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Determination of Content of Nonmetallic Inclusions in Steel
– Billet Full Section Method

钢中非金属夹杂物含量的测定 钢坯全截面法

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Determination of Content of Nonmetallic Inclusions in Steel

– Billet Full Section Method

1 Scope

This Document specifies the principles, specimen preparation, test equipment, test methods and test reports for the content of non-metallic inclusions in billets.

This Document is applicable to the test of non-metallic inclusions (with dimensions no less than 30 μm) in billets that have not been rolled, deformed or otherwise treated. Non-metallic inclusions with a size less than 30 μm can also be used for reference when the equipment allows.

2 Normative References

The provisions in following documents become the provisions of this Document through normative reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 226 Test Method for Macrostructure and Defect of Steel by Etching

GB/T 4236 Steel - Examination by Sulphur Print

3 Terms and Definitions

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

3.1 Mirror surface sample

The billet full section specimen with the roughness $R\alpha$ in the parallel machining direction of less than 0.02 μm , and the roughness $R\alpha$ in the vertical machining direction of less than 0.05 μm .

NOTE 1: The width of the mirror specimen corresponds to the width of the billet, and the thickness of the mirror specimen corresponds to the thickness of the billet.

NOTE 2: The parallel processing direction corresponds to the sample width, and the vertical processing direction corresponds to the mirror surface sample thickness.

3.2 Suspected defect feature points

Defects such as bubbles and shrinkage holes on the surface of the mirror surface sample (3.1)

5 – reflected light;

6 – scattered light.

Figure 1 – Schematic Diagram of Collection Principle of Suspected Defect Feature Point

5 Sample Preparation

5.1 Sample-billet cutting

The cutting of the sample-billet is carried out according to the provisions of GB/T 226 and GB/T 4236. The continuous casting billet sample shall be clearly marked on the inner arc or outer arc side; and ensure that it is clearly visible during processing, measurement and preservation.

5.2 Sample processing

The sample-billet is processed into a mirror surface sample through several processes such as milling, grinding, ultra-fine grinding or polishing, etc.

5.3 Preservation of mirror surface sample

The mirror surface sample shall be stored in a dry and clean space; and the ambient humidity shall be less than 60% to prevent the test surface of the sample from becoming dark, polluted, and rusted, and not to affect the test results.

6 Test Equipment

6.1 Imaging system

The imaging system shall acquire and image the detection surface of the mirror surface sample at one time. The collected pictures shall be free of distortion and the resolution should be no greater than 30 μ m.

NOTE: The minimum size of non-metallic inclusions that can be resolved is determined by the resolution of the line scan camera.

6.2 Imaging analysis system

The imaging analysis system shall be able to perform statistical analysis on the suspected defect feature points in the collected picture, and it should have the following functions:

- a) Automatically complete the coordinate recording, quantity counting and size measurement of all suspected defect feature points in the collected picture;

- b) Give the distribution map of the suspected defect feature points on the inspection surface of the mirror surface sample;
- c) Establish a database of test results and a remote online analysis system.

6.3 Microscopic analysis system

The microscopic analysis system shall be equipped with a mobile metallographic microscope for microscopic detection and analysis of suspected defect feature points, and it should have the following functions:

- a) Perform two-dimensional movement and Z-direction macro movement focusing functions on the surface of mirror surface sample;
- b) Complete automatic positioning, focusing and photographing functions for multiple suspected defect feature points;
- c) Multi-magnification observation function, the maximum magnification is no less than 100X;
- d) Dark field, polarized light, differential interference and other functions.

7 Test Method

7.1 Establishing the coordinate system

7.1.1 Before testing, align the test surface of the mirror surface sample with the imaging system in the test equipment; adjust the test surface of the mirror surface sample to the horizontal; and establish a coordinate system on the mirror surface sample.

7.1.2 The coordinate system of rectangular billet and square billet takes the width direction of the mirror surface sample as the *X*-axis and the thickness direction as the *Y*-axis [see Figure 2a)].

7.1.3 The circular billet coordinate system takes the center of the mirror surface sample as the origin; and the two mutually perpendicular diameters as the coordinate axes, where the intersection between the *X*-axis and the edge of the circular billet can be the tangent point of the outer arc or the inner arc of the circular billet continuous casting [See Figure 2b)].

7.1.4 The coordinate identification on the sample shall be clear and complete, to ensure that after the mirror surface sample leaves the test equipment, the coordinate system can still be established based on the coordinate identification and the coordinates of the suspected defect feature points can be confirmed.

7.5 Establishing a database of non-metallic inclusions

Retain the analyzed pictures of non-metallic inclusions; establish a database of non-metallic inclusions; and output a summary table of non-metallic inclusions. The summary table shall include the serial numbers, coordinates and sizes of non-metallic inclusions.

7.6 Test example

See Appendix A for an example of testing the non-metallic inclusion content in the full section of the continuous casting slab for ship plate.

8 Test Report

The test report shall include but not be limited to the following contents:

- a) this Document number;
- b) product standard or contract number;
- c) sample-billet name, designation, specification, furnace number and batch number, etc.;
- d) sample size and test area;
- e) test equipment and test personnel;
- f) summary table of non-metallic inclusions;
- g) distribution map of non-metallic inclusions;
- h) Report number and date.

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