

The Study on Metallurgical Property of 380m³ Blast Furnace Slag of YIGANG

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Abstract: At the present of the material and fuel, in order to keep good fluidity and high desulfurization capacity of the slag of 380m³ blast furnace of YIGANG, the article described the influence of the contents of MgO, Al₂O₃ and basicity on the melting temperature and fluidity of the blast furnace slag based on the four main contents (CaO, SiO₂, MgO, Al₂O₃) of the slag. The result shows that the CaO/SiO₂ in the slag should be controlled between 1.1-1.2 and the temperature of slag be not lower than 1450 °C.

Key words: Slag; fluidity; Desulfurization capacity

1. Forewords

The chemical composition of blast furnace slag that impacts on the slag viscosity, melting temperature and desulfurization capacity is a very concerned problem by blast furnace workers, and adjusting the slag component to achieve desired metallurgical properties is generally used. 380m³ blast furnace of YIGANG owning relatively well raw materials, equipment and operating conditions, therefore, it is very necessary to systemic investigate the metallurgical performance of 380m³ blast furnace of YIGANG.

Yicheng Iron and Steel Company exist 2 380 m³ blast furnace at present, the average utilization factor about 2.3 t/m³, in the middle or lower level counterpart at home, for a long time which slag basicity (R) has been controlled around 1.1. BF lies some problems, such as low grade, large amount of slag, fiercely changes of the composition slag, MgO content of the slag about 9%, Al₂O₃ high content, and the composition fluctuations of blast furnace slag not only directly affect the blast furnace operation, but also affect mineral components and the cost of pig iron. For this purpose, YIGANG technical personnel on how to adjust the slag composition, once hoped that by increasing magnesium material into the BF to improve MgO content of slag, and to further improve stability of slag, but the actual result is poor. In order to

uniformly understand the actual BF burden, therefore its slag metallurgical properties were studied to determine a reasonable slag component to guide blast furnace production practice.

2. Influence of slag components on viscosity and the melting temperature of YIGANG blast furnace slag

The experiment selected YIGANG's five blast furnace slags, whose chemical composition are showed in Table 1. The relationship between slag viscosity and slag composition can be seen from the table 1.

Table 1 The Chemical Composition of The Blast Furnace Slag

炉渣编号	Slag Chemical Composition (%)						
	CaO	SiO ₂	MgO	Al ₂ O ₃	S	R	TiO ₂
1	39.5	35.11	9.03	12.13	0.85	1.12	1.06
2	38.83	36.11	8.97	12.29	0.86	1.08	1.20
3	37.1	36.05	8.69	12.21	0.98	1.03	1.31
4	39.84	35.00	9.20	12.76	0.93	1.14	1.01
5	39.94	36.26	8.75	12.16	0.92	1.10	0.96

The temperature curves of the viscosity of slag have been shown in the Figures, and slag composition influence on the viscosity of slag shown in the table. According to the data in the table, Figure 1 to Figure 9 can be made, from Table 1 and Figure 1 to Figure 9 we can see as the followings.

YIGANG's scene blast furnace slag is a typical "short slag ".The viscosity of high-temperature melting state is small, but in the vicinity of the temperature of melting, the viscosity of slag rapidly changes ,lost to the free fluidity temperature range of only 20 °C to 30 °C in the slag; if slag basicity is between 1.1 to 1.2, slag is the lowest viscosity and melting temperature, beyond this range of basicity due to the slag higher melting point and slag complex structures, the viscosity and the melting temperature of slag to increase ^[2]. In order to ensure a good flow of slag, the basicity of YIGANG blast furnace slag should be controlled between 1.1 to 1.2.

The components of the scene blast furnace slag of YIGANG that influence on viscosity, melting temperature and the sulfur content of pig iron have been shown in Figure 1 ~ Figure 9.

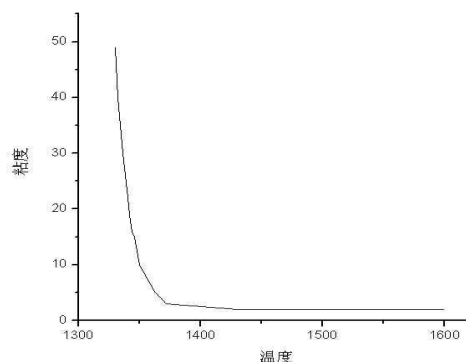


Fig.1 the relationship between the viscosity of slag and temperature

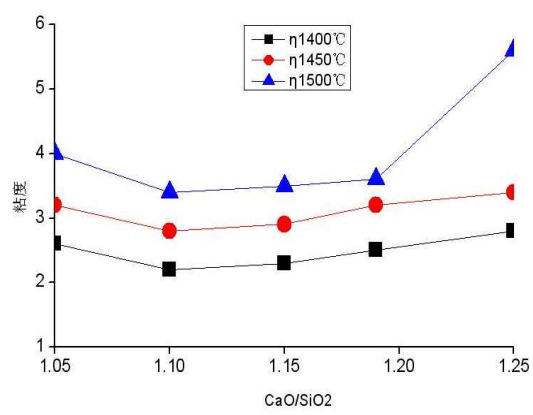


Fig.2 Influence of slag basicity on the viscosity of slag

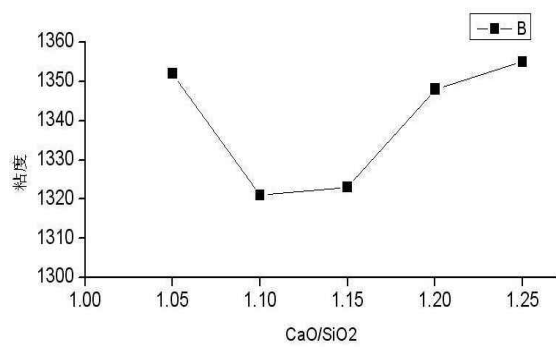


Fig.3 Influence of slag basicity on the melting temperature of slag

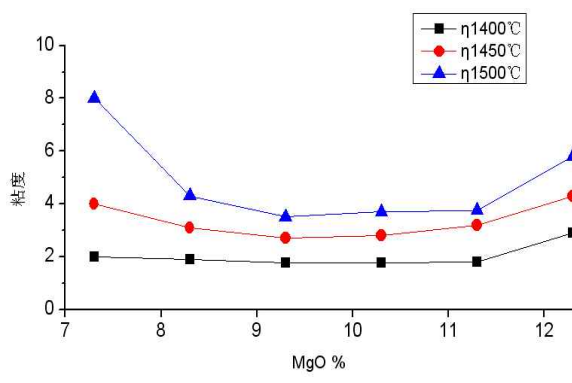


Fig.4 Influence of MgO content in the slag on the viscosity of slag

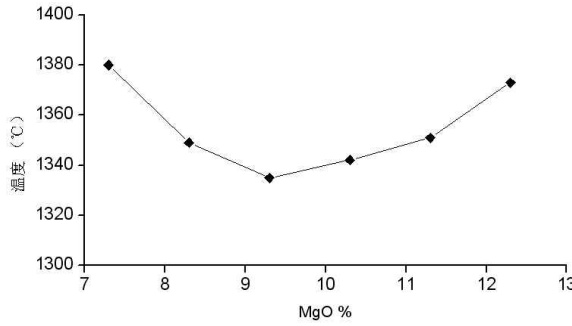


Fig.5 Influence of MgO content in the slag on the melting temperature of slag

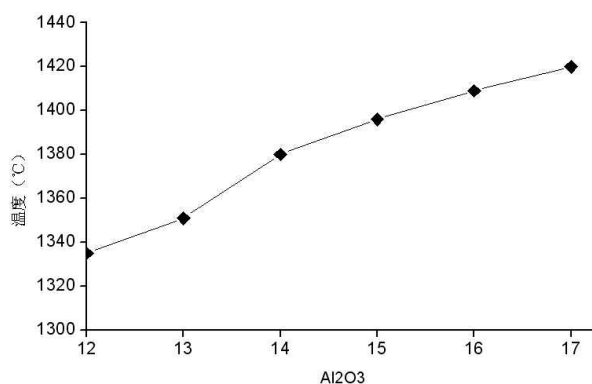


Fig.6 Influence of Al₂O₃ content in the slag on the melting temperature of slag

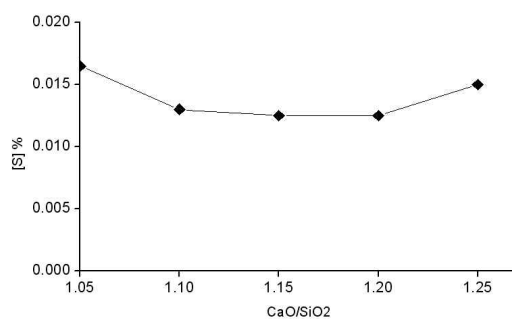


Fig.7 Influence of Slag basicity on the sulfur content of Pig iron

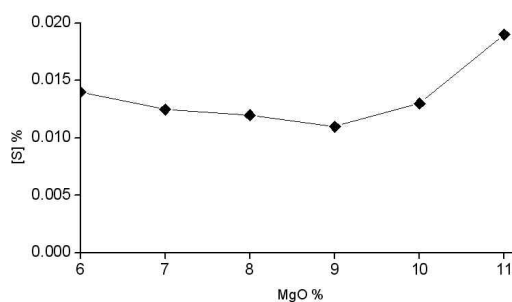


Fig.8 Influence of MgO content in the slag on the sulfur content of Pig iron

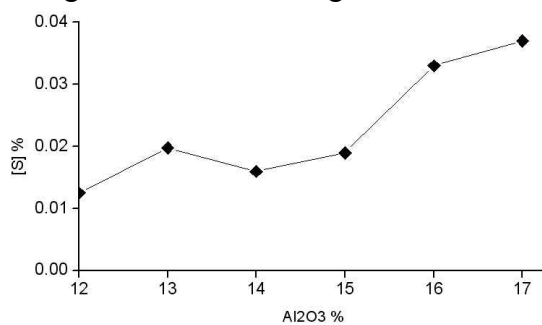


Fig.9 Influence of Al₂O₃ content in the slag on the sulfur content of pig iron

From the Figures can be seen in the following:

- (1) The viscosity of YIGANG blast furnace slag under high-temperature melting is small, but in the vicinity of the melting temperature, the viscosity of slag rapidly changes, slag lost to the free flow range of only 20 °C to 30 °C.
- (2) If the slag basicity is between 1.1 to 1.2 (Figure 2, Figure 3), the viscosity of the slag and melting temperature is the lowest, beyond the areas of basicity due to the slag melting point and slag complex structure, and the viscosity of slag and melting temperature have increased. To ensure that the slag has good mobility, the slag basicity in the Blast Furnace controlled about 1.1 is more appropriate.
- (3) If MgO content in the slag changes within 10% (Figure 4, Figure 5), the lower the viscosity of slag, the lower melting temperature; if MgO content of the slag increases more than 10%, the viscosity of slag and melting temperature instead rise, therefore MgO content of the slag controlled in the 8-9 percent would be more appropriate.
- (4) With the increase of Al_2O_3 content of the slag (Figure 6), it will lead to increase slag viscosity and melting temperature. After Al_2O_3 content of slag increases in the slag the number of $(\text{AlO}_4)^{5-}$ ion will increase, at the same time in the slag is easy to form high melting point complex compounds, slag showing the complex internal structure, so that the viscosity of slag and melting temperature has increased. We should manage to via technological means such as allocating through the sintered ore and reducing coke ash to reduce the Al_2O_3 content in the slag.
- (5) If the slag basicity is between 1.1 to 1.15 (Figure 7), the slag has the strongest desulfurization capacity .Increasing or decreasing slag basicity will have the effect on desulfurization. After slag basicity increases, on the one hand,if the activity of CaO increases, the thermodynamic conditions of slag desulfurization reaction will improve; on the other hand, it appears the particle which has insoluble components in the slag. The solid phase can not be completely dissolved by the slag, which make the viscosity of slag to increase.The increased viscosity of the slag, which will affect the mass transfer process of slag and metal, S^{2-} transferring to the slag, finally has worsened the desulfurization of dynamic conditions [4].
- (6) One of the main functions of higher MgO slag is desulfurization, and the viscosity of slag having the best performance of the desulfurization is just the lowest. This is because slag viscosity also will be reduced with the proportion of alkaline increasing, and high alkalinity are conducive to desulfurization ^[5]. If MgO content is about 7~10 percent, slag desulfurization capacity is relatively higher. If MgO content in the slag increase, it can lower the viscosity of slag, meliorate slag flow, and improve the desulfurization ability of the slag ^[6]. If MgO content is more than 10 percent, the desulfurization capacity of the slag decreases obviously (Figure 8). This is because that MgO in the slag appears high melting point substance such as periclase, viscosity increasing and the deterioration of the mobility of slag, which seriously aggravated the dynamic conditions of desulfurization.
- (7) If the Al_2O_3 content in the slag is about 12 percent, slag desulfurization capacity will decrease (Figure 9); if Al_2O_3 content in the slag is more than 15%, the increasing of Al_2O_3 content would rise higher sulfur content in the hot iron significantly.

3. Conclusions and recommendations

Test on the YICHENG Steel Iron and Steel Company can have some proposals in the following:

- (1) Basicity in the slag controlled between 1.05-1.15 is more appropriate.
- (2) MgO content in the slag should control in the 8~9 percent, or it will increase the viscosity of slag and melting temperature, and reduce slag desulfurization ability.
- (3) The increase of Al_2O_3 content in the slag will be detrimental to lower the viscosity of slag and slag desulfurization. We should use appropriate technology which will control Al_2O_3 content less than 13% in the slag.
- (4) To ensure that the slag has good fluidity and higher desulfurization capacity, the temperature of the slag must not be lower than 1450°C , and should take effective measures to maintain a sufficiently high temperature of the hearth.

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