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**Determination of coke reactivity index (CRI)
and coke strength after reaction (CSR)**

焦炭反应性及反应后强度试验方法

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Determination of coke reactivity index (CRI) and coke strength after reaction (CSR)

1 Scope

This standard specifies the principles of test method, test instruments, equipment and materials, collection and preparation of specimen, test procedures, calculation of results, precision for determination of coke reactivity and coke strength after reaction.

This standard is applicable to the determination of the reactivity and strength after reaction of coke which is used in blast furnace ironmaking. The coke for other purposes may refer to this standard

2 Normative references

The following documents are essential to the application of 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) are applicable to this standard.

GB/T 1997 Coke-sampling and preparation of specimens

YB/T 4494 Technical specifications for mechanical specimen preparation of coke reactivity and coke strength after reaction

3 Principles

Weigh a certain amount of coke specimen. Place it in a reactor. After reacting with carbon dioxide at 1100 °C for 2 h, use the percentage of the mass loss of coke to represent the coke reactivity index (abbreviated as CRI).

After the post-reaction is subjected to the type-I drum test, use the percentage of the mass of the coke which has a grain size greater than 10 mm to the mass of the coke after reaction to represent the coke strength after reaction (abbreviated as CSR).

4 Test instrument, equipment and materials

4.1 Electric furnace

4.6.2 Nitrogen's mass-flow controller: the range is 5 L/min, the accuracy is not less than $\pm 1.5\%$ F.S.

4.6.3 The air inlet of the equipment is equipped with the nitrogen pressure-reducing valve.

Note: When the gas purity cannot meet the requirements, it may use the instruments in Appendix B for purification and drying. The volume and flow rate of the gas used in this standard are the volume and flow rate in the standard state (0 °C and one barometric pressure).

4.7 Circular-hole sieve

$\phi 10$ mm, the effective diameter of the sieve frame is 200 mm.

$\phi 23$ mm, the effective diameter of the sieve frame is 300 mm.

$\phi 23$ mm and $\phi 25$ mm, sieve surface 400 mm x 500 mm, see GB/T 2006 for the production of circular-hole sieve.

4.8 Drying box

A blast drying box which has a working chamber's volume of not less than 0.07 m³.

4.9 Balance

The maximum weighing is not more than 1000 g, the sensitivity is 0.1 g.

4.10 Rhodium-platinum thermocouple

Type-S, not lower than industrial grade II, installed in a heat-resistant protective tube, to measure and control the temperature of the specimen required for the test conditions.

4.11 Standard specimen

A standard specimen of coke reactivity index and coke strength after reaction, which is used to regularly test the stability of the equipment.

4.12 Three-stage heating-furnace method - Testing system of coke reactivity index

The schematic diagram is as shown in Figure 5.

coke which has large bubble and is in honeycomb status as well as the burner coke which has blackhead and not completely gray.

5.2 Make the coke into approximately spherical particles of 23 mm ~ 25 mm. The mechanical specimen preparation is carried out in accordance with the requirements of YB/T 4494.

5.3 The specimen for the coke of the test coke oven may be directly prepared by the coke which has a grain size greater than 40 mm.

5.4 Use a reducer to reduce the prepared specimen to 900 g, dry it at the temperature of 170 °C ~ 180 °C for 2 h, place it in a drier to cool it to room temperature, then use a sieve of $\phi 23$ mm and $\phi 25$ mm to remove the coke powder which is adhered to the coke block. Use the quarter method to divide the specimen into four sets, each set is not less than 220 g, contain them into a sealed vessel to prepare for use. The coke's moisture can be determined by referring to Appendix C. If the coke's moisture is less than 1%, it may not be dried.

6 Test steps

6.1 Number of tests

Perform at least two tests. Record the quantity of coke particles per test, ensure that the difference between the quantity of coke particles used in the repeatability test and the reproducibility test is not more than one. If it cannot guarantee meeting the requirements for the quantity of coke particles, indicate it in the report and state the causes.

6.2 Preparation of specimen

Weigh (200 ± 2) g of specimen, accurate to 0.1 g, record the mass as m . The final mass correction may be carried out by replacing a piece of lighter or heavier coke.

6.3 Loading of specimen into reactor

Load the coke specimen in the reactor and flatten it, to ensure that the coke layer in the reactor is in the middle of the constant-temperature zone of the electric furnace. Insert the thermocouple into the casing and place it at the center of the material layer. Fix the reactor. Connect the gas inlet of reactor to the gas supply system, to check the gas path to ensure the air-tightness of the system.

6.4 Temperature-rise

The electric furnace is heated up, at a heating rate of 8 °C/min ~ 16 °C/min.

m - The pre-reaction mass of coke, in grams (g);

m₁ - The post-reaction mass of coke, in grams (g).

7.2 Coke strength after reaction

The coke strength after reaction (CSR) is calculated according to formula (2), the value is expressed in %:

$$CSR = \frac{m_2}{m_1} \times 100 \quad \dots\dots\dots (2)$$

Where:

m₂ - The mass of the coke whose grain size is greater than 10 mm after drumming, the unit is gram (g).

The test results of coke reactivity index and coke strength after reaction take the arithmetic mean of the parallel tests, retaining one decimal place.

8 Precision

The repeatability and reproducibility of coke reactivity index (CRI) and coke strength after reaction (CSR) shall not exceed the values as specified in Table 1:

Repeatability is, using this method under the normal and correct operating conditions, the maximum difference of the two independent test results at the 95% probability level of the two independent tests as made for the same specimens (see 6.2) by the same operator using the same instrument in the same lab in a short time period.

Reproducibility is, using this method under the normal and correct operating conditions, the maximum difference of the two independent test results at the 95% probability level of the two independent tests as made for the same specimens (see 6.2) by two operators in the same lab.

Table 1

Precision requirements	Repeatability / %	Reproducibility / %
Coke reactivity index (CRI)	≤ 2.4	≤ 4.0
Coke strength after reaction (CSR)	≤ 3.2	≤ 5.0

7 - Air inlet;

8 - Thermocouple.

Figure A.1 -- Schematic diagram of single-point temperature-measuring heating-furnace structure

A.3 Temperature-control device

Control accuracy: $(1100 \pm 3) ^\circ\text{C}$.

Accuracy grade: not less than 0.2% FS.

A.4 Thermocouple

Type-S type or other conditional thermocouple, not lower than industrial grade-II, the thermocouple's measuring end is located at the center of the coke layer.

Note: The height of the coke layer changes with the density of the coke. During the test, adjust the position of the thermocouple's measuring end according to the height of the coke in the reactor.

A.5 Reactor (see Figure A.2)

Reactor's material: GH3044.

Reactor's wall-thickness: $\geq 1.5 \text{ mm}$.

Reactor's inner diameter: $\phi 80 \text{ mm} \pm 1 \text{ mm}$.

Reactor's length: 500 mm.

A.6 Testing system of coke reactivity index of single-point temperature-measuring heating-furnace

The schematic diagram of the process flow of the testing system of coke reactivity index of the single-point temperature-measuring heating-furnace is as shown in Figure A.3.

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