CRI-CSR Test system

This CRI-CSR Test system is used for determining the important performance of coke used for iron-smelting in blast furnace under the high-temperature----coke reactivity and post-reaction strength measuring apparatus. The whole set of instrument consists of special high-temperature reaction electric stove, computer control system, N2, CO2 gas supply case, Ⅰrotary drum automatic lift device ,etc. Computer control system controls the high-temperature reaction electric stove to rise temperature according to fixed rate and control temperature according to designated temperature, many kinds of pictures of change can be intercepted on the screen of the computer in the course of reacting of coke, and confirm the whole course of reaction of coke, meanwhile store the data of numerous experiment, also equipped with automatic lifting, waste gas automatic burning and discharging equipment, which achieves the automation of the experiment course. The whole set of instrument accords with the technical requirement for GB/T4000-1996, being the essential apparatus for testing coke quality and studying coke performance in the coking plant, steel plant, foreign trade department, R&D institution.

1、Measuring principle

A 200±0.5g sample of prepared and dried coke (25mm ≥ particle size ≥ 23mm) is placed in a specially designed reactor and heated up to 1100℃. The coke reacts with carbon dioxide for 2 hours at 1100±5℃. The weight loss percentage of the coke is known as the reactivity (CRI).

The reacted coke is placed in an I-type drum. The percent of material removed

from the drum that is +10mm is known as the coke strength after reaction (CSR).

2、Main technical performance

2.1 Fully comply with GB/T4000-2008 Coke-Determination of Reactivity and Strength after Reaction.

2.2 Heating wire, constant temperature area that is +150mm

2.3 Reactor material uses high temperature alloy steel GH23 or GH44.

2.4 The whole test process is highly automated and controllable.

2.5 Use special automatic electromagnetic cut-off valve for gas control and high accuracy flow meter for flow control. The computer may automatically switch between nitrogen and carbon dioxide.

2.6 With integrated electric and gas circuit, the controller is easy to use, reliable and maintenance-free. Experimental data and temperature curves may be saved and displayed.

2.7 Alarm on over-temperature caused by SCR breakdown, thermocouple damage and signal interference, etc. Automatic power-off in the case of over-temperature to prevent burnout of furnace, thermocouple and reactor and protect and extend their service life.

3、Main Function Requirements of Control Software System

3.1 Full software operation control and full hardware isolation control;

3.2 Automatic drawing interface of two-color real-time curves and direct curve display of temperature control quality and variable heating process;

3.3 Real-time curves and pictures may be screenshot and saved in BMP format and saved in the form of graphic data, and historical curve graphics may be called at any time for comparative analysis;

3.4 Equipped with administrator password and operator password logging-in mechanism to prevent unauthorized persons operating system or modifying data;

3.5 Support all related data reports that are available on request at any time

for query;

3.6 All data are saved in the computer hard disk as exclusive data groups, and they may be permanently saved as long as the capacity is sufficient;

3.7 Equipped with PID adjustment interval for large temperature lag to enable excellent temperature control accuracy indicators;

3.8 PID parameters may be modified online and saved automatically and permanently;

3.9 Intelligent judgment ability of faults or operational errors, and protection function to guarantee the life of important hardware;

3.10 Unique sustainable protection, once you enter the process curve flow, the experiment will be automatically completed even if the computer and controller are out of any contact;

3.11 Full hardware manual control, independent manual operation based on the habits of operators;

3.12 Hardware and software dual automatic and manual conversion, flexible application according to needs;

3.13 The controller is equipped with automatic air cooling system, intelligent temperature judgment, low noise;

3.14 Non-periodical free software update

4、Equipment Installation

First prepare a coke sample (25mm ≥ particle size ≥ 23mm) according to the requirements of GB4000 and then place it in an oven to dry for 2 hours at 170~180℃ and cool it to room temperature. Screen coke breeze and unqualified specimens with a 23mm round-hole screen of ф300mm mesh size and weigh a 200±0.05g sample.

4.1 Connect the power supply to the reaction furnace.

4.2 Put the chemicals prepared into the gas washing bottle and the drying tower according to the standard GB4000.

4.3 Connect the gas cylinders (N_2 and CO_2) to the flow meter, surge flask, gas washing bottle and drying tower with hoses according to the experimental

flow chart, place them in the gas cabinet and strictly check their air tightness and smoothness.

4.4 Connect the precision temperature controller and check the circuit connection.

5、Preparation before Test

5.1 Use the sampling method stipulated in GB/T1997 to take 20kg coke of not less than 25mm on pro rata basis and discard porous coke and coke of oven end. Use a jaw crusher to crush, blend and divide 10kg coke, screen it with round-hole screens of φ25mm and φ23mm and crush and screen coke lumps of greater than φ25mm again. Take screenings of φ23mm, remove thinner coke flakes and strips, retain thicker coke flakes and strips, trim the thicker ones into granular coke lumps manually, screen them with a round-hole screen of φ23mm and blend them with the untrimmed granular coke lumps. Divide to obtain 2kg coke lumps, place them in an I-type drum in two times (1kg per time), subject them to 50 revolutions at 20r/min, and then take them out to screen with a round-hole screen of φ23mm. Divide 900g from the screenings as a sample and quarter it with each part not less than 220g.

Note: coke of 40mm~60mm size range from the test coke oven may be used for sample preparation.

5.2 Place the sample in a drying oven to dry for 2 hours at 170~180℃, take it out, cool it to room temperature, screen it with a round-hole screen of φ23mm and weigh 200±0.05g.

6、Test method

6.1 Open the reactor top cover, spread a layer of high aluminum ball of φ20mm with height of 100mm on the reactor's bottom firstly, place a screen plate flatly on it. Then pack the prepared coke sample of 200±0.5g, put the top cover. Make the electronic couple covering tube on the top cover lie in the center of material layer, otherwise adjust the height of the high aluminum ball. Then fix the top cover and reaction barrel with screws. Put the reactor into electric stove, and place it on the bracket on the top of stove, place the asbestos board between the bracket and cover of electric stove for insulating against heat. Put the roof brick made from high aluminum light brick around the

flange of the reactor in order to reduce heat loss.

6.2 Connect the intake pipe of the reactor with gas course cabinet well, the exhaust pipe should be stretched outdoors, then inserted into the electronic couple.

6.3 Put through power supply of precise temperature controller, firstly to use inserting regulator temperature rising current, the current should rise to maximum within 15min, and raise temperature automatically. The speed of temperature rising is generally within 8～16℃/min. When the temperature in the coke layer reaching 400℃, and feed nitrogen with the flow of 0.81/min to protect the coke and prevent it from burning.

6.4 When the temperature in the material layer reaching 1050℃, preheat the mouth of CO2 gas cylinder. When the temperature reaching 1100℃, cut off the nitrogen, feed the carbon dioxide with the flow of 51/min, start the reaction, the reaction time is 2h. After feeding carbon dioxide, the temperature in the material layer should resume to 1100±5℃ within 5～10 min, and has been keeping at 1100±5℃ in the course of reacting.

6.5 After 2h of reaction, reaction stops, stop heating. Cut off the gas course of carbon dioxide, replace it with nitrogen, cool the coke, control the flow within 21/min. Take the reactor from the reacting stove, and place it on the bracket to cool it. When the coke is cooled below 100℃, stop feeding the nitrogen, open the upper cover of the reactor, pour the coke, weigh it and make a record, accurate to "g", calculate G1.

6.6 Put the coke after reaction into the Ⅰ rotary drum, rotate it with the speed of 20r/min, then fetch the coke, sift it with the hole screen of 10mm, and weigh the coke on the screen G2.

7、The results calculation

Coke reactivity CRI is calculated according to formula (1).

Post-reaction strength CSR is calculated according to formula (2).

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

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

In the formula: m—weight of coke sample, g;

m_1—weight of residual coke, g;

m_2—after rotation of Ⅰ rotary drum, weight of coke with the grit size of more than 10mm , g;

8、Experimental error

The error of coke reactivity Gr and post-reaction strength Sar in the same laboratory can't exceed the following data after the reaction.

CRI:r≤2.4%

CSR:r≤3.2%

9、Attentive matters

9.1 The working current of reaction stove is comparatively large, the maximum working current is around 30A. So when connecting the power supply of reaction stove, pay attention to connect it firmly, in order to avoid bad contact, and influencing the experimental effects.

9.2. Connect the gas tube among the parts of gas course cabinet well. And tighten them with the iron wire, after connecting, check whether the gas course is smooth and whether it leaks gas, ensure the air tightness and smoothness of the gas course.

9.3 Because of a very high temperature of reaction stove, so when fetching the reactor, wear the protective equipment well, pay attention to the safety to prevent accidents such as scalding.

9.4 The separate grounding wire must be equipped with this instrument in order to avoid disturbance from the high temperature to influence the normal working.

10、Temperature Control System Description

10.1 Software Operating Instructions

Software characteristics are as follows. See the software manual for specific operations.

10.1.1 Full software operation control and full hardware isolation control;

10.1.2 Automatic drawing interface of two-color real-time curves and direct curve display of temperature control quality and variable heating process;

10.1.3 Real-time curves and pictures may be screenshot and saved in BMP format and saved in the form of graphic data, and historical curve graphics may be called at any time for comparative analysis;

10.1.4 Support all related data reports that are available on request at any time for query;

10.1.5 All data are saved in the computer hard disk as exclusive data groups, and they may be permanently saved as long as the capacity is sufficient;

10.1.6 Equipped with PID adjustment interval for large temperature lag to enable excellent temperature control accuracy indicators;

10.1.7 PID parameters may be modified online and saved automatically and permanently;

10.1.8 Unique sustainable protection, once you enter the process curve flow, the experiment will be automatically completed even if the computer and controller are out of any contact

10.2 Adjustment and Use

The placement of thermocouples is different for different furnaces, but there are several principles for choosing the placement of thermocouples that are to be observed.

First, it should reflect the true temperature of furnaces as far as possible.

Second, it should make thermocouples reflect the change of furnace temperature as soon as possible.

Under correct connection, turn on the power. The power switch indicator lights up. Switch on and open the computer control system. After confirmation, you may start testing. After 5 minutes from power-on, preheat with a small current to prevent damage to the components, and then use control algorithm for automatic temperature control.

11、Main Technical Parameters

11.1 Technical indexes of temperature controller

Temperature control process: room temperature~1100℃, heating-up time according to requirements of GB; maintain constant temperature of 1100℃ for 2h;

Temperature control accuracy: constant temperature of 1100℃, accuracy: ±2℃

11.2 Technical indexes of flow controller

Fully independent switch (manual and automatic) between CO_2 and N_2, switching rate of 0.1s; controlled by computer in automatic mode; manual operation in manual mode;

Flow range: 5.0L/min (CO_2); 0.8~2.0L/min (N_2);

Accuracy: ±1.0%FS

11.3 Main technical indexes of high temperature reaction furnace

Movable, stainless steel enclosure, special high temperature reaction furnace (split type);

High-aluminum casing: 140mm (internal diameter), 160mm (external diameter), 640mm (height);

Working temperature: 1250℃ (MAX);

Electric power: 10kw (MAX);

Constant temperature maintenance power: 3-5kw;

OCr27A17Mo2 furnace wire

11.4 Technical indexes of coke strength after reaction tester

The I-type drum consists of drum body, motor, reducer and rack. It is of integrated structure. The controller may predict and control revolution and is capable of automatic memory and screen real-time digital display.

The drum rotation speed is 20±1r/min, the body is made of seamless steel tubes of Φ140×700mm (length), and it is equipped with a special motor.

11.5 Characteristics of furnace accessories

Reactor: 80mm (internal diameter), 500mm (height)

Thermocouple: Φ8mm (external diameter), core: Φ0.5mm×650mm

11.6 Characteristics of gas line

Withstand pressure: 1.5MPa

Equipped with CO_2 dedicated electric heating gas pressure reducer

11.7 Communication characteristics

Communication line: twisted-pair shielded cable of 2x0.52mm

The analysis results may be uploaded directly to a superior network system, in line with TCP/IP protocol

11.8 Gas cabinet

Built-in gas cylinder holder that may hold surge flask of 6000ml, gas washing bottle of 500ml and drying tower of 500ml

12. Installation, Commissioning and Acceptance

12.1 Party B shall be responsible for installation and commissioning at the place designated by Party A within 5 working days.

12.2 Party B shall provide the instruction manual.

12.3 Inspection and acceptance shall be subjected to the GB/T4000-2008 standard and the technical agreement. Matters not covered herein shall be subjected to acceptance in accordance with the standard configuration. Test data errors and accuracy shall be within the range specified in the standard.

12.4 Party B shall be equipped with professional maintenance personnel to respond and give guidance over the phone within two hours after Party A issues a maintenance requirement; and if the said guidance fails, designate professionals to the scene to solve the problems. Party B shall train operators for Party A free of charge in respect of instrument application, daily operation and maintenance, etc. until they learn.

12.5 After-sales service: the warranty period of the equipment is one year starting from the date of formal acceptance, in which period Party B shall

provide “three guarantees” service.