Experimental Study about the Low Temperature Pulverization of Pellets

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ABSTRACT: This paper mainly discusses the pellets low temperature pulverization performance experiment research. Through KSZ-03 ore comprehensive metallurgical properties tester and drum devices such as low temperature for pellets in index for performance test, to determine the low temperature reduction degradation and the influence factors of the degree of pulverization. Results show that when the gas conditions remain stable, and improve the low temperature pulverization experiment of reduction gas flow, degree of pellets reduction degradation also increased significantly; When the reduction temperature reaches 500℃, low temperature pulverization phenomenon is the most serious, and temperature higher than 500℃ and below 500℃ will reduce the degree of pulverization.

Pellets has qualities of uniform granularity, high strength, low powder content, high iron grade and good reducibility, so it can help to increase production, save the coke, improve ironmaking technical economic indicators and raise revenue [Liu Wenquan,2006][Ye Kuangwu,2007]. The charging will decline gradually from putting pellets into the blast furnace from charging equipment, and when temperature reaches 400-600℃, pellets would reduce with the coal gas from the lower part of blast furnace, what causes the pellet to have different degrees of smash [K.Grebe,1981]. The low temperature pulverization performance is one of the important metallurgical properties of pellets，which can directly affect the gas flow in furnace and blast furnace anterograde. At present, most pellets produced in China still have a big gap with foreign advanced level in par amers[Ye Kuangwu,2007][Ye Kuangwu,2005][Li Meng,2004], including higher powder content, bigger sieve sub index and higher powder content of pellets which is more than 1.5%. In recent years, along with the development of the blast furnace smelting technology and the diversification of energy, the gas composite in blast furnace has the tendency of high H_2, making H_2 more and more important in ore reduction [LI Fumin,2006]. So, in low-temperature pulverization performance experiment, researching on the effects of H_2 at different temperature and H_2 reduction gas flow to the pellets low temperature reduction degradation is essential to improve the pellets metallurgical properties.

1 EXPERIMENTAL METHOD

Pellets in the experiment are provided by a large domestic steel mills, and the main mineral composition is hematite through XRD testing [Zuo Xiaojian,2013]. The TFe content is 62.7% and the FeO content is lower than 0.5%. Puts pellets samples in stoving chest before the experiment, parch more than 2 hours at 105±5℃ and then cool to room temperature, preserved samples in drier. Get the size range 10.0-12.5mm pellets through the sieve, take 500g as experimental samples at random. Put the experimental samples on the fixed bed of experimental redactor, use H_2, N_2 reduction gas reduce samples staticly in gas flow of 10L/min at the constant temperature of 450℃, 500℃ and 550℃, use H_2, N_2 reduction gas reduce samples staticly in gas flow of 5 L/min, 10 L/min and 15 L/min at the constant temperature of 500℃. An hour later, cool samples to room temperature indoor and remove samples, then revolve 300r with small drum, sieve samples with square hole of 6.30mm, 3.15mm and 500 μ m. Finally, consider the reduction disintegration index as a measure of the degree of iron pulverization [GB/T 13241-91]. The reduction and protection gas in the experiment is provided by H_2 and N_2, the bulk and flow of reduction gas are under standard reference conditions[GB/T 13242-91], compounds gas include 20% H_2 and 80% N_2.

The strength of the pellets low temperature pulverization performance which is measured by low temperature reduction degradation index (*RDI*):

$$RDI_{+6.3}=\frac{m_{D1}}{m_{D0}}\times 100 \qquad RDI_{+3.15}=\frac{m_{D1}+m_{D2}}{m_{D0}}\times 100$$

$$RDI_{-0.5}=\frac{m_{D0}-(m_{D1}+m_{D2}+m_{D3})}{m_{D0}}\times 100$$

In the formula: m_{D0}—the quality of the sample after reduction and before the drum(g); m_{D1}—the quality of the sample left on the 6.30 mm sieve (g); m_{D2}—the quality of the sample left on the 3.15 mm sieve(g); m_{D3}—the quality of the sample left on the 500 μ m sieve (g).

2 RESULTS AND DISCUSSION

Fundamental reason for the pellets low temperature reduction degradation phenomenon is the Fe_2O_3 of ore [TANG Jingkun,2013]. When pellets enter blast furnace from charger, charging decline gradually. When temperature reaches 400-600℃, pellets would reduce with the coal gas from the lower part of blast furnace and have different degrees smash. When reduction at low temperature (400-600℃), lattice changes when Hematite turns into magnetite, including trigonal system hexagonal lattice turns into cubital vein cubic lattice which cause lattice distortion, generate enormous internal stress and lead to iron ore cataclastic pulverization by the action of mechanical force[LAN Rongzong,2012]. Reduction gas flow and reduction temperature both can affect pellets low temperature pulverization.

2.1 The effects of gas flow to the pellets reduction pulverization

Keep other conditions stable, change reduction gas flow, leave pellets to be reduced in gas flow of 5L/min, 10L/min and 15L/min. An hour later, the reduction pulverization of pellets changes as following figures.

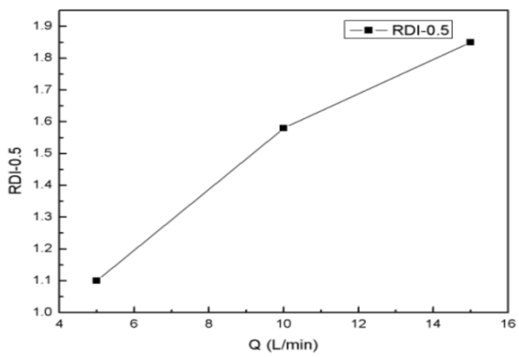

Fig.1 Pellets of reduction degradation index RDI-0.5 change

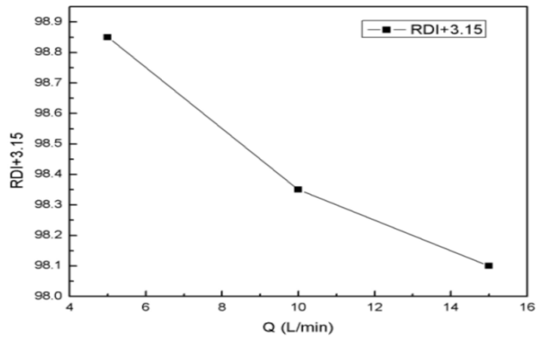

Fig.2 Pellets of reduction degradation index RDI+3.15 change

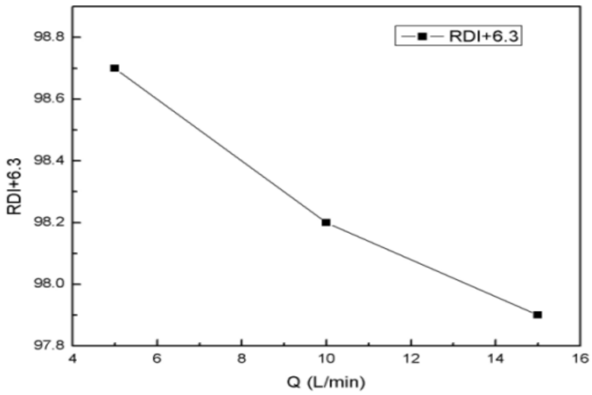

Fig.3 Pellets of reduction degradation index RDI+6.3 change

Combining figure 1-3, when increasing the reducing gas flow, $RD_{I-0.5}$ of pellets increases while $RDI_{+6.3}$ and $RDI_{+3.15}$ decrease, and the degree of low temperature pulverization becomes greater. Reducing gas flow has an impact on the reduction disintegration. When increasing reduction gas flow, the amount of gas which participate in the reaction would increase, reaction more fully and the degree of pellets pulverization increases significantly. The icrease of H_2 cause the pellet to form more small cracks. H_2 has good diffusion and penetration, which causes more H_2 to participate in the reaction, making the original reduction on more serious of pellets surface, meanwhile more H_2 will react with material in the mineral. In the process of hematite in pellets reduced to magnetite, low temperature pulverization performance of pellets also become more evident.

2.2 The effect of temperature to the pellets reduction pulverization

Keep the reducing gas flow stable in 10L/min, change the temperature and leave pellets at 450℃, 500℃ and 550℃ crespectively to be reduced. An hour later, the reduction pulverization of pellets changes as following figures.

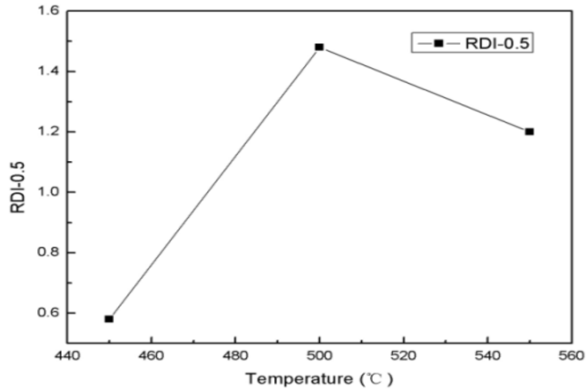

Fig.4 Pellets of reduction degradation index RDI-0.5 change

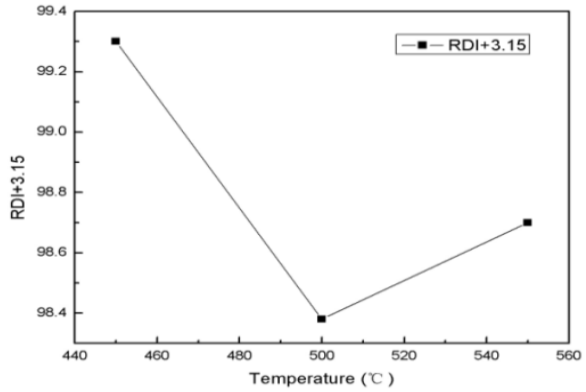

Fig.5 Pellets of reduction degradation index RDI+3.15 change

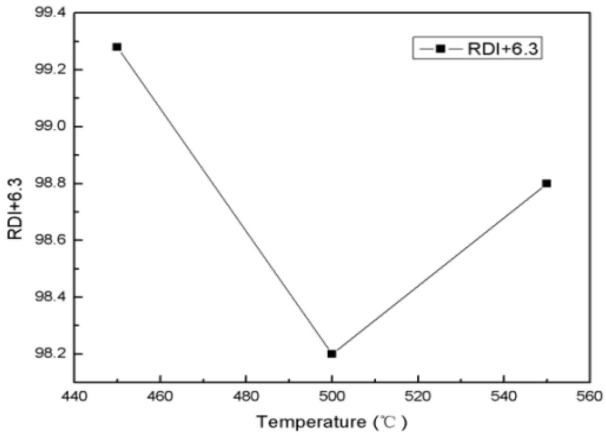

Fig.6 Pellets of reduction degradation index RDI+6.3 change

Combining figure 4-6, when changing the reduction temperature of pellets, the degree of low temperature pulverization would change as well. In detail, the RDI+3.15 and RDI+6.3 of Pellet get minimum at 500℃, while RDI-0.5 get maximum under the same conditions, the low temperature pulverization phenomenon is the most serious at 500℃. The contributory factory is the reduction speed in fast at 500℃ around, stress in time and space is highly concentrated. What's more, there is no enough plasticity in sinter to absorb stress at low temperature. Apart from the original cracks, sinter arises new micro cracks. These new cracks in the sinter would grow constantly, and number becomes larger with the temperature increasing. These front-end stress concentrate and finally cause the overall fragmentation.

3 CONCLUSION

1. The reduction gas flow has an obvious effect on the degree of pellets low temperature pulverization. When the gas conditions remain unchanged, and improve the low temperature pulverization experiment of reduction gas flow, the amount of gas which participate in the reaction would increase, the degree of pellets reduction degradation increases significantly

2. The temperature also has an obvious effect on the degree of pellets low temperature pulverization. When the reduction temperature reaches 500℃, low temperature pulverization phenomenon is the most serious, stress in pellets reaches maximum in time and space, and temperature higher than 500℃ and below 500℃ will reduce the degree of pulverization.

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