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

GB/T 223.6-2025

**Iron, steel and alloy - Determination of boron content -
Neutralization titrimetric method and spectrophotometric
method**

(English Translation)

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1 Scope

This document describes a method for determining the boron content in iron and steel and alloys, using neutralization titration and curcumin spectrophotometric method.

The methods in this document are applicable as follows. Method One, neutralization titration, is suitable for determining the boron content of 0.50%~2.00% in high-boron stainless steel. Method Two, methanol distillation-curcumin spectrophotometric method, is suitable for determining the boron content of 0.0005%~0.20% by mass in carbon steel, alloy steel, high-temperature alloys, and precision alloys. Method Three, curcumin direct spectrophotometric method, is suitable for determining the boron content of 0.0005%~0.012% in steel and 0.0001%~0.0005% in non-alloy steel.

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 6379.1, Accuracy (trueness and precision) of measurement methods and results -- Part 1.General principles and definitions (GB/T 6379.1-2004, ISO 5725-

1.1994, IDT)

GB/T 6379.2, Measurement methods and results -- Accuracy (trueness and precision)

-- Part 2.Determine the standard methods of measurement repeatability and reproducibility

of the basic method (GB/T 6379.2-2004, ISO 5725-2.1994, IDT)

GB/T 6682, Water for analytical laboratory use -- Specification and test methods (GB/T 6682-2008, ISO 3696.1987, MOD)

GB/T 7729, Chemical analysis of metallurgical products -- General rule for spectrophotometric methods

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)

ISO 385-1, Laboratory glassware -- Burette -- Part 1.General requirements

ISO 648, Laboratory glassware -- One-mark pipettes

ISO 1042, Laboratory glassware -- One-mark volumetric flasks

ISO 3696, Water for analytical laboratory use -- Specification and test methods

ISO 5725-1, Accuracy (trueness and precision) of measurement methods and results -- Part 1.General principles and definitions

ISO 5725-2, Accuracy (trueness and precision) of measurement methods and results -- Part 2.Basic method for the determination of repeatability and reproducibility of a standard measurement method

ISO 5725-3, Accuracy (trueness and precision) of measurement methods and results -- Part 3.Intermediate measures of the precision of a standard measurement method

ISO 14284, Steel and iron -- Sampling and preparation of samples for the determination of chemical composition

3 Terms and definitions

This document does not contain any terms or definitions that need to be defined.

4.1 Principle

Dissolve the specimen in hydrochloric acid. Hydroxide is oxidized by peroxide. Iron, chromium, nickel, and other elements are separated by a strong base. Use p-nitrophenol as an indicator to adjust the solution to acidity. Boil the solution to remove carbon dioxide. The pH of the solution is readjusted to 7. In the presence of mannitol, use phenolphthalein as an indicator to titrate with a standard sodium hydroxide solution.

When the tungsten content in 1 g of specimen is greater than 15 mg or the molybdenum content is greater than 15 mg, it shall interfere with the determination.

4.2 Reagents

Unless otherwise specified, only reagents confirmed to be analytically pure and Grade

II water as specified in GB/T 6682 shall be used in the analysis.

0.01081 - The mass of boron, equivalent to 1.00 mL of sodium hydroxide standard titration solution [$c(\text{NaOH}) = 1.000 \text{ mol/L}$], in grams (g).

4.6 Precision

The precision of this method was tested in 1993 by eight laboratories determining the boron content at four levels. Each laboratory repeated the test three times for each boron content level. The repeatability limit r and reproducibility limit R were calculated based on the test results. The precision is shown in Table 1. The raw data are shown in Table

C.1 of Annex C.

The repeatability limit (r) and reproducibility limit (R) are obtained according to the equations given in Table 1.

Under repeatability conditions, the absolute difference between two independent test results shall not exceed the repeatability limit (r), and the cases that exceed the repeatability limit (r) shall not exceed 5%.

Under reproducibility conditions, the absolute difference between two independent test results shall not exceed the reproducibility limit (R), and the cases that exceed the reproducibility limit (R) shall not exceed 5%.

5 Method Two -- Methanol distillation-curcumin

spectrophotometric method

5.1 Principle

After the test material is dissolved in acid, boron compounds are decomposed using phosphoric acid and sulfuric acid. Boron reacts with methanol to form methyl borate, which is then separated from other elements by distillation. In the presence of oxalic acid, boron forms a red complex with curcumin. Measure the absorbance at a wavelength of 545 nm.

5.2 Reagents

Unless otherwise specified, only reagents confirmed to be guaranteed reagents and

Grade II water as specified in GB/T 6682 shall be used in the analysis.

5.2.1

Methanol. analytically pure.

5.2.2

Acetone. analytically pure.

5.2.3

Hydrogen peroxide. rho is approximately 1.10 g/mL.

5.2.4

Sulfuric acid. rho is approximately 1.84 g/mL.

5.2.5

Sulfuric acid, 1+6. Mix 1 portion of sulfuric acid (5.2.4) with 6 portions of water.

5.2.6

Phosphoric acid. rho is approximately 1.69 g/mL, MOS grade.

5.2.7

Nitric acid. rho is approximately 1.42 g/mL.

5.2.8

Hydrochloric acid. rho is approximately 1.19 g/mL.

5.2.9

Hydrochloric acid, 1+4.

Mix 1 portion of hydrochloric acid (5.2.8) and 4 portions of water.

5.2.10

Sulfur-phosphoric acid mixture, 3+5+2.

Mix 3 portions of sulfuric acid (5.2.4), 5 portions of phosphoric acid (5.2.6), and 2 portions of water.

5.2.11

Calcium hydroxide suspension.

Weigh 3.7 g of calcium hydroxide and add water to a volume of 500 mL. Store in a plastic bottle. Mix well before use.

5.2.12

Oxalic acid solution, 100 g/L.