Minerals characterization of stainless steel EAF and AOD slag

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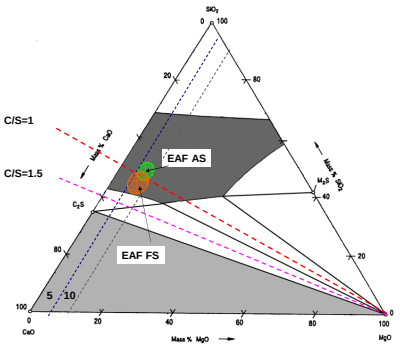
Abstract

The aim of the present slag mapping is to provide the knowledge on the mineral phase and chemical composition of hot stage and slag yard slags. A comprehensive mapping of stainless steel slag from EAF and AOD processes, collected both from high temperature and slag yards was carried out. Minerals of stainless steel EAF and AOD slag oriented to slag stability was investigated by using XRF, Q-XRD and SEM. The samples were collected before the de-slagging process and from the cooled slag yard, respectively. Analysis indicated that both the high and room temperature EAF slags consist of mainly merwinite, akermanite and spinel phases. Cr-oxide exists mainly in the (Mg, Al) spinel phase. With boron treatment ($Na_2B_4O_7$) and cooling, the AOD slags exhibit significantly different minerals between the high and cooled slags. The major minerals of the hot AOD slag (austenitic & ferrtic steels) is γ-Ca_2SiO_4 (C2S), merwinite, bredigite and cuspidine, while the room temperature austenitic AOD slags contain merwinite, bredigite and cuspidine phases. The stabilized C2S phase was found in the yard ferritic AOD slags (C/S: ~ 2.0) after boron treatment and cooling.

Results

Chemical composition of the AS and FS EAF slag

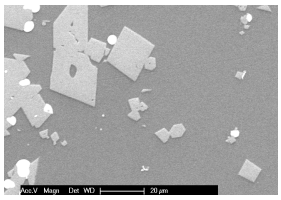


* In practice also Al_2O_3, Cr_2O_3 … present)

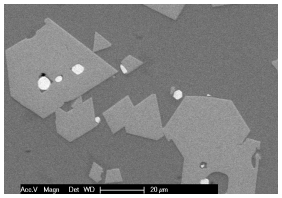
AS EAF slag

Hot stage

Microstructure



Slag yard



Merwinite + Akermanite + Spinel

Cr-oxide distribution in the AS EAF slag

	Hot		Yard	
Sample	Hot A	Hot B	Yard A	Yard B
C/S	0.77	1.05	0.74	0.95
Cr_2O_3 Total	18.2 wt%	6.1 wt%	15.8 wt%	5.6 wt%
Spinel	76 Cr_2O_3	66 Cr_2O_3	78 Cr_2O_3	66 Cr_2O_3
Matrix	6.6 Cr_2O_3	2.1 Cr_2O_3	5.5 Cr_2O_3	1.8 Cr_2O_3

Both EAF AS & FS slags are located in a single liquid slag area at 1600 ° C.
Low C/S value leads to high MgO dissolution.

AS AOD slag

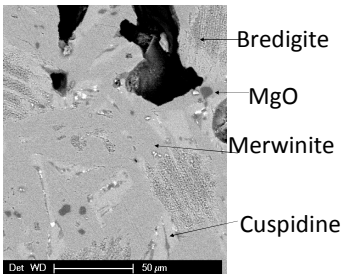
γ-C_2S (10-60 wt%)
Merwinite (10-40 wt%)
Bredigite (20-30 wt%)
Cuspidine (14-20 wt%)
CaF_2 (2-5 wt%)
MgO (2-7 wt%)

Hot slag

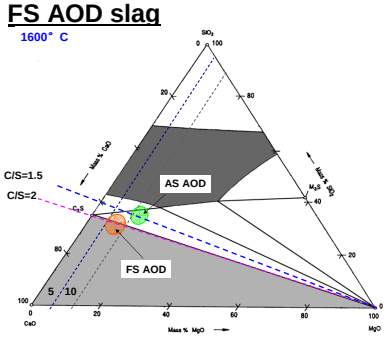
\+ $Na_2B_4O_7$ + Time for reaction

Yard slag

No γ or β-C_2S
Merwinite (45-60 wt%)
Bredigite (12-25 wt%)
Cuspidine (25 wt%)
No CaF_2
MgO (1-3 wt%)



FS AOD slag



Minerals of the hot and yard FS AOD slag

Slag	Hot slag	Yard slag
Morphology	Powder	Aggregate, grey
C/S	2.2~2.6	1.8 ~ 2.1
Phase constitution	**γ-C2S (60-85 wt%)** Bredigite (0-21 wt%) Cuspidine (0-3 wt%) CaF_2 (3-7 wt%) MgO (7-15 wt%)	**β-C2S (30-65 wt%)** Bredigite (10-35 wt%) Cuspidine (15-30 wt%) CaF_2 (0 wt%) MgO (4-12 wt%)
C2S phase	High γ -C2S	High β -C2S
Stabilizer	No	$Na_2B_4O_7$

Both the AS & FS AOD slags are in the area where C2S phase can form. The borate treatment is essential, especially for the FS AOD slags. The AS AOD slag has the basicity 1.4~ 1.7. In this area, the C2S can also be stabilized by MgO or CaF2 to form the stable mineral phases, such as merwinite, bredigite and cuspidine.

Conclusions

- ✓ It is not necessary to treat the EAF slags with borate due to its low basicity and lack of C2S. Cr-oxide is mainly distributed in the spinel phase.
- ✓ The AS AOD slags (C/S: 1.4~1.7) contain the unstable γ-C2S phase at hot stage. With borate addition and cooling, the slag yard slags change into intact aggregates. The much higher content of merwinite and cuspidine phases in the yard slag indicates that the dissolution of MgO and CaF_2 in the C2S phase during cooling.
- ✓ The high C/S value in the FS AOD slag results in the formation of high unstable C2S phase, which need to be stabilized with boron treatment to maintain slag intergrity.

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