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GB/T 4000-2008

Replacing GB/T 4000-1996

Coke - Determination of reactivity and strength after reaction

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Table of Contents

Foreword.....	3
1 Scope	4
2 Normative references	4
3 Principles.....	4
4 Test instruments, apparatuses and materials	4
5 Sampling and sample preparation.....	12
6 Test procedures.....	12
7 Calculation of results	15
8 Degree of precision	15
Annex A	16
Annex B	18

Foreword

This Standard replaces GB/T 4000-1996 “Coke - Determination of Reactivity and Strength after Reaction”.

Compared with GB/T 4000-1996, the main changes of this Standard are as follows:

- Preparation method of coke sample is revised as preparation method that jaw crushing combines with hand finishing;
- Narrow the particle size control range of coke sample;
- Test apparatuses are improved to facilitate the maintenance.

Annex A and Annex B of this Standard are normative.

This Standard was proposed by China Iron and Steel Industry Association.

This Standard shall be under the jurisdiction of National Steel Standardization Technical Committee.

Drafting organizations of this Standard: Wuhan Iron and Steel (Group) Corp., China Metallurgical Information and Standardization Institute AND Shangyu HongXing Machinery Instrument Manufacturing Co., Ltd.

Main drafters of this Standard: Sun Wei, Xi Wanze, Zhu Mingsan and Zhang Jinying.

The historical versions replaced by this Standard are as follows:

- GB 4000-1983, GB/T 4000-1996.

Coke - Determination of Reactivity and Strength after Reaction

1 Scope

This Standard specifies the principles of coke determination of reactivity and strength after reaction, test instruments, apparatuses and materials, sampling and sample preparation, test procedures, calculation of results and degree of precision.

This Standard applies to the determination of reactivity of coke for blast furnace iron making and strength after reaction; coke for other purposes may refer to this Standard for implementation.

2 Normative references

The articles contained in the following documents have become part of this document when they are quoted herein. For the dated documents so quoted, all subsequent modifications (including all corrections) or revisions made thereafter do not apply to this Standard. However, the parties who reach an agreement according to this Standard are encouraged to study whether the latest versions of these documents may be used. For the undated documents so quoted, the latest versions (including all modification sheets) apply to this document.

GB/T 1997 Coke - Sampling and preparation of samples

GB/T 2006 Coke for metallurgy - Determination of mechanical strength

3 Principles

Weigh a certain mass of coke sample and place into a reactor; use the percentage of coke mass loss to express the coke reactivity (CRI), after 2 h of reaction with carbon dioxide at $1100^{\circ}\text{C}\pm 5^{\circ}\text{C}$.

After reaction, and after the revolving drum test of type I, use the mass fraction OF coke, that is greater than 10 mm size, OVER the coke after reaction TO express the coke strength after reaction (CSR).

4 Test instruments, apparatuses and materials

4.1 Electric furnace

Electric furnace heating wire, silicon carbide and other heating elements that can meet

may be adopted.

4.6 Φ precision temperature control device

Temperature control range is 0 °C~1 600 °C, precision grade is 0.5.

4.7 Round-hole screen

One for Φ 10 mm, effective diameter of screen frame is 200 mm.

One for Φ 23 mm, effective diameter of screen frame is 300 mm.

One for Φ 25 mm and one for Φ 3 mm, screen surface is 400 mm×500 mm, made according to the provisions on round-hole screen in GB/T 2006.

4.8 Drying oven

Workshop capacity is not less than 0.07 m³.

Maximum operating temperature: 300 °C.

4.9 Balance

Maximum capacity is 500 g, sensitivity is 0.5 g.

4.10 Rhodium-platinum thermocouple

Diameter is 0.5 mm, length is 650 mm.

High-alumina thermocouple protection pipe A (Φ 7 mmX5 mmX400 mm)

High-alumina dual-hole insulation pipe D (Φ 4 mmX1 mmX400 mm)

High-alumina single-hole insulation pipe C (Φ 1 mmX0.6 mmX10 mm)

4.11 Board

It is of high temperature resistance alloy steel (GH23 or GH44), thickness of 2 mm~5 mm and diameter of 79 mm. Drill holes evenly with a uniform diameter of 3 mm and hole interval is 5 mm.

4.12 High-alumina ball

Diameter is 20 mm.

4.13 Bracket

Bracket is shown in Figure 8, made of material Q235A. Material of three branch pipes is of 1Gr18Ni9Ti.

top of furnace; place into electric furnace; place asbestos board between bracket and electric furnace lid for thermal insulation. Fill the surrounding of reactor flange with thermal insulation material to reduce heat dissipation.

6.2.2 When using corundum reactor, load about one half of $200 \text{ g} \pm 0.5 \text{ g}$ of prepared coke samples; then insert into thermocouple sleeve; load another half of coke; make thermocouple sleeve to pass the center hole in reactor lid; apply reactor lid. The surrounding is filled with insulation materials to reduce heat dissipation.

6.3 Insert temperature thermocouple into reactor thermocouple sleeve (protected by thermocouple high-alumina dual-hole insulation pipe and high-alumina thermocouple protection pipe).

6.4 Respectively connect reactor intake pipe and vent pipe with gas supply system and vent pipe. Check gas circuit to ensure tightness.

6.5 Switch on and adjust electric furnace for heating through precision temperature control device. Rate of temperature increase is $8 \text{ }^{\circ}\text{C}/\text{min} \sim 16 \text{ }^{\circ}\text{C}/\text{min}$. When temperature at the center of bed of material is up to $400 \text{ }^{\circ}\text{C}$, feed nitrogen at a flow rate of $0.8 \text{ L}/\text{min}$ to protect coke and prevent burning.

6.6 When temperature at the center of bed of material reaches $1050 \text{ }^{\circ}\text{C}$, switch on power plug of carbon dioxide pressure reducing valve with preheating device; preheat the exit of carbon dioxide gas cylinder to ensure stable outflow of carbon dioxide. When temperature at the center of bend of material reaches 1100°C , stabilize for 10 min; cut off nitrogen and replace with carbon dioxide at a flow of $5 \text{ L}/\text{min}$; record reaction start time. Temperature of bend of material shall recover to $1100 \text{ }^{\circ}\text{C} \pm 5^{\circ}\text{C}$ within 5 min ~ 10 min after carbon dioxide feeding starts.

6.7 Stop heating after reaction for 2 h. Cut off gas line of carbon dioxide and replace with nitrogen; the flow is controlled at $2 \text{ L}/\text{min}$.

6.8 Sample cooling

6.8.1 When using high temperature resistance alloy steel reactor, unplug vent pipe and lift reactor out of electric furnace; place on bracket and continue nitrogen feeding for cooling.

6.8.2 When using corundum reactor, reactor is still placed in furnace; naturally cool to room temperature.

6.9 Stop nitrogen feeding when coke in reactor cools to $100 \text{ }^{\circ}\text{C}$ below. Open upper lid of reactor and pour out the coke to weigh and record.

6.10 Place all coke after reaction into drum of type I; achieve total revolving of 30 min at a revolving speed of $20 \text{ r}/\text{min}$. Total number of revolutions is 600 r. Take out and apply $\Phi 10 \text{ mm}$ round-hole screen; weigh oversize products and record.

6.11 Original data of test are recorded based on the format of – Record form of coke determination of reactivity and strength after reaction, as shown in Annex B.

7 Calculation of results

7.1 Coke reactivity

Coke reactivity index is expressed by the percentage of lost coke mass over total sample mass before reaction. Coke reactivity (CRI) is calculated according to Formula (1), expressed by %:

$$\text{CRI}(\%) = (m - m_1) / m \times 100 \quad \dots\dots\dots(1)$$

Where,

m — Mass of coke sample, in grams (g);

m_1 — Residual coke mass after reaction, in grams (g).

7.2 Strength after reaction

Strength index after reaction is expressed by the mass percentage of coke with a size-level greater than 10 mm after drum revolving OVER the residual coke after reaction. Strength after reaction (CSR) is calculated according to Formula (2), expressed by %.

$$\text{CSR}(\%) = m_2 / m_1 \times 100 \quad \dots\dots\dots(2)$$

Where,

m_2 — Mass of coke with a size-level greater than 10 mm after drum revolving, in grams (g);

m_1 — Mass of residual coke after reaction, in grams (g).

7.3 Take the arithmetic mean of parallel results as the test result of coke reactivity and strength after reaction.

8 Degree of precision

Repeatability r of coke reactivity (CRI) and strength after reaction (CSR) must not exceed following values:

CRI: $r \leq 2.4\%$,

CSR: $r \leq 3.2\%$.

- | | |
|---|--|
| 1 — Carbon dioxide steel cylinder | 9 — Reactor; |
| 2, 4 — Flowmeter; | 10 — Electric furnace; |
| 3 — Nitrogen steel cylinder; | 11 — Sample; |
| 5 — Tee piston; | 12 — Buffer bottle; |
| 6 — Precision temperature control device; | 13 — Concentrated sulfuric acid gas-washing bottle |
| 7 — Thermocouple; | 14, 16 — Drying tower; |
| 8 — Bracket | 15 — Coking gallic acid gas-washing cylinder. |

Figure A.1 Flow diagram of test with carbon dioxide and nitrogen purification device

Annex B

(Normative)

Record form of coke determination of reactivity and strength after reaction

Sample name				Remarks:
Test date		Test start time		
Start time of carbon dioxide feeding		Test end time		
Mass of coke after reaction/g		Reactivity/%		
Mass of coke after drum revolving/g		Strength after reaction/%		
Number of coke particles		Operator		
Average value of reactivity/%				Remarks:
Average value of strength after reactivity/%				

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