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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

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Replacing GB/T 39077-2020

Test methods for detecting detrimental phase in austenitic-ferritic (duplex) stainless steels

奥氏体-铁素体（双相）不锈钢中有害相的检测方法

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Foreword Foreword

The document is drafted in accordance with the rules given in GB/T 1.1-2020, Directives for standardization-Part 1: Rules for the structure and drafting of standardizing documents.

It replaces GB/T 39077-2020, Test methods for detecting detrimental phase in lean austenitic-ferritic duplex stainless steels. Apart from structural adjustments and editorial changes, the main technical changes are: the terms and definitions have been changed (Clause 3, against Clause 3 of the 2020 edition); sampling requirements for large-section products, for flanges and for welded joints have been added (Clause 4); electrolytic etching reagents and electrolytic parameters have been added to the microstructural examination method (5.2.3); a corrosion solution has been added to the ferric chloride corrosion test method (5.4.3.2.2); and methods for the examination of detrimental phases and for the assessment of the result have been added for the 22Cr duplex type, the 25Cr duplex type and the 27Cr duplex type (5.2.4, 5.2.5.2, 5.3.2, 5.3.3, 5.4.4 and 5.4.6). In this list of changes the 25Cr duplex type is printed as 25r duplex type.

The document was proposed by the China Iron and Steel Association and is under the

jurisdiction of the National Technical Committee on Steel of Standardization Administration of China (SAC/TC 183). It was first issued in 2020 as GB/T 39077-2020, and the present edition is the first revision.

1 Scope

The document lays down the test conditions, the test methods and the acceptance requirements for detecting detrimental phases in austenitic-ferritic (duplex) stainless steels. The test methods are the microstructural examination method, the Charpy impact test method and the ferric chloride corrosion test method.

It applies to the examination of detrimental phases precipitated in austenitic-ferritic (duplex) stainless steel during production and manufacture, such as heat treatment or welding, or during long service at a given temperature. It does not apply to a loss of toughness or of corrosion resistance in austenitic-ferritic (duplex) stainless steel arising from other causes.

A note refers to Annex A for the product grades to which the document mainly applies.

2 Normative references

The following documents are cited normatively in the text and their content constitutes indispensable provisions of the document. For dated references only the edition cited applies; for undated references the latest edition, including all amendments, applies.

GB/T 229 Metallic materials-Charpy pendulum impact test method (GB/T 229-2020, ISO 148-1:2016, MOD).

GB/T 2650 Destructive tests on welds in metallic materials-Impact tests (GB/T 2650-2022, ISO 9016:2022, MOD).

GB/T 13298 Inspection methods of microstructure for metals.

GB/T 17897-2016 Corrosion of metals and alloys-Method of ferric chloride pitting corrosion test for stainless steels.

GB/T 30067 Metallographic terms.

3 Terms and definitions

The terms and definitions given in GB/T 30067 and the following apply.

3.1.1 Austenitic-ferritic (duplex) stainless steel: a stainless steel whose matrix is made up of the two phases austenite and ferrite, the lesser phase amounting to at least 25 percent, and which can be strengthened by cold working. A note records that, for ease of examination, the document divides austenitic-ferritic (duplex) stainless steels according to their chromium content and their pitting resistance equivalent number PREN into the 20Cr duplex type group A, the 20Cr duplex type group B, the 22Cr duplex type, the 25Cr duplex

type and the 27Cr duplex type; in that note the 25Cr duplex type is printed as 25r duplex type.

3.1.2 Type 20Cr duplex group A: an austenitic-ferritic (duplex) stainless steel whose pitting resistance equivalent number lies between 24.0 and 28.0.

3.1.3 Type 20Cr duplex group B: an austenitic-ferritic (duplex) stainless steel whose pitting resistance equivalent number lies between 28.0 and 30.0.

3.1.4 Type 22Cr duplex: an austenitic-ferritic (duplex) stainless steel whose pitting resistance equivalent number lies between 30.0 and 40.0 and whose chromium content is not less than 21.0 percent by mass.

3.1.5 Type 25Cr duplex: an austenitic-ferritic (duplex) stainless steel whose pitting resistance equivalent number lies between 40.0 and 48.0.

3.1.6 Type 27Cr duplex: an austenitic-ferritic (duplex) stainless steel whose pitting resistance equivalent number lies between 48.0 and 55.0 and whose chromium content is not greater than 33.0 percent by mass.

3.2.1 Pitting resistance equivalent number, PREN: a parameter based on the chemical composition that quantifies the resistance of a stainless steel to pitting, expressed as a mass fraction in percent. Note 1 gives PREN = w(Cr) + 3.3 w(Mo) + 16 w(N), or, for steels containing tungsten, PREN = w(Cr) + 3.3 x [w(Mo) + 0.5 w(W)] + 16 x w(N). Note 2 states that PREN values are absolute values based on the ladle analysis.

3.3.1 Detrimental phase: the intermetallic phases and non-metallic precipitates formed in an austenitic-ferritic (duplex) stainless steel at a given temperature that have an adverse effect on the in-service performance of the steel.

3.3.2 Intermetallic phase: a compound or intermediate solid solution containing two or more metals. A note records that the intermetallic phases precipitated in austenitic-ferritic (duplex) stainless steels are mainly the sigma phase, the chi phase and the R phase.

3.3.3 Non-metallic precipitate: a non-metallic compound precipitated in an austenitic-ferritic (duplex) stainless steel. Note 1 excludes the sulfide and oxide non-metallic inclusions produced during smelting. Note 2 records that the non-metallic precipitates in these steels are mainly chromium carbide, Cr23C6, and nitride, Cr2N.

3.3.4 Boundary percentage content of the detrimental phases, P: the percentage of the total phase-boundary area occupied by the detrimental phases. A note records that P reflects the degree to which the detrimental phases have precipitated on the phase boundaries and bears directly on the toughness and the corrosion resistance of the duplex stainless steel.

4 Sampling method

4.1 General. The test piece is to be cut from the finished product or from the final test coupon accompanying the furnace charge. Cutting is not to affect the microstructure; where the sample is cut by flame cutting or another thermal cutting method, the melted zone, the plastically deformed zone and the heat-affected zone are to be removed completely.

4.2 Sampling from products. The sampling position and the number of samples follow the product standard or the agreement between the two parties. Where these are not laid down, sampling as given in Table 1 is recommended; with the agreement of the purchaser, representative test samples may also be chosen.

Table 1 sets, for each product form, the way the sample is cut, its size in millimetres, the test method, the direction of examination and the sampling position. The product forms covered are plate and strip, discs, seamless tube, pipe and fittings; welded tube and fittings; bar and forgings, with separate lines for an outside diameter or section thickness below 50 mm and one of 50 mm and above; flanges and other hollow-profile forgings with welded ends, including tees; and castings, with separate lines for a section thickness below 50 mm and one of 50 mm and above. For each of these, the three test methods are listed with their direction of examination, given as longitudinal, transverse, tangential or any direction, and their sampling position, stated as the full wall thickness, one half or one quarter of the thickness, from the surface to the core, or the central region of the wall. A note records that the product thicknesses in the table are the thickness of the thickest part of the batch.

Footnote a to Table 1: for large-section products the test piece for the corrosion test method is to be cut perpendicular to the longitudinal axis, with a size of 6 mm by 25 mm by the product thickness. Where the section is very large, the product thickness in that size may be reduced, and one half to one third of the product thickness may then be taken for the test.

Footnote b: where the thickness of the flange body is less than 50 mm or the outside diameter of the welded end is not greater than 100 mm, the test piece may be taken tangentially at the mid-thickness of the flange body.

Footnote c: for bar, the outside diameter or section thickness range is 50 mm to 200 mm.

4.3.1 Sampling from welded joints. A test piece for the microstructural examination method is to include the weld metal, the heat-affected zone and the parent metal. Where the parent metal is thicker than 25 mm, several test pieces may be taken to cover the full thickness of the product. All test pieces are to comply with the product standard or with the agreement between the two parties.

4.3.2 For the Charpy impact test method, where the parent metal is not thicker than 25 mm three sets of test pieces are to be taken, from the weld metal, from the fusion line and from the fusion line plus 2 mm respectively. Where the parent metal is thicker than 25 mm, two further sets are to be taken from the weld root region 2 mm from the inner surface, one from the weld metal and one from the fusion line plus 2 mm.