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ANALYSIS AND STUDY TEST MATERIALS COKE IN A HIGH TEMPERATURE FURNACE

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The test material of a high temperature furnace is coke. in order to study the influence of temperature on the reactivity of coke, the reactivity index and weight loss rate of coke were measured under different reaction temperature conditions, and the dynamic observation of coke reaction process was made under the microscope. The reaction mechanism of coke was analyzed, and the influence of temperature on metallurgical properties was evaluated.

Key words: coke temperature, reactivity index, weight loss ratio, metallurgical properties

INTRODUCTION

As the world within the scope of more perfect of oxygen-enriched coal injection technology and the continuous improvement of coal injection quantity, coke as the source of the blast furnace production of thermal energy, chemical energy and carburizing have been partly replaced by coal injection, blast furnace ironmaking process of tons of iron coke consumption fell sharply at the same time[1], the skeleton inside the blast furnace as the high charge column effect has become more prominent. The change of coke strengthx after the reaction with CO_2 is one of the most important factors affecting the air permeability of the lower part of the blast furnace. The equipment capacity, domestic research on coke degradation temperature equipment capacity, domestic research on coke degradation temperature usually control under 1 200 °C, and there are many differences between blast furnace internal environment, and there are many differences and there are many differences between blast furnace internal environment, this article through the coke in closer to the blast furnace under the condition of the internal working temperature degradation speculated that the degradation of coke in the blast furnace process is of great importance to industrial production.

TEST METHOD AND CONTENT

The test samples are all from the blast furnace sampling site, the sampling location is the coke belt of the blast furnace. Thermogravimetric method was used to determine the deterioration trend of coke samples during the continuous heating process, and the temperature interval was controlled between 800 °C and 1 400 °C. According to the national standard GB/t4 000-1 996 coke reactivity and post-reaction strength test method", the reactivity test temperature of the blast furnace was set at 1 100 °C. In order to test the reaction characteristics of coke under different temperature conditions, the test temperature was controlled between 800 °C and 1 400 °C, so as to judge the influence on the reaction performance.

Coke reactivity index test

Coke reactivity test is carried out according to the method of national standard coke reactivity test. The coke sample was made into particles with a particle size of 23 ± 1 mm, put into a drying box, dried at 170~180 °C for 2 hours, and cooled to room temperature. Then, 200 g was weighed and loaded into the reaction tube. In order to evenly distribute the CO_2 flow in the reaction tube, a high aluminum ball was installed at the bottom of the reaction tube. When the temperature rises to 400 °C, the protective gas nitrogen will be removed. When the temperature rises to the set temperature of the test, the protective gas nitrogen will be cut off and the CO_2 gas will be injected. The flow rate will be set at 5 L/min. All the coke after the reaction was loaded into the type I rotary drum, which was rotated at a speed of 20 r/min for a total of 30 min, with a total revolution of 600 r. Then take out coke screening, weighing, recording the weight of each screen.

Coke reactivity is expressed as a percentage of the coke mass lost as compared to the total coke mass before the reaction. Coke reaction performance is calculated as follows:

Coke reactivity index is

$$\frac{(m_0 - m_1)}{m_0} \times 100\ \%$$

Where, m_0 is the quality of coke sample before reaction; m_1 is the mass of coke sample after reaction. The test temperatures were set at 900 °C, 1 000 °C, 1 100 °C, 1 200

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°C, 1 300 °C, and 1 400 °C, respectively, to observe the differences in coke reaction properties under different temperature conditions.

Determination of coke weight loss rate by thermogravimetric method

Thermogravimetric method is a technique to obtain the relationship between the mass and temperature of a substance by means of thermogravimetric balance. The method is adopted to improve the reaction performance of coke under the condition of set temperature experiment, weigh and dry samples after 10 and 0.5 g, make the thermocouple is located in the center of sample height, the small basket of coke samples in electrical heating furnace temperature area, to specify the heating speed to temperature. When the core temperature of the material layer reaches 400 °C, the coke is prevented from being oxidized and nitrogen protection is introduced. When the temperature is increased to the specified reaction temperature, the protective gas is cut off and the flow rate is 1L/min. After the constant temperature reaction for 1h, the test is completed. The test temperatures are set at 800 °C, 900 °C, 1 000 °C, 1 100 °C, 1 200 °C, 1 300 °C and 1 400 °C, respectively.

Observation of coke reaction process under microscope

The experiment is a method to continuously observe the reaction process of coke at a specified temperature by means of a large polarizing microscope with a heating table. The sample to be observed is made into a optical sheet of 3 mm x 3mm x 1,5mm. The upper and lower planes of the optical sheet should be kept as parallel as possible, otherwise the observation effect will be affected.[2] Place the prepared sheet on the quartz sheet in the heating table, cover the sealed glass, and adjust the microscope until a clear image can be observed for camera observation. The heating rate of this experiment is 100 °C/min.[3,4] The high temperature test bench is equipped with a gas pipe for the passage of protective gas and reactive gas. Meanwhile, it is also equipped with a cooling water pipe for the passage of circulating water, so as to protect the high temperature test bench and observe the whole process of the reaction.

RESULTS AND DISCUSSION

Coke reactivity index test

Figure 1 is an experimental result of the reactivity index of coke after the reaction with the same flow rate of CO_2 at different temperatures. As can be seen from Figure 1, when the reaction between coke and CO_2 is at 800 °C, the weight loss rate of coke is only 0.14 %, while the gasification reaction has not yet started. At 900 °C, the weight loss rate is 2 %, so the gasification reaction can be deemed to have started. With the continuous increase of reaction temperature, the reaction rate of coke under the action of CO_2 increases rapidly. When the reaction temperature exceeds 1 200 °C, the gasification reaction becomes more intense and the reactivity index increases significantly. At 1 400 °C, the weight loss rate of coke is as high as about 70 %. Temperature is a key factor in coke degradation.

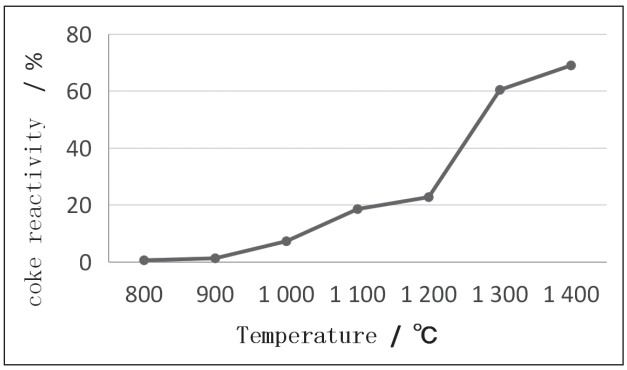

Figure 1 Influence of temperature reaction rate of coke

The influence of temperature factors on coke degradation was determined by thermogravimetry

From Figure 2 to Figure 4, we can also see that the reaction speed of coke is quite different at different temperatures. Under different temperature conditions, the absolute weight loss rate of coke varies with the passage of time. The weight loss process of the whole reaction is not linear, and the early reaction rate is fast. With the passage of time, the weight loss rate of coke shows a downward trend. With the increase of temperature, the inflection point of the downward trend will appear earlier. China's national standard GB/t4 000-1 996 coke reactivity and post-reaction strength test method used coke to measure the reactivity of the blast furnace. According to the standard, the reactivity test temperature is set at 1 100 °C, and the coke has a severe reaction in the inner part of the blast furnace, and the environment temperature is more than 2 000 °C. It can be seen from the test results that this method can't objectively reflect the performance of coke in the blast furnace, and the temperature of the test should be raised to make it closer to the real environment of the blast furnace, so as to guide the metallurgical enterprises to carry out the coking and coal blending work more scientifically.

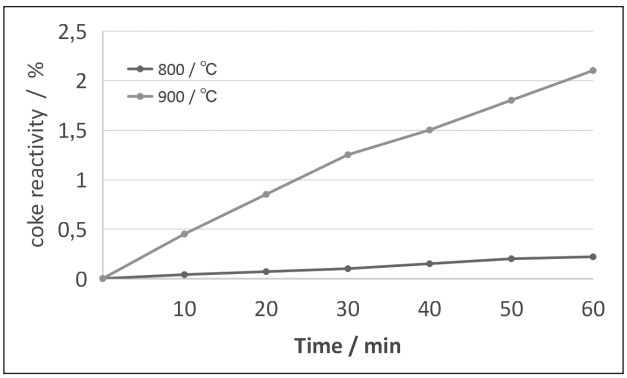

Figure 2 Dynamic weight loss rate of coke at low temperature

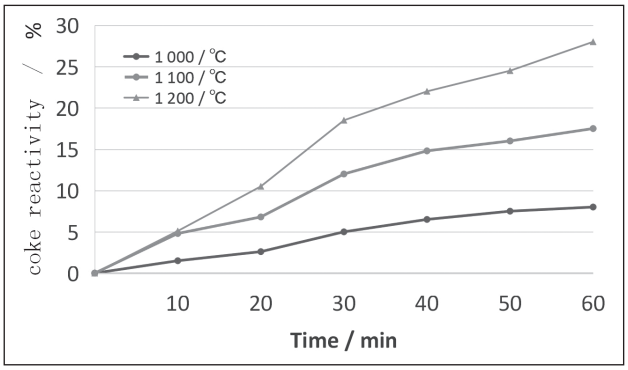

Figure 3 Dynamic weight loss rate of coke at medium temperature

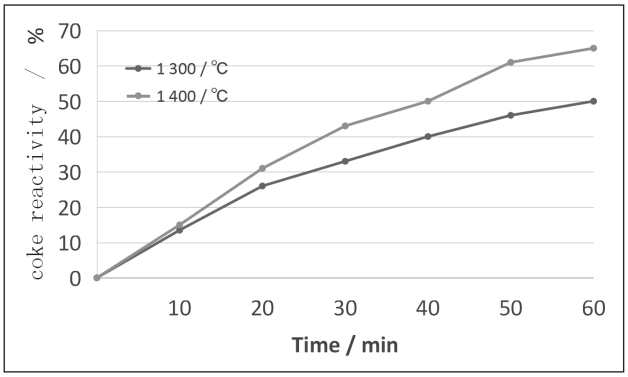

Figure 4 Dynamic weightloss rate of coke at high temperature

Observation of coke reaction process under microscope

As can be seen from the diagram of coke reaction process below, under the temperature of 900 °C. From Figure 5, we can see the change degree and speed of coke structure are extremely obvious. The optical structure of coke has a large area of blackening phenomenon, the main reason is that the temperature has reached high enough, the more reactive isotropic tissue in the optical structure of coke, the inert tissue and the fine grain Mosaic tissue have participated in the reaction with CO_2, and the surface of the coke is no longer flat, so it becomes black.

CONCLUSIONS

1 The carbon dissolution reaction rate of coke is greatly affected by temperature. In different reaction temperature zones, the reaction rate of coke is greatly different. The microreaction range is below 900 °C, and the weight loss rate is below 2 %. The temperature range of 1 000 °C ~ 1 200 °C was medium speed reaction range, and the weight loss rate was in the range of 5-25 %. Above 1 200 °C is a high-speed reaction interval, and the weight loss rate is more than 40 %, which increases with the temperature rise.

2 In the descending process of coke in the blast furnace, with the increase of temperature and the deepening

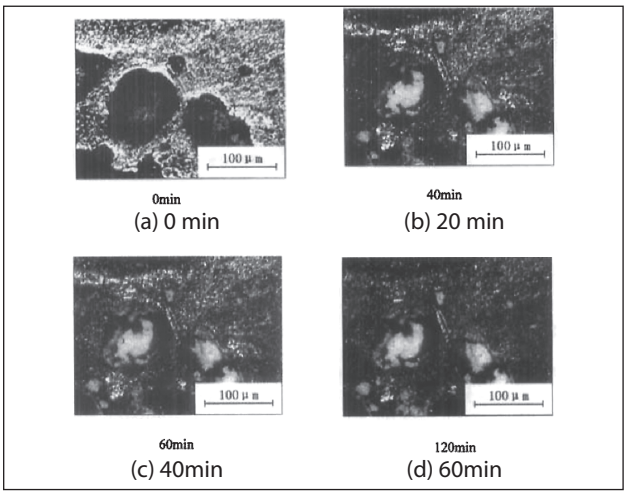

Figure 5 Reaction process at 900 °C

of gasification reaction, the porosity of coke increases, the average thickness of the pore wall decreases obviously, the average radius of the pore increases, and the small pores decrease and tend to change in the direction of the large pores. This is the main reason why coke is pulverized in the lower part of blast furnace. It is very important to control the internal temperature field of blast furnace reasonably, reduce the height of high temperature section and increase the height of middle temperature section to improve the skeleton function of coke in the process of blast furnace smelting.

3 China's national standard GB/t 4 000-1 996 coke reactivity and post reaction strength test method used coke to measure the reactivity of the blast furnace. According to the standard, the reactivity test temperature was set at 1 100 °C, and the coke where the intense reaction occurred inside the blast furnace was in the furnace waist and abdomen area, and the ambient temperature was more than 2 000 °C. It can be seen from the test results that this method can't objectively reflect the performance of coke in the blast furnace, and the temperature of the test should be raised to make it closer to the real environment of the blast furnace.

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