danger of it being applied in highly stressed or corrosive areas and the purchaser should give guidance as to the location of such marks. Indentations used for marking in radiographic examination should be subject to similar precautions.

Welds which are to be inspected and approved should not be painted or otherwise treated until they have been accepted.

7.2 Weld details

Welding details should be described in an appropriate Welding Procedure Specification (WPS) in accordance with ISO 9956-2.

Further details of weldability aspects are given in annexes A to D.

Acceptance criteria for misalignment of joints are given in ISO 5817. For certain applications (e.g. the welding of pipework) and welding processes, closer tolerances may be necessary.

Where run-on/run-off pieces are used these should be manufactured from a grade of stainless steel compatible with that used for the fabrication and should have a thickness and edge preparation similar to that used for the joint.

The removal of run-on/run-off pieces should be performed by a method that does not adversely affect the properties of the parent metal and weld deposit. Inspection should be carried out to demonstrate that both the parent material and weld deposit are free from unacceptable imperfections.

Where the weld has to be made from one side only, it may be necessary to protect the root side from atmospheric contamination in order to maintain the corrosion resistance of the joint. The root run of such welds is generally made using the TIG or plasma welding process.

NOTE Pulse MIG/MAG-technique is also used.

7.3 Weld backing

Permanent backing should consist of a compatible grade of stainless steel and should not be used where there is a risk of crevice corrosion.

When it is not appropriate to use part of the structure as backing material, the material to be used should be as required by the design specification.

When using copper as a temporary backing material, a groove should be machined into the backing material in the fusion area. Care should be taken when welding as there is a risk of copper pick-up. This can be reduced by nickel or chromium plating of the copper backing material. When using high heat input, the copper backing may be water-cooled.

Backing material shall be free from contamination such as grease, moisture, oxide, etc.

Where temporary or permanent backing is used, the joint should be arranged in such a way as to ensure that complete fusion of the parts to be joined is readily obtained.

When it is necessary to prevent oxidation on the reverse side of a weld, purging using a suitable gas supply should be carried out. This is where a high purity gas or gas mixture, in accordance with ISO 14175, compatible with the parent and weld metal, is passed over the weld root. The purpose is to prevent contamination by the atmosphere, principally oxygen, which can lead to unacceptable imperfections in the weld and/or a reduction of corrosion resistance.

Where purging of the root area is to be carried out, the duration of purging prior to welding should be sufficient to ensure that the level of root oxidation is as required by the design specification. The prepurge time will depend principally on gas flow rate, volume to be purged and, to a lesser extent, purging gas density and injection point.

Where maximum permissible oxygen levels are specified in the contract, it will be necessary to use an oxygen analyser of suitable sensitivity to measure the oxygen content of the exit gas. As a guideline, it is suggested that ten volume changes be made before commencing welding.

Gas purging should be maintained for sufficient duration to ensure that the finished weld underside surface oxidation level is contractually acceptable.

8 Quality requirements of welds

Welded joints should be free from imperfections that would impair the service performance of the construction. Acceptance levels should be in accordance with the application standard where it exists. If no application standard exists, acceptance levels should be based on ISO 5817.

Special quality requirements for stainless steels may be taken into account, such as appearance and corrosion resistance, and shall be specified in the contract.

9 Distortion

Distortion in a weldment results from non-uniform expansion and contraction of weld metal and adjacent parent metal during welding. In austenitic stainless steel, this phenomenon is much more pronounced than in unalloyed steel due to a larger expansion coefficient and a lower thermal conductivity.

There are various practical ways of minimizing distortion such as:

— minimizing the weld metal volume;

— balanced (double sided) joint welding;

— reduced heat input;

— reduced numbers of weld layers;

— backstep welding;

— preset of the parts to be welded;

— jigs and mechanical restraints;

— tack welding;

— heat sinks.

Care should be taken that the methods chosen do not have a deleterious effect on the properties of the welds and the overall structure.

10 Post-weld cleaning

10.1 General

The corrosion resistance of stainless steel weldments is significantly affected by their surface condition. The degree of post-weld cleaning necessary depends upon the weld quality requirements and should be as required by the design specification.

Post-weld cleaning can be carried out by several processes, either separately or in combination. See 10.2 to 10.6.

10.2 Brushing

Dedicated wire brushes made with stainless steel bristles or other compatible material should be used. This technique cannot be used, in general, to remove adherent contaminants. Care should be taken when using mechanical rotary brushing as this may deform the surface giving microcrevices which will reduce corrosion resistance. It may be necessary to follow brushing with a pickling operation (see 10.5).

10.3 Shot blasting

This technique is used for the removal of adherant contaminants and also to give residual compressive stresses in the surface. Recommended blasting media include glass and stainless steel shot. These should be free from iron or carbon steel contamination. It is also known as peening.