TECHNICAL REPORT

ISO/TR 17671-5

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Welding — Recommendations for welding of metallic materials —

Part 5: Welding of clad steels

Soudage — Recommandations pour le soudage des matériaux métalliques —

Partie 5: Soudage des aciers plaqués

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 document may be the subject of patent rights. ISO should not be held responsible for identifying any or all such patent rights.

ISO/TR 17671-5 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*

— *Part 5: Welding of clad steels*

— *Part 6: Laser beam welding*

— *Part 7: Electron beam welding*

Introduction

This Technical Report is based on the European Standard EN 1011-5:2003, *Welding — Recommendations for welding of metallic materials — Part 5: Welding of clad steel*.

Requests for official interpretations of any aspect of this Technical Report should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body, a complete listing which can be found at www.iso.org.

Welding — Recommendations for welding of metallic materials —

Part 5: Welding of clad steels

1 Scope

This part of ISO/TR 17671 gives general recommendations for welding of clad steels by means of appropriate arc welding processes and electroslag strip cladding.

It is generally applicable to all clad steels and is appropriate regardless of the type of fabrication involved, although the application standard may have additional requirements. Non-ferrous claddings, such as titanium, tantalum, zirconium and their alloys are not covered by this part of ISO/TR 17671.

Examples for joint preparation are given in ISO 9692-4.

This part of ISO/TR 17671 covers welding of cladding deposits as well as welding of the transition zone(s), when existing, between parent metal and cladding. These transition zones are metal combinations of non-alloyed ferrous parent metal with high alloyed stainless steels, nickel alloys or other non-ferrous metals.

The mechanical and physical design of the joints is not covered by this part of ISO/TR 17671. Methods of testing and acceptance levels are not included because they depend on the service conditions of the fabrication. These details should be obtained from the design specification. The corrosion resistance of the cladding depends on many factors and is not part of this part of ISO/TR 17671.

For general guidelines see ISO/TR 17671-1.

2 Normative references

The following referenced documents are indispensable for the application 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 2553, *Welded, brazed and soldered joints — Symbolic representation on drawings*

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 austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

ISO 9692-4:2003, *Welding and allied processes — Recommendations for joint preparation — Part 4: Clad steels*

ISO 13916, *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*

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

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

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

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

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

ISO/TR 17671-3, *Welding — Recommendations for welding of metallic materials — Part 3: Arc welding of stainless steels*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
clad steel
combination of two or more dissimilar metals bonded inseparably by different cladding processes

4 Materials

4.1 Clad steels

Clad steels can be produced by several cladding processes such as:

— hot roll cladding;

— explosive welding;

— surfacing by welding;

— combined weld/hot roll cladding.

The inseparable cladding (commonly $t_2 \geqslant 2$ mm wall thickness), which will be in contact with the adjacent medium, is designed to meet requirements such as corrosion resistance, abrasion and/or heat resistance at different working temperatures.

4.2 Parent metal

The parent metal is a weldable steel, commonly in accordance with those referenced in groups 1 to 6 of ISO/TR 15608:2000. The parent metal should provide the required strength and toughness to maintain mechanical integrity.

— Stainless steels (e.g. see EN 10088-1).

— Nickel and nickel alloys.

— Copper and copper alloys.

— Cobalt alloys (stellites).

Cladding should be capable of being joined by arc welding processes to the parent metals.

The finished surface conditions of cladding, particularly used in components for the chemical industry, should guarantee adequate corrosion resistance and other specified characteristics. For information on corrosion resistance of cladding, see relevant application standards.

5 Welding consumables for cladding deposits

The cladding deposit, including dilution with the cladding, should be compatible with the cladding. Therefore, consumables should be selected with regard to the parent metal, to the cladding and the particular application. The consumables should comply with the relevant standards and/or specifications.

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

In some cases, the filler metals used for the buttering may also be used for filling and capping runs, if appropriate for the application.

The service conditions of a clad steel component, such as working temperature or possible post-weld heat treatment (PWHT) should be considered when selecting appropriate consumables.

It is necessary to pay attention to the effects of dilution when depositing one layer on another, especially the first layer on the parent metal. The welding process, the welding conditions and the consumables have a significant influence on the chemical compositions and the ferrite numbers (FN) of a stainless cladding deposit. Gains or losses of alloying elements, e.g. the metallurgical reactions between wire/strip and fluxes or gases, should be taken into account.

If the ferrite number is a requirement in the specification, the methods of measurement in accordance with ISO 8249, e.g. the magnetic determination with calibrated instruments, should be in accordance with the design specification. In case of dispute, the WRC-92 constitution diagram should be used.

6 Welding procedures

Different arc welding processes may be used to produce cladding deposits matching specified requirements. Deposits in one, two or more layers can be realized in order to achieve the required characteristic. The number of the layers depends on several factors and should be confirmed by a welding procedure specification.

Commonly, the selection of any welding procedure depends on:

— welding position;

— access conditions;

— alloy type;

— specified requirements, such as dilution rate (which should generally be kept as low as possible, provided that penetration is adequate).

7 Fabrication

When storing, handling or fabricating clad steels, measures should be taken to protect the cladding from contamination and surface damage. In case damage impairs the service performance, reconditioning should be undertaken in accordance with ISO/TR 17671-3 or other relevant standards.

Repair/restoring of damaged cladding should be such as to avoid the formation of brittle phases.

Joint preparation should be in accordance with ISO 9692-4.

Clad steels can be cut using normal methods; shearing (for thin plates) and plasma cutting should be started from the clad side. When preparing joint faces, oxidation, hardening and general contamination from thermal cutting processes should be eliminated by mechanical machining (grinding) to a sufficient depth from the cut face. During shearing, cracking and work hardening can occur. This should be removed prior to welding.

Mechanical joint preparation is preferable.

Cold or hot forming operations can be carried out on clad steels by the manufacturer as appropriate. The processing treatment and instructions are supplied by the manufacturer or fabricator as appropriate.

Hard stamping on the cladding causes highly stressed and/or corrosion sensitive areas and should be avoided.

All operations leading to the formation of brittle phases in the transition zones, e.g. when grinding, should be avoided.

8 Welding

8.1 Welding from both sides

8.1.1 Parent metal

The parent metal should first be welded in accordance with an approved welding procedure.

The root run should not penetrate into the cladding.

8.1.2 Single-layer cladding deposits

The cladding deposit should be welded using an approved welding procedure. All requirements concerning the arc welding of dissimilar metals should be observed.

A single layer cladding deposit may be applied when the welding procedure has been shown to achieve the specified requirements, especially the chemical composition. The consumables used for this application should be sufficiently alloyed in order to compensate the dilution with the parent metal and to match the specified characteristics. The welding consumables should be verified by a qualified procedure and they should be appropriate for the application. Welding processes with low penetration characteristics are recommended.

8.1.3 Multi-layer cladding deposits

The cladding deposit should be welded using an approvied procedure. All requirements concerning the arc welding of dissimilar metals should be observed.

For the buttering (first layer), the same procedure as mentioned in 8.1.2 may be valid.

The subsequent runs should be welded using consumables with a higher or equal alloy content to that of the cladding, or be adequate for the requirements.

8.1.4 Non-ferrous metal deposits

For non-ferrous metal and high-temperature ($\leqslant$ 300 °C) applications, special agreement in the design specification should be provided.

8.2 Single side welding

In the case of single side welding, the joint preparation in accordance with ISO 2553 is generally an “HU”- or a “U”-preparation for the parent metal with the root face entirely within the cladding (see ISO 9692-4:2003, reference numbers: 8 and 9). The root run should be welded using a process and consumables appropriate for the application. The welding consumables should be verified by a qualified procedure and they should be appropriate for the application.

The filling run(s) should be welded with consumables and procedures as commonly used for the buttering (see 8.1.3). All requirements concerning the arc welding of dissimilar metals should be observed.

To prevent oxidation or contamination during arc welding of the root run and the filling runs, a back shielding gas in accordance with ISO 14175 should be applied.

8.3 General welding conditions

8.3.1 Preparation of joint faces

Any large notches or any other imperfections in joint geometry which might impair welding, should be corrected by applying a weld deposit in accordance with an approved welding procedure. Subsequently, it should be ground smooth and flush with the adjacent surface in order to produce an acceptable finish.

When preparing joint faces for stainless steels and non-ferrous cladding, dedicated tools should be used. This particularly applies to grinding wheels and wire brushes.

Tools for forming the cladding should be cleaned before use in order to avoid cross contamination. Lubricants used in the forming operations should be removed from the workpiece.

8.3.2 Run-on/run-off plates, temporary attachments

When run-on/run-off plates and temporary attachments are used, they should be compatible with the parent metal and cladding. The removal of run-on/run-off plates should be performed by a method that does not adversely affect the properties of the main plates. Inspection should be carried out in order to demonstrate the absence of any unacceptable imperfections.

8.3.3 Back shielding of single-side welding and tack welding

To maintain the corrosion resistance of single-side welded joints, it may be necessary to protect the root from atmospheric contamination with back shielding gases.

8.3.4 Preheating

Preheating as specified by the application standard may be necessary depending on type and thickness of the parent metal. Where a blowpipe is used for this purpose, the flame should be neutral and it should be pointed only at the parent metal.

Preheating should be measured in accordance with ISO 13916.

8.3.5 Post-weld heat treatment

Post-weld heat treatment of clad steels is a difficult subject. When PWHT is required by the application standard, it should be carried out considering the parent metal, the cladding and the different cladding deposits.