For further analysis, the melting point was calculated with FactSage and shown in FIG 3.

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Analysis on Composition and Physical-chemical Property Change of PbO-bearing Slag in Pb Smelting

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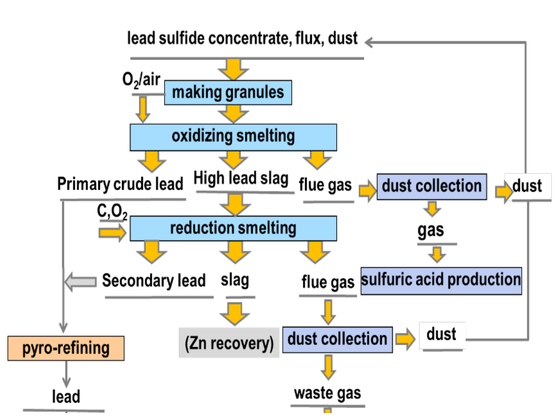
1 INTRODUCTION

Lead direct smelting is the main process for lead production. Most of the processes is composed of three stages as shown in Fig.. Up to now, there is fewer results on the slag physical-chemical properties with its composition change systematically. In this work, the typical lead direct smelting processes were analyzed at theoretical and practical point. The full-period slag composition and slag melting point change were compared. Especially, to the PbO and ZnO reduction steps, composition change, the slag properties were predicted. Based on dust composition and test results, the mechanism of Pb compound evaporation and its effect on practice and measurement of high PbO bearing slag physical-chemical property is discussed.

2 RESULTS

● The Process introduction

In oxidization smelting stage, PbS is oxidized to PbO; In reduction smelting stage, PbO is reduced to Pb; In Zn recovery stage, ZnO is reduced and Zn collected. The relevant slag and dust composition are listed in following table.

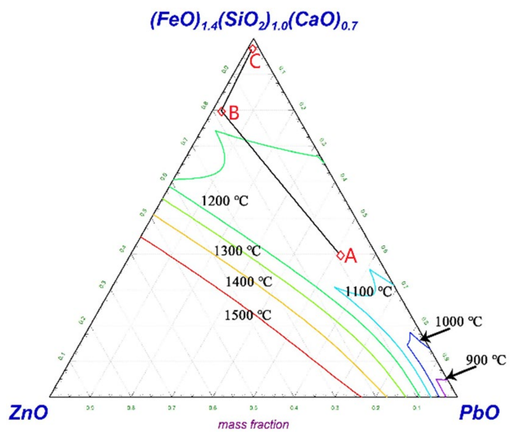


stages	materials	Composition, %						
		Pb	Zn	Cu	Fe	CaO	SiO_2	S
oxidizing stage	Mixed ore	55.0	4.7	0.80	8.25	0.35	3.8	17.0
	Dust	49.0	4.7	0.12	0.83	0.04	0.38	7.17
	High-PbO slag	42.11	6.54	0.45	11.66	7.42	10.60	0.19
reduction stage	Dust	50.78	5.28	0.05	1.88	1.20	1.71	0.10
	slag with higher Zn	2.38	12.35	0.41	22.15	18.99	21.10	0.07
Further reduction,	Final slag	0.42	1.46	0.47	26.40	24.63	24.40	0.06
	Dust	10.94	60.0	0.06	2.99	25.71	2.86	0.12

● The slag composition change

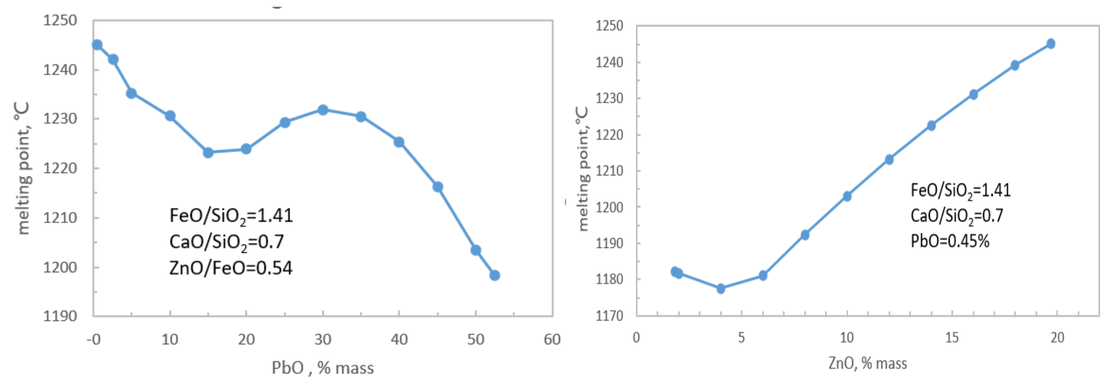
From the high PbO content slag with above 40% PbO along, the slag composition change can be show as Fig. below.

In PbO reduction process, slag composition changes form point A to B), FeO/SiO_2=1.4,CaO/SiO_2=0.7, ZnO/FeO=0.54. As a result, the ZnO content can reach about 20% in mass. In ZnO reduction, the slag composition changes from B to C, only ZnO content decreases and $FeO+CaO+SiO_2$increases proportionally.



● The slag physico-chemical properties change

The slag physico-chemical properties will change with its chemical composition and is mainly determined by PbO and ZnO content. Fig. below is the results by FactSage. It can be seen that with the PbO reduction, the slag melting point will increase gradually from 1198℃ to 1245℃. And then with the further reduction of ZnO, the slag melting point will decrease gradually from 1245℃ to 1182℃. This is in accordance with relevant practical results. The smelting temperature and slag composition should be adjusted properly according to these changes.



The test results is in accordance with these. With the PbO content decreased from 43.09% to 2.69%, the melting point increased from 1158℃ to 1269℃. The viscosity also increased to some extent.

● The evaporation and its effect

① In reduction stage of practice, there is much Pb and less Fe, Si, and Ca in dust than in slag(see above table). This reflects that the dust is not high-Pb slag splashing, but evaporation in main. The main volatiles should be PbO and Pb. In triple-furnace system, the dust rate is about 13-15%. So the evaporation will have great influence to the process.

② The weight loss results(TG-DSC test) of different slag are listed in below table. It can be seen that the weight loss is very obvious at 736°C -1450°C. This represents the evaporation effect. To the slag with 43.09% PbO, the weight loss can reached about 38.69%. The collected dust in test is mainly PbO and less ZnO. That means almost all of the PbO in the slag can exit from the slag at 1450°C. With the increase of FeO/SiO_2 and CaO/SiO_2, the weight loss increases.

③ Then a problem arises. Slag properties are measured at high temperature. If evaporation happens so strongly, how can we get the correct property data? Traditional methods are evidently not fit these slag again.

Slag type	composition		weight loss 410°C -736°C	weight loss 736°C -1450°C
	FeO/SiO_2, CaO/SiO_2	PbO		
Slag with low PbO content	1.54, 0.4	2.69%	12.88%	3.95%
	1.8, 0.6	2.69%	13.3%	4.66%
Slag with medium PbO content	1.54, 0.4	21.54%	9.34%	21.62%
	1.8, 0.6	20%	9.69%	24.4%
Slag with high PbO content	1.54, 0.4	43.09%	7.92%	38.69%
	1.8, 0.6	40%	8.09%	43.3%

3 CONCLUSION

- The slag composition at reduction process will changes continuously and deduce the slag property changes. The slag melting point will increase with PbO reduction and then decrease with the ZnO reduction.
- Evaporation in practical oxidizing step and PbO reduction step is mainly PbS and PbO respectively.
- PbO in slag evaporates evidently and can causes physical-chemical property measurement uncertainty to high PbO-containing slag.
- Relevant fundamental research should be pushed forward to give references for Pb-smelting parameters control and process optimization.

REFERENCES

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