Pilot-scale brick production and trials at the steel plants

Fines2EAF - Cement-free brick production technology for the use of primary and secondary raw material fines in EAF steelmaking

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Overview

- Raw materials
- Pilot-scale brick production
- Trials with CaO and MgO-rich bricks for substitution of lime
- Trials with self-reducing Iron-rich bricks
- Results

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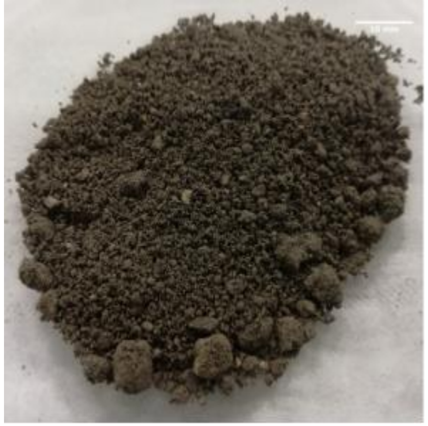
Spend refractory materials

Chem. composition	Weight - %
Aluminium oxide Al_2O_3	14.06
Calcium oxide CaO	36.54
Chromium(III) oxide Cr_2O_3	0.78
Iron(III) oxide Fe_2O_3	12.00
Magnesium oxide MgO	13.17
Manganese oxide MnO	2.84
Phosphorus pentoxide P_4O_{10}	0.59
Sulfur S	0.60
Silicon oxide SiO_2	15.46



Phy. parameters	
Moisture	14.50 %
True denisty	2.5 – 3.5 g/cm³

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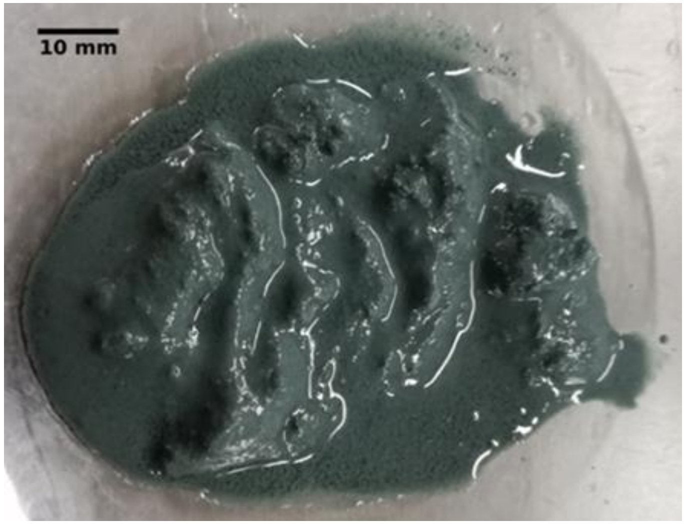
Ladle furnace slag

Chem. composition	Weight - %
Aluminium oxide Al_2O_3	14.55
Calcium oxide CaO	51.52
Chromium(III) oxide Cr_2O_3	0.112
Iron(III) oxide Fe_2O_3	1.54
Magnesium oxide MgO	6.92
Manganese oxide MnO	0.64
Phosphorus pentoxide P_4O_{10}	0.50
Sulfur S	1.45
Silicon oxide SiO_2	19.65



Phy. parameters	
Moisture	45.51 %
True denisty	4.50 g/cm³

Combustion chamber dust

Chem. composition	Weight - %
Aluminium oxide Al_2O_3	1.91
Calcium oxide CaO	9.30
Chromium(III) oxide Cr_2O_3	1.29
Iron(III) oxide Fe_2O_3	64.09
Magnesium oxide MgO	1.95
Manganese oxide MnO	3.46
Zinc oxide ZnO	7.78
Potassium oxide Na_2O	3.17
Silicon oxide SiO_2	4.39

Phy. parameters	
Moisture	6.95 %
True denisty	4.2 g/cm^3

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Oxicutting fines

Chem. composition	Weight - %
Aluminium oxide Al_2O_3	0.17
Calcium oxide CaO	1.30
Chromium(III) oxide Cr_2O_3	0.65
Iron(III) oxide Fe_2O_3	92.72
Magnesium oxide MgO	0.37
Manganese oxide MnO	0.82
Phosphorus pentoxide P_4O_{10}	0.53
Sulfur S	0.19
Silicon oxide	1.07

Phy. parameters	
Moisture	4.7 %
True denisty	4.7 g/cm³

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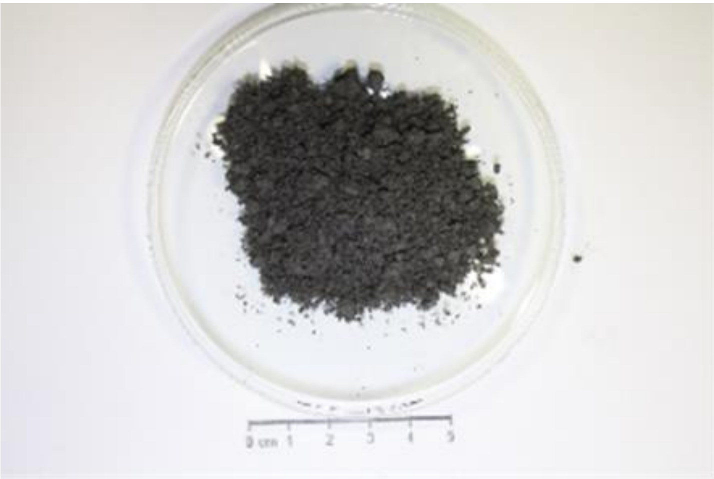
Grinding sludge

Chem. composition	Weight - %
Aluminium oxide Al_2O_3	1.07
Calcium oxide CaO	0.16
Chromium(III) oxide Cr_2O_3	1.74
Iron(III) oxide Fe_2O_3	92.10
Magnesium oxide MgO	0.10
Manganese oxide MnO	0.32
Phosphorus pentoxide P_4O_{10}	0.44
Sulfur S	0.01
Silicon oxide	3.58



Phy. parameters	
Moisture	25.30 %
True denisty	5.3 g/cm³

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Recipes

Exp.	LF-slag	Spend refractory	Paper fibres	Wheat starch	Potato starch
MI31R	53.1 %	38.5 %	0.77 %	7.7 %	
MI52C	53.4 %	38.7 %	0.20 %		3.9 %

Exp.	Grinding sludge	Oxicutt-ing fines	Combust. Chamber dust	Coal	Polymeric binder	Molasses
MA604B	46.5 %	34.5 %		13.4 %	1.4	
CC02		40.9 %	40.9 %	15.3 %		3.0 %

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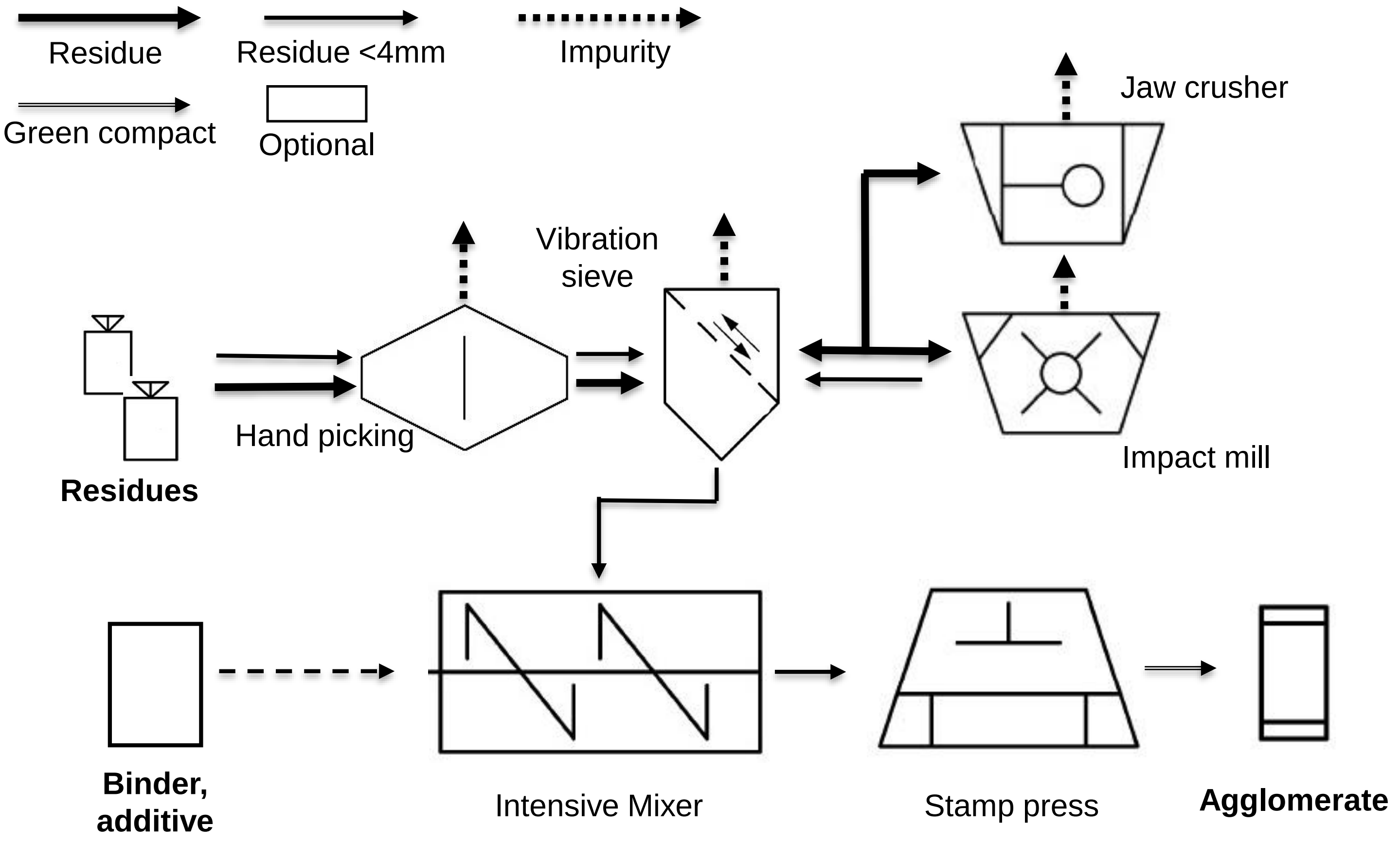
Flow chart of the brick production



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Impressions of the production






Trials with CaO- and MgO-rich bricks for substitution of lime

- Trials at 2 AC-EAFs for carbon steel (EAF 1) and alloyed steel (EAF 3) (each 100 t tapping weight) in two campaigns
- Per charge 3,000 kg pneumatically injected fine lime and additionally 1,000 kg CaO- and MgO-containing slag former via scrap basket
- Stepwise 500 kg of bricks charged with the first scrap basket and substituted partly or completely the coarse dolomitic lime
- Slag samples of each charge and reference samples

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Campaign 1

Number of Samples	Recipe	EAF	Charged materials
2	Reference	1	1,000 kg Dolomitic lime + 0 bricks
4	MI31R	1	1,000 kg dolomitic lime + 500 kg bricks
4	MI31R	1	800 kg dolomitic lime + 500 kg bricks
4	MI31R	1	500 kg dolomitic lime + 500kg bricks
3	MI31R	1	0 kg dolomitic lime + 2,000 kg bricks

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Campaign 2

Number of Samples	Recipe	EAF	Charged materials
2	Reference	1	1,000 kg dolomitic lime + 0 kg bricks
4	MI52C	1	0 kg dolomitic lime + 2,000 kg bricks
2	Refeence	3	1,000 kg dolomitic lime + 0 bricks
4	MI31R	3	0 kg dolomitic lime + 2,000kg bricks

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Results (EAF-slag composition)

Campaign 1

wt.-%	Mg	Al	Si	Ca	Ti	Cr	Mn	Fe
R1-EAF1	3,36	7,63	22,35	21,36	0,47	2,89	5,92	36,00
E1-1000-500	4,26	5,93	26,89	26,36	0,45	2,69	6,59	26,46
E1-800-500	4,83	7,40	20,75	28,31	0,45	2,94	6,44	28,93
E1-500-500	4,04	6,06	19,98	32,85	0,47	2,11	6,40	27,99
E1-0-2000	4,13	8,86	24,00	26,61	0,59	3,05	7,40	25,09

Campaign 2

wt.-%	Mg	Al	Si	Ca	Ti	Cr	Mn	Fe
R2-EAF1	3,11	7,895	21,37	21,90	0,59	4,815	7,4	32,84
E1-0-2000	3,41	5,14	19,28	30,17	0,41	1,56	8,58	31,29
R2-EAF3	4,01	5,65	19,70	29,29	0,26	2,17	7,18	31,49
E3-0-2000	2,62	10,91	24,01	21,24	0,73	2,54	6,00	31,93

Results

- Composition of the EAF slag formed by residue bricks is typical for EAF slag
- No changes in the composition of the slag for both recipes
- No negative influence to raw steel composition and metallurgical performance
- No changes in the composition and the quality (environmental view) of the slag

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Trials with self-reducing Iron-rich bricks

- Trials at AC-EAF for carbon steel and alloyed steel (135 t tapping weight) in two campaigns
- Charging through 5th hole located on the roof of the furnace
- 3 heats with each 5 t of CC02
- 3 heats with each 5 t of MA604B
- Slag sample of each charge and reference samples
- Calculated metallic yield via mass balance
- Energy consumption measured

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Results for trials with CC02

- Mass balance indicates that 0.9 tons out of 7 tons Fe available in the bricks were recovered (13%). Most of the Fe in the bricks in the off-gas due to disintegration of the bricks due to long storage under harsh weather conditions
- Electrical consumption: no significant difference (<0,1% difference)
- Slag weight: no significant difference, slag removal on each heat is too variable and operator dependant
- Slag composition: no significant difference

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Results for trials with MA604B

- Mass balance indicates that 5.5 tons out of 8.9 tons Fe available in the bricks were recovered (62%)
- Electrical consumption: No significant difference (<0,1% difference)
- Slag weight: No significant difference, slag removal on each heat is too variable and operator dependant
- Slag composition: No significant difference

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Thank you for your attention

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