The effect of binary basicity (mass ratio of CaO to SiO2) on the sintering of titanomagnetite concentrate was investigated in an experimental-scale sintering pot. The results indicated that increasing basicity can improve yield, productivity, and reduction index (RI) of the finished sinter. However, sinter strength and reduction disintegration index (RDI) have a significant decrease at the basicity varying from 1.0 to 2.0. It also proved that titanomagnetite and titanohematite are the main minerals in sinter, while kirschsteinite and calcium silicate (CS) are the main melted phases. The amount of perovskite increases then slightly decreases with the increasing basicity as silicoferrite of calcium and aluminum (SFCA) began to generate and increase with basicity from 1.5 to 3.0. It is concluded that adjusting sinter basicity is capable to restrain the adverse effect of TiO2 on sintering of titanomagnetite concentrate.

KEY WORDS: sintering; titanomagnetite concentrate; basicity; TiO2; ironmaking.

1. Introduction

Vanadium-bearing titanomagnetite ore, a multi-mineral ore mainly composed of Fe, Ti and V, is abundant in China, Russia, South Africa and USA. More than 7 400 million tons of V-bearing titanomagnetite ore are reserved in Panzhihua-Xichang area, Sichuan Province, China. Titanomagnetite concentrate has been used for extraction of Fe and V by the route of blast furnace-basic oxygen furnace (BF-BOF) presently in China. The effect of binary basicity (mass ratio of CaO to SiO2) on the sintering of titanomagnetite concentrate was investigated in an experimental-scale sintering pot. The results indicated that increasing basicity can improve yield, productivity, and reduction index (RI) of the finished sinter. However, sinter strength and reduction disintegration index (RDI) have a significant decrease at the basicity varying from 1.0 to 2.0. It also proved that titanomagnetite and titanohematite are the main minerals in sinter, while kirschsteinite and calcium silicate (CS) are the main melted phases. The amount of perovskite increases then slightly decreases with the increasing basicity as silicoferrite of calcium and aluminum (SFCA) began to generate and increase with basicity from 1.5 to 3.0. It is concluded that adjusting sinter basicity is capable to restrain the adverse effect of TiO2 on sintering of titanomagnetite concentrate.

KEY WORDS: sintering; titanomagnetite concentrate; basicity; TiO2; ironmaking.

2. Results and Discussion

3.1. Effects of Basicity on Sintering Indexes

The permeability of the bed during sintering strongly affects the sintering speed, sinter productivity and quality, which is mainly determined by the permeability of pre-ignition bed. Figure 1(a) shows that the permeability decreases with the increasing basicity from 0.5 to 3.0, which appears in a linear relationship. Figure 1(b) shows a significant decrease in TI from 1.0 to 2.0 of basicity and sinter strength improves with increasing basicity. It is different from previous results. Figure 1(c) shows that with an
increase in basicity from 0.5 to 3.0, the sintering speed increases. Figure 1(d) shows when the basicity is increased, the sinter yield increases. Productivity is determined by sintering speed and sinter yield. Figure 1(e) shows that the productivity increases with the increase in basicity.

### 3.2. Effects of Basicity on Reduction Properties of Sinter

Figures 1(f) and 1(g) show reduction properties of sinters. RI increases from 72.55% to 83.55% with increasing basicity from 0.5 to 3.0, which indicates that sinter with a higher basicity is easy to be reduced in the blast furnace. The RDI\textsubscript{1.15} decreases from 86.2% to 67.5% with the basicity increase from 0.5 to 1.5. However, as the basicity further increases from 1.5 to 3.0, the RDI\textsubscript{1.15} increase gradually. These results indicated that sinter basicity in the range of 1.0 to 2.5 has a negative effect on RDI\textsubscript{1.15}. It should be noted that the suitable basicity of conventional iron ore sintering is in the range of 1.7 to 2.2, in which RDI\textsubscript{1.15} increases with increasing basicity due to the improved sinter strength and decreased hematite content.\textsuperscript{9,10} Therefore, a higher basicity should be chosen for the sintering of titanomagnetite concentrate, considering the factor of RDI.

### 3.3. Effects of Basicity on Minerals Constituent and Microstructure of Sinter

According to reflective color of minerals in sinter described in reference,\textsuperscript{17} minerals constituent of sinters is shown in Fig. 2. It is indicated that titanomagnetite and titanohematite are the main minerals in sinters, which are accounting for about 80% of the sinter. When the basicity is 0.5, kirschsteinite and CS are the main melted phases, while SFCA and perovskite are not observed. When basicity increases to 1.0 and 1.5, the content of kirschsteinite decreases gradually, while that of CS increases accordingly. Meanwhile, the content of perovskite is observed and increased to 7.9%. SFCA is observed in sinter at basicity 2.0, which accounts for 4.5% of the sinter. When the basicity increases to 2.5 and 3.0 further, SFCA content increases to 9.5% and 13.3%, respectively. Besides, perovskite decreases slightly.

The microstructures of sinters with basicity 0.5, 2.0 and 3.0 are shown in Fig. 3. When the basicity is 0.5 (Fig. 3(A)), interweaved titanomagnetite and titanohematite are the main structure in sinter and kirschsteinite and CS are the

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**Table 2. Blending ratio of blends and calculated composition of sinters (mass%).**

<table>
<thead>
<tr>
<th>Basicity</th>
<th>Blending ratio</th>
<th>Calculated composition of sinters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Titanomagnetite concentrate</td>
<td>Coke</td>
</tr>
<tr>
<td>0.5</td>
<td>94.23</td>
<td>4.5</td>
</tr>
<tr>
<td>1.0</td>
<td>91.61</td>
<td>4.5</td>
</tr>
<tr>
<td>1.5</td>
<td>88.93</td>
<td>4.5</td>
</tr>
<tr>
<td>2.0</td>
<td>86.17</td>
<td>4.5</td>
</tr>
<tr>
<td>2.5</td>
<td>83.34</td>
<td>4.5</td>
</tr>
<tr>
<td>3.0</td>
<td>80.44</td>
<td>4.5</td>
</tr>
</tbody>
</table>

* Return fines ratios are fixed at 23.08% to blend.
main melted phases. SFCA and perovskite are not obviously observed in this sinter. When basicity increases to 2.0 (Fig. 3(B)), perovskite is observed in the gaps between joined crystals of titanomagnetite or titanohematite. When the basicity increases to 3.0 further (Fig. 3(C)), the content of SFCA increases remarkably, which closely associated with titanomagnetite.

From these results, the strength and RDI property of sinter from titanomagnetite concentrate is deteriorated by the increasing perovskite in sinters. However, the adverse effects are offset by the increasing of SFCA at basicity over 2.0. In addition, acidic sintering (basicity lower than 0.5) and ultra high basicity (basicity higher than 2.5) sintering is considered to be better choices for titanomagnetite concentrate sintering with respect to RDI.

4. Conclusions

(1) Increasing basicity can improve titanomagnetite concentrate sintering performances and RI of product sinters. While sinter strength and RDI-3.15 have a significant decrease at the basicity ranging from 1.0 to 2.0.

(2) Titanomagnetite and titanohematite are the main minerals in sinters, while kirschsteinite and CS are the main melted phases. Perovskite increases then slightly decreases with the increasing basicity. SFCA began to generate and increase with basicity from 1.5 to 3.0.

(3) The adverse effect of TiO$_2$ on sintering of titanomagnetite concentrate is able to be restrained to a large extent by adjusting the basicity of sinter mixture in a suitable range.

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REFERENCES