NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

GB/T 4334-2020

Corrosion of metals and alloys - Test methods for intergranular corrosion of austenitic and ferritic-austenitic (duplex) stainless steels

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1 Scope

This Standard specifies the samples, test solutions, test instruments and equipment, test conditions and procedures, test result evaluation and test report of test methods for intergranular corrosion of austenitic and ferritic-austenitic (duplex) stainless steels.

This Standard applies to the inspection of intergranular corrosion tendency of austenitic stainless steels and ferritic-austenitic (duplex) stainless steels (hereinafter referred to as duplex stainless steels). It includes the following test methods:

a) Method A: 10% oxalic acid corrosion test method It is a screening test to check the intergranular corrosion of austenitic stainless steels. After the sample is electrolytically etched in 10% oxalic acid solution, observe the metallographic structure of the etched surface under a microscope, so as to determine whether Method B, Method C, Method E and other long-time hot acid tests are required. In the case of not allowing damage to the tested structural parts and equipment, it can also be used as an independent intergranular corrosion inspection method.

b) Method B: 50% sulfuric acid-ferric sulfate corrosion test method Place the austenitic stainless steels in the 50% sulfuric acid-ferric sulfate solution for a boiling test; then, use the corrosion rate to evaluate the intergranular corrosion tendency.

c) Method C: 65% nitric acid corrosion test method Place the austenitic stainless steels in the 65% nitric acid solution for a boiling test; then, use the corrosion rate to evaluate the intergranular corrosion tendency.

d) Method E: copper-copper sulfate-16% sulfuric acid corrosion test method Place the austenitic stainless steels and duplex stainless steels in the copper-copper sulfate-16% sulfuric acid solution for a boiling test; then, use the bending method or the metallographic method to determine the intergranular corrosion tendency.

e) Method F: copper-copper sulfate-35% sulfuric acid corrosion test method Place the austenitic stainless steels and duplex stainless steels in the copper-copper sulfate-35% sulfuric acid solution for a boiling test; then, use the bending method or the metallographic method to determine the intergranular corrosion tendency.

f) Method G: 40% sulfuric acid-ferric sulfate corrosion test method Place the austenitic stainless steels and duplex stainless steels in the 40% sulfuric acid-ferric sulfate solution for a boiling test; then, use the bending method or the metallographic method to determine the intergranular corrosion tendency.

Appendix C of this Standard gives the characteristics of each test method in the form of a table; Appendix D gives the application examples of method E, method

F, and method G.

The test methods in this Standard are not applicable to predicting the intergranular corrosion resistance of stainless steels under other media, nor to predicting the corrosion resistance of stainless steels to other forms of corrosion (such as pitting corrosion, uniform corrosion, stress corrosion).

2 Normative references

The following documents are indispensable for the application of this document.

For dated references, only the dated version applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 625, Chemical reagent - Sulfuric acid (GB/T 625-2007, ISO 6353-2:1983, NEQ)

GB/T 626, Chemical reagent - Nitric acid (GB/T 626-2006, ISO 6353-2:1983, NEQ)

GB/T 655, Chemical reagent - Ammonium persulfate

GB/T 665, Chemical reagent - Copper (II) sulfate pentahydrate (GB/T 665-2007, ISO 6353-2:1983, NEQ)

GB/T 2100, Corrosion-resistant steel castings for general applications (GB/T 2100-2017, ISO 11972:2015, MOD)

cannot be ground or pickled, the surface cannot be oxidized during heat treatment.

3.1.9 During the cutting and surface grinding process of samples for Method B, Method C, Method E, Method F, Method G , the surface shall be prevented from overheating; the surface roughness Ra value of the processed sample shall generally be no more than 0.8 um. For samples that cannot be ground, other surface roughness can also be used according to the agreement between the two parties.

Table 1 -- Sample size and preparation requirements of Method B and

Method C Classification Thickness or diameter a mm Sample size mm Number of samples pcs

Note Length Width Thickness Steel plate, strip (flat steel)

<=3 30+/-10 20+/-10 - 2 Take samples along the rolling direction >3 30+/-10 20+/-10 3~4 2 Take samples along the rolling direction; process one sample from one side to the thickness of the sample;

process the other sample from the other side to the thickness of the sample Section steel, forging - 30+/-10 20+/-10 3~4 2 Take samples longitudinally from the middle of the cross section Steel rod (steel wire)

<=10 30+/-10 - - 2 ->10 30+/-10 <=20 <=5 2 Take samples longitudinally from the middle of the cross section Seamless steel tube < 5 30+/-10 - - 2 Take a full-tubular sample 5~15 30+/-10 - - 2 Take a semi-tubular or boat-shaped sample >15 30+/-10 <=20 -Wall thickness <

4 mm 2 -Wall thickness >=

4 mm Process one group (2 samples) from the outer wall to the thickness of the sample; process the other group (2 samples) from the inner wall to the thickness of the sample 1 -- welding sample;

2 -- welding sample;

3 -- welding plate.

Figure 6 -- Cross weld sampling

3.2.1 For ultra-low carbon stainless steels (whose carbon content is not more

than 0.030%) and stabilized stainless steels (that are added titanium or niobium), when evaluating the intrinsic intergranular corrosion sensitivity, the sample shall be sensitized before the test; the sensitization system of the sample is determined through consultation between the supplier and the buyer.

For austenitic stainless steels, the recommended sensitization system is 650 °C +/- 10 °C, heat preservation of 2 h, air cooling. For duplex stainless steels, the recommended sensitization system is 700 °C +/-10 °C, 30 min, water cooling; or 650 °C +/- 10 °C, 10 min, water cooling.

3.2.2 For other stainless steels, whether the sample needs to be sensitized and

which sensitization system is adopted shall be determined through consultation by the product standard or between the supplier and the buyer.

3.2.3 Welding samples are generally tested after welding. Welded parts that are

subjected to hot working above 350°C after butt welding shall be sensitized after welding. The sensitization system is negotiated by both parties.

3.2.4 The sample sensitization shall be performed before grinding. Before

sensitization and before the test, use an appropriate solvent or detergent (non-chloride) to degrease and dry the sample.

4.1.1 Dissolve 100 g of high-grade pure oxalic acid in accordance with GB/T

9854 in 900 mL of distilled water or deionized water, to prepare a 10% oxalic acid solution.

4.1.2 For the molybdenum-containing steel, when it is difficult to have a stepped

structure, use 100 g of analytically pure ammonium persulfate in accordance with GB/T 655 to dissolve in 900 mL of distilled water or deionized water, to prepare a 10% ammonium persulfate solution instead of 10% oxalic acid solution.

The test report shall include the following contents:

a) number and name of this Standard;

b) test method;

c) name of the sample and size of the test area;

d) current density;

e) etching time and temperature;

f) metallographic photograph after etching;

g) judgment result.

5 Method B -- 50% sulfuric acid-ferric sulfate corrosion

test method

5.1.1 Slowly add 236 mL of guaranteed pure sulfuric acid in accordance with

GB/T 625 to a conical flask that is filled with 400 mL of distilled water to prepare a 50% (49.4% ~ 50.9%) sulfuric acid solution (pay attention to prevent bumping).

5.1.2 Weigh 25 g of hydrated ferric sulfate [Fe2(SO4)3.xH2O]; add about 75%

(mass fraction) of ferric sulfate to the above sulfuric acid solution.