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Study on dephosphorization mechanism by roasting iron ore pellets with high phosphorus content

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Abstract

Based on high phosphorus pellets as the research object, combined with Factsage7.1 thermodynamic simulation software simulation of pellets roasting atmosphere, through the single variable method, the gasification process and influence factors of dephosphorization of preliminary simulation has been done, and according to the results of simulation calculation for pelletizing, pellets roasting hot process experiments to explore the dephosphorization agent and the effects of key factors on the gasification dephosphorization. It is concluded that the reasonable roasting of high phosphorus pellets can reduce the phosphorus content and provide theoretical and technical support for the efficient utilization of high phosphorus ore powder.

Keywords

High phosphorus pellets; Thermodynamic analysis; Analog computation; Gasification dephosphorization; Roasting way.

1. Introduction

The slag from steelmaking process has very high phosphorus content and is difficult to be recycled in the enterprise. In order to achieve effective dephosphorization, many researchers have carried out a large number of experiments and various attempts. In general, there have been some successful methods, mainly focusing on mineral dressing dephosphorization, reduction dephosphorization, chemical dephosphorization and microbial dephosphorization.

There have been a lot of experimental studies on dephosphorization by sintering and converter at home and abroad, but few systematic studies on dephosphorization mechanism of high phosphorus pellet have been reported. The dephosphorization pressure of blast furnace and converter will be greatly reduced if the phosphorus in high phosphate ore can be removed in advance in pelletizing process. Therefore, the project is based on the mechanism of carbon thermal reduction, through Factsage thermodynamics analysis software, and high phosphorus hot state experiments the ball team points, calcination temperature, carbon and atmosphere with high phosphorus pellets the intrinsic relationship between dephosphorization, by means of microscopic analysis method, study the migration behavior of the roasting process of phosphorus and its evolvement rules, as well as the regularity of influence on the quality of pellets which system to clarify high phosphorus dephosphorization mechanism of pellets for high phosphorus iron ore powder and the actual production of the high phosphorus steel slag is more efficient to provide theoretical and technical support.

2. The experimental method

2.1. Research plan

2.1.1. Experimental procedure and equipment

The single variable method was used to study the influence of SiO2 content and CaCl2 content on pellet gasification dephosphorization. According to the calculation to determine the

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proportion of weighing materials, pelletizing test. The influence of SiO2 content of dephosphorization agent on gasification dephosphorization was studied to obtain the optimal SiO2 mixture. Then, on this basis, the influence of CaCl2 on gasification dephosphorization was explored to obtain the optimal ratio of additives. Under the condition of adding the best ratio of dephosphorization agent, the influences of carbon content, temperature and coke size on gasification dephosphorization were investigated to obtain the best process conditions.

2.2. Thermodynamics of gasification dephosphorization

Gasification dephosphorization mainly takes advantage of the high temperature characteristics of pellet roasting and the formation of local carbon-containing reduction atmosphere to convert phosphates into phosphates or gaseous phosphates and discharge them through the voidage in pellet roasting, so as to achieve the purpose of gasification and dephosphorization. FactSage7.1 thermodynamic software is mainly used in pellet roasting to study the effect of different dephosphorization agents on the transformation and gasification of phosphorus during pellet roasting. The phase diagram module of the software was used to simulate the main diagram area of gasification dephosphorization, and the influence of roasting atmosphere on gasification dephosphorization was analyzed. In order to facilitate the thermodynamic simulation calculation, the composition of steel slag in Table 1 was sorted and calculated to make the compound content reach 100%. The results are shown in Table 1.

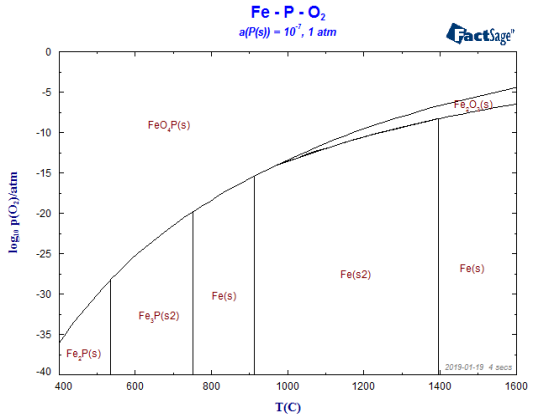
Table 1 Thermodynamic simulation of the chemical composition of steel slag /%

Chemical composition	CaO	MgO		SiO_2	$Ca_3(PO4)_2$	Al_2O_3	FeO
percentage（%）	48.87	14.75		13.28	4.49	3.68	14.64

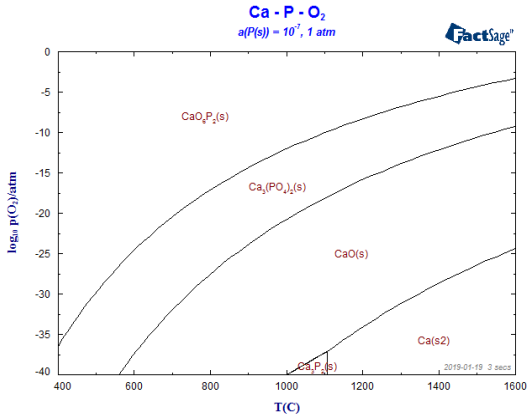
According to the oxygen potential diagram of oxide, the oxygen potential line of phosphorus oxide is lower than that of iron oxide. In the oxygen potential diagram, at a certain temperature, the lower the oxide oxygen potential line, the smaller the oxygen potential, the more stable the oxide, and the more difficult it is to reduce the oxide.

3. FactSage7.1 software simulation calculation

The following figure shows the favorable area diagram of FE-P-O and CA-P-O systems and MG-P-O and al-P-O systems drawn by FactSage7.1 software phase diagram module.



(1)Fe-P-O



(2)Ca-P-O

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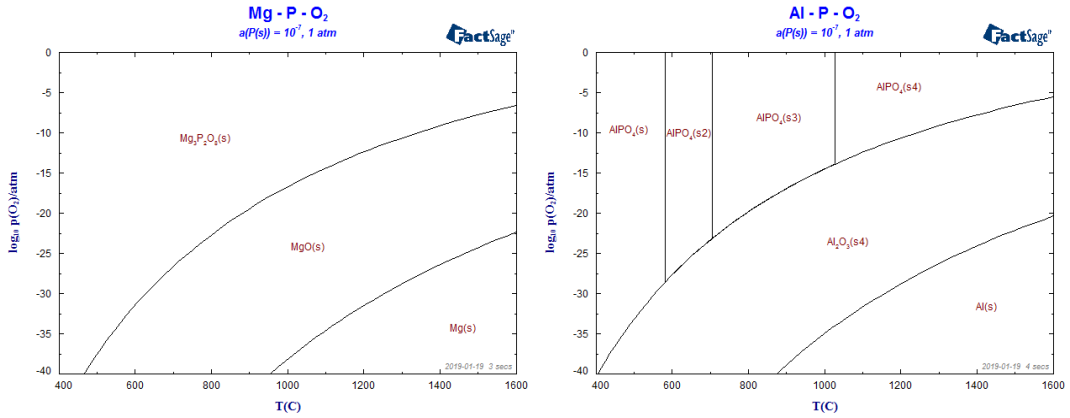

(3)Mg-P-O (4)Al-P-O

Figure. 1 Dominant regions of FE-P-O and CA-P-O systems and MG-P-O and al-P-O systems

As can be seen from Figure 1, when the temperature of FE-P-O is low or the partial pressure of oxygen is high, phosphorus is stable in the form of FePO4. With the increase of temperature, FePO4 is decomposed into iron, which is beneficial to gasification and dephosphorization. At low temperature and low partial pressure of oxygen, phosphorus exists in solid Fe2P and Fe3P. With the increase of temperature, iron phosphide is unstable and decomposing into elemental iron, which is beneficial to gasification and dephosphorization. As for CA-P-O, CaO6P2 and Ca3(PO4)2 are stable phases when oxygen partial pressure is high. With the increase of temperature or the decrease of oxygen partial pressure, Ca3(PO4)2 is decomposed into CaO, which is conducive to gasification and dephosphorization. However, if the oxygen partial pressure is too low, Ca3P2 will be formed with the increase of temperature, which is not conducive to dephosphorization. For MG-P-O and al-P-O, under the conditions of low temperature and high oxygen partial pressure, Phosphorus exists stably in Mg3(PO4)2 and A1PO4, respectively. When the temperature increases or the oxygen partial pressure decreases, phosphorus will be decomposed into MgO and A12O3, which is conducive to gasification and dephosphorization.

4. Conclusion

(1) Through the chemical composition detection, the phosphorus content in the high-phosphorus steel slag is 0.65%, the fixed carbon of the reducing agent coke is 85.52%, and the ash content is 13.36%.

(2) High phosphorus steel slag is mainly composed of dicalcium silicate, tricalcium silicate, calcium ferrite and RO minerals, while phosphate minerals are calcium phosphate, which mainly co-exists with silicate minerals.

(3) Combined with Factsage thermodynamic software, gasification preponderance diagram analysis, reaction initiation temperature calculation and simulation of the influence rule of components were conducted to determine the theoretical dephosphorization agents as SiO2 and CaCl2.

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