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Distribution of Impurity Elements in Oxygen-enriched Top-blowing Nickel Smelting with Fe Extraction-oriented Slag Adjustment

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1 INTRODUCTION

There is about 40% Fe in nickel smelting slag. How to recover the Fe and total component utilization is of great significance. The key problem is that the Fe is mainly at the state of Ferro-silicate which is stable and very difficult to be reduced, leading to difficulties in Fe extraction from the slag. Our team suggested that adjustments were made to use CaO as flux instead of SiO_2 in traditional nickel smelting process. The earlier test results shown that the new slag can meet the requirement of nickel smelting and is suitable for further Fe extraction. In this paper, the effects of slag composition change to the transforming of impurity elements in oxygen-enriched top-blowing nickel smelting process is studied. The work is aimed to providing a theoretical basis for subsequent parameter control and pollution control in the smelting process.

2 METHODS

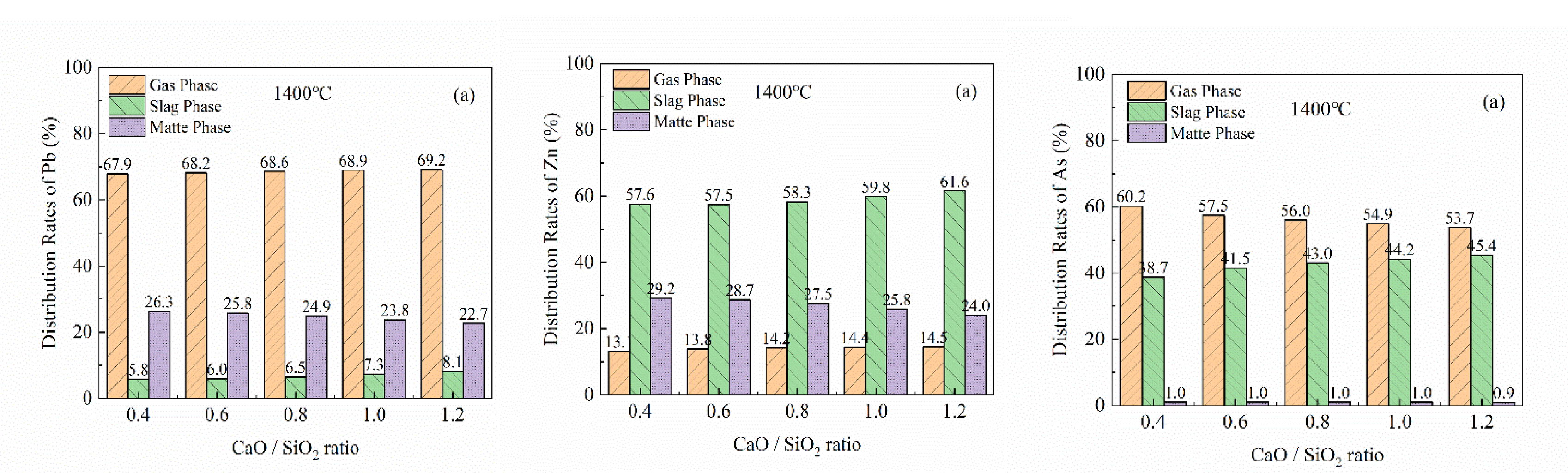
Based on the oxygen-enriched top-blowing smelting condition and the idea of slag adjustment for Fe extraction, theoretical calculations on the distribution of Pb, Zn, and As were conducted using FactSage 7.1. Smelting experiments were carried out with the slag samples which chemical composition for matte production was chosen in previous as shown in Tab.

The content of impurity elements in the produced slag and matte after the reactions were analyzed through chemical analysis. The forms of impurity elements in the slag and matte samples were investigated with XPS.

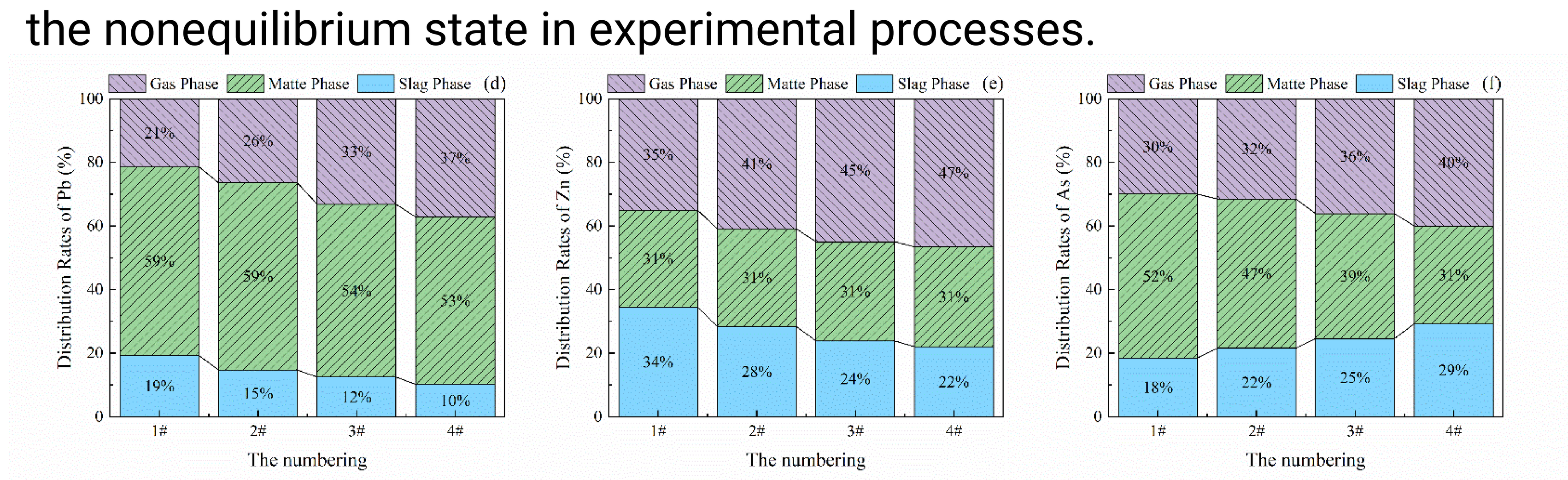
No.	FeO	CaO	MgO	SiO_2	Fe/SiO_2	Basicity
1#	46.12	4.13	13.63	36.11	0.99	0.11
2#	45.22	10.91	13.36	30.50	1.00	0.66
3#	45.21	13.85	13.36	27.56	1.27	0.50
4#	41.92	20.11	12.39	25.56	1.27	0.79

3 RESULTS

With an increase in the CaO/SiO_2 ratio, the distribution of Pb and Zn increased in the gas and slag and decreased in the nickel matte. With the increase in the CaO content in the slag, more iron oxides are free from silicates. As a result, most of Pb exists in the form of oxides, making it more prone to entering the slag and exhaust gas. so to Zn. The distribution of As increased in the gas and slag and a decreased in the matte with the increase of CaO. That is because elevated the oxygen potential in the molten facilitated the transformation of As(III) into the more stable form of As(V). The volatilization of arsenic oxides was reduced.



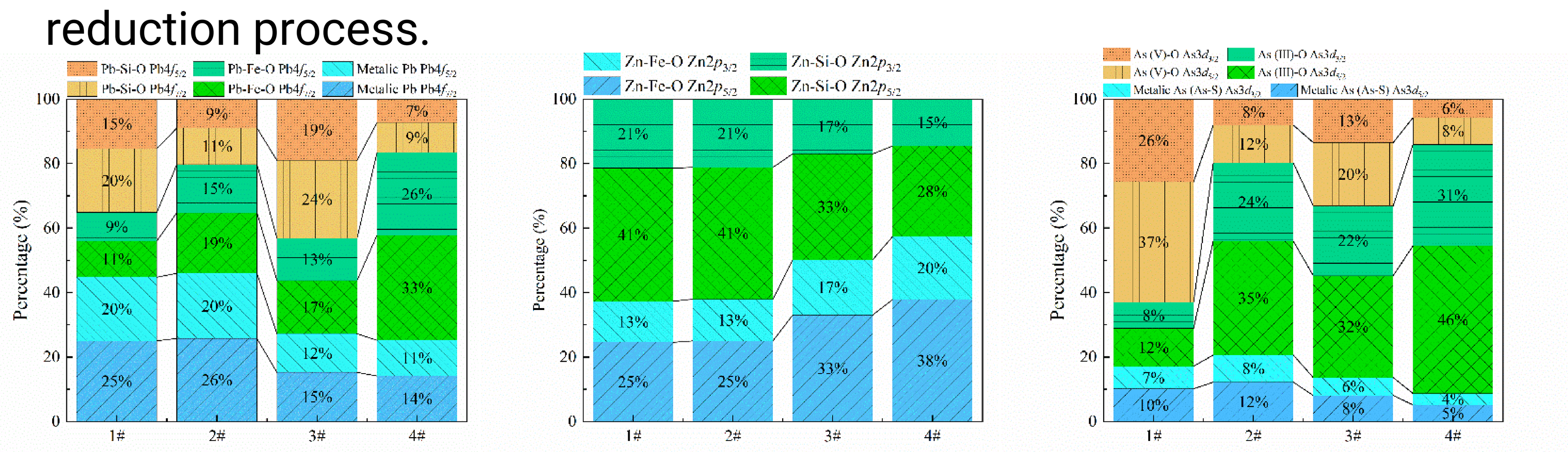
As the content of CaO in the slag increases, the content of Pb, Zn, and As in the gas and matte increases and decreases, respectively. The content of Pb, Zn in the slag decreases, while the content of As in the slag increases. The deviation between test results and theoretical calculations is attributed to the difference between equilibrium state and the nonequilibrium state in experimental processes.



The primary forms of Pb in nickel slag include metallic lead, lead silicate, and lead sulfate. Adjusting slag's composition enhance the stability of Pb compounds in the slag, and reducing the risk of Pb release, while the content of lead iron sulfate gradually increases. When the slag has higher alkalinity, CaO more easily combines with silicate ions, displacing Fe and resulting in lower lead silicate content and higher lead iron sulfate content in the slag.

Zn in nickel slag is mainly present in the forms of zinc silicate and zinc iron sulfate. There is an increasing trend in the proportion of zinc iron sulfate in the slag, while the proportion of zinc silicate decreases. With high alkalinity, the increased combination of sulfate ions with calcium ions may be influenced by the dissolution and loss of metal sulfides in the slag.

As in nickel slag mainly exists in the form of As(V)-O arsenate, with small amounts of trivalent arsenic oxide and metallic or sulfide arsenic. Sulfide arsenic or metallic As in the slag tends to decrease, while the proportion of As_2O_3 in nickel slag shows an increasing trend. Compared to arsenates, As_2O_3 is more easily removed in the subsequent Fe reduction process.



5 CONCLUSION

With increasing CaO, the content of Pb, Zn and As entering gas increases, matte decreases, respectively. The content of Pb, Zn in the slag decreases, while the content of As in the slag increases. Adjusting slag's composition is advantageous for the volatilization and enrichment of impurity elements in the gas and slag. The impurity elements in slag are transformed into ferrite and As_2O_3, which reduces the impact of impurity elements on product performance during subsequent matte refining and iron extraction from nickel slag process.

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