



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 38223-2019

**Determination of ferrite content in austenitic stainless-steel
castings**

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1 Scope

This Standard specifies metallographic method, magnetic method, chemical composition method in determination methods of ferrite content in austenitic stainless-steel castings and test report.

This Standard is applicable to the determination of ferrite content in Cr-Ni austenitic stainless-steel castings. The determination of ferrite content in duplex stainless-steel castings refer to this Standard for implementation.

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.

GB/T 1954, Methods of determination for ferrite content in austenitic Cr-Ni stainless-steel weld metals (GB/T 1954-2008, ISO 8249:2000, MOD)

GB/T 5678, Sampling methods of spectrochemical analysis for cast alloys

GB/T 13298, Inspection methods of microstructure for metals

GB/T 13305, Micrographic method for determining area content of the alpha-phases in stainless-steels

GB/T 15749, Determining method in quantitative metallography

GB/T 20066, Steel and iron - Sampling and preparation of samples for the determination of chemical composition (GB/T 20066-2006, ISO 14284:1996, IDT)

3 Terms and definitions

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

4.2.1 When sampling, the heat treatment state of the casting is agreed by the supplier and the purchaser.

4.2.2 It shall perform sampling on the base metal of the casting. The sampling position and quantity are agreed by the supplier and the purchaser. Cut the sample according to the provisions of GB/T 13305.

4.3.1 Sample preparation

Sample grinding, polishing and etching shall be carried out according to GB/T 13305 or GB/T 13298. The chemical etching method of the sample can be carried out according to GB/T 1954 or Annex B.

4.3.2.1 Use the worst field of view method or the average field of view method

to determine the ferrite percentage in the sample, agreed by the supplier and the purchaser. When necessary, determine on two sections of the sample that are perpendicular to each other.

4.3.2.2 When using the worst field of view method, it shall select a lower

amplification factor to fully observe the entire inspection surface. Select the field of view that has the most ferrite percentage to determine.

4.3.2.3 When using the average field of view method, generally, each detection

surface randomly selects no less than 5 representative non-overlapping fields of view. Take the average value as the determination result. If the ferrite distribution is found to be uneven during the determination, it shall give the average, maximum and minimum percentages in the determination results and explain.

4.3.3.1 Use the grid number point method, grid line method and image analyzer

method to determine the ferrite percentage in the field of view. During determination, it shall select a suitable determination method according to the ferrite morphology distribution.

4.3.3.2 The grid number point method is only applicable to the determination of

ferrite percentage in casting that its form is approximately isometric. The grid line method and image analyzer method are applicable to the determination of ferrite percentage of all forms.

4.3.4.1 Grid number point method

tested;

d) Automatically determine the area fraction of the ferrite to be tested AA.

According to equation (1), obtain the ferrite percentage of this sample.

5.1.1 When the material requires heat treatment, the determination shall be

performed after the casting is subject to the final heat treatment. During sampling, it shall avoid the effect of heat treated surface on the determination result.

5.1.2 The roughness of the surface to be tested shall meet $Ra < 20\mu m$. During

sample processing, it shall use the minimum feed of the grinding machine to process the last 0.5mm. During determination, the distance between the determination point and the sample or component edge shall exceed 5mm.

When determining on a curved surface, the radius of curvature shall be greater than 10mm.

5.2.1 Except special requirements, the determination shall be performed on the

sample (the sample is extracted from the base metal of casting, non-weld metal).

If the determination position is the casting position designated on the design drawing, it shall be regulated on the agreement.

5.2.2 Extract the sample on the attaching casting test block of the casting. The

minimum size of the sample shall be 30mm x 30mm x 30mm. When the sample is extracted from a single casting test block, the sample shall be extracted 15mm below the surface.

5.2.3 When the tensile test is required to conduct in the product specification, the position for determination shall be selected to represent the undeformed end of the tensile sample of the casting of same furnace number.

5.3.1 The ferrite determining instrument, before use, shall use the calibration

block to calibrate. The ferrite determining instrument and the calibration block shall be calibrated regularly (usually it does not exceed one year).

5.3.2 The magnet (or probe) of the instrument and the surface to be tested, before the testing, shall be removed from rust, grease, dander or dust that affects the determination accuracy.

6.3.1 When using graphic method to calculate, it shall determine the

percentages of carbon, manganese, silicon, chromium, nickel, molybdenum, niobium and nitrogen in casting. Use equation (2) to calculate the ratio of chromium equivalent $CR(Cr)$ to nickel equivalent $CR(Ni)$ of castings. And use the center line (solid line) in Figure 1 to determine the ferrite percentage. Or directly find the average ferrite percentage corresponding to the ratio of chromium equivalent to nickel equivalent in Table 2.

Where, the percentage of each element is represented in mass fraction.

6.3.2 The ratio of chromium equivalent to nickel equivalent can be obtained

from the intersection of the solid line and the ferrite volume fraction in Figure 1 or obtained from Table 2. For example, when the ferrite percentage is 12%, the ratio of chromium equivalent to nickel equivalent is 1.234.

6.3.3 The average ferrite percentage in the casting is obtained from the

intersection of the centerline and the equivalent ratio of Figure 1. The dotted line in Figure 1 shows the possible error range. If the equivalent ratio is 1.234, specify it as 12% of ferrite volume fraction, which varies from 8%~17%, corresponding to Table 3.

NOTE: Since there is error in chemical composition method, the calculated value may deviate from the actual value. Therefore, the ferrite percentage may be higher or lower than the corresponding value of the centerline.

6.3.4 The equivalent ratio value (CR) of the specific ferrite percentage (F) is

solved from the center line equation (3). The ferrite percentage F corresponding to the equivalent ratio CR can be solved by equation (4).