Practical Applications of FactSage at VOEST Donawitz

Alexander Paul

Content

- Goal and motivation
- Facilities and aim of the secondary metallurgy treatment
- Calculations and comparisons
- Summary

Goal and motivation

- **Goal:**

  The secondary metallurgy helps to reduce the NMI and modifies their composition.

- **Motivation:**

  The understanding of the thermodynamics of the secondary metallurgical treatment helps to fit the optimal operating parameters.

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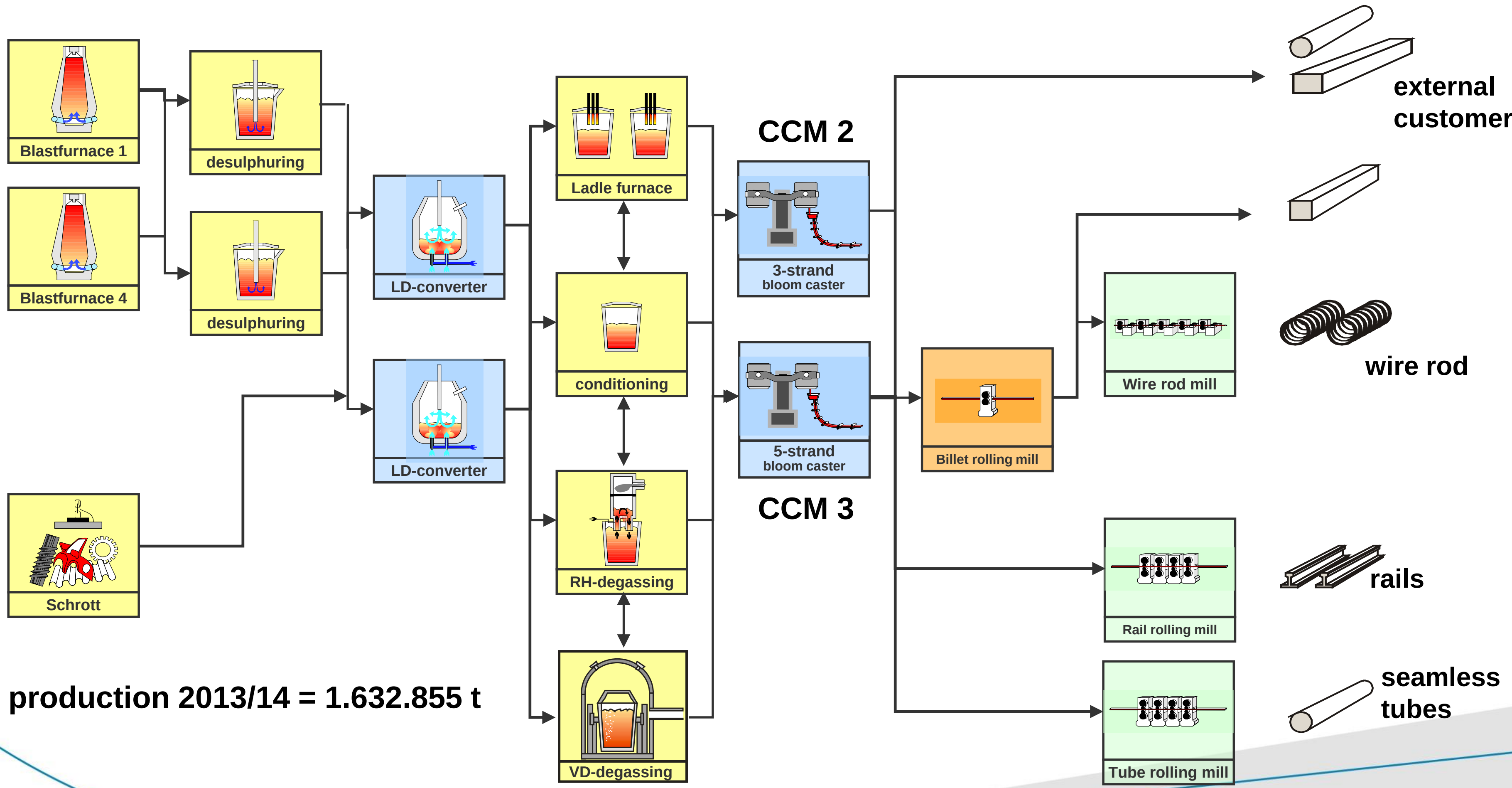
Flowchart: voestalpine Stahl Donawitz GmbH



production 2013/14 = 1.632.855 t

Why ladle furnace?

Operating parameters:

- 65 t capacity
- 5 °C/min heating capacity
- Ladle lining based on Al_2O_3

Aim of the treatment:

- Regulation of temperature
- Si/Mn deoxidation
- Slag treatment
- Bubbling
- Modification of the NMI-composition
- Agglomeration and segregation of NMI

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Why vacuum-(RH)-treatment?

Operating parameters:

- 1550-1600 °C
- 1 mbar
- 12-20 min

Aim of the treatment:

- Vacuum-carbon-deoxidation (C=0.5-0.7%)
- Reduction of O_{tot} (total oxygen content)
- Modification of the NMI-composition
- Agglomeration and segregation of NMI

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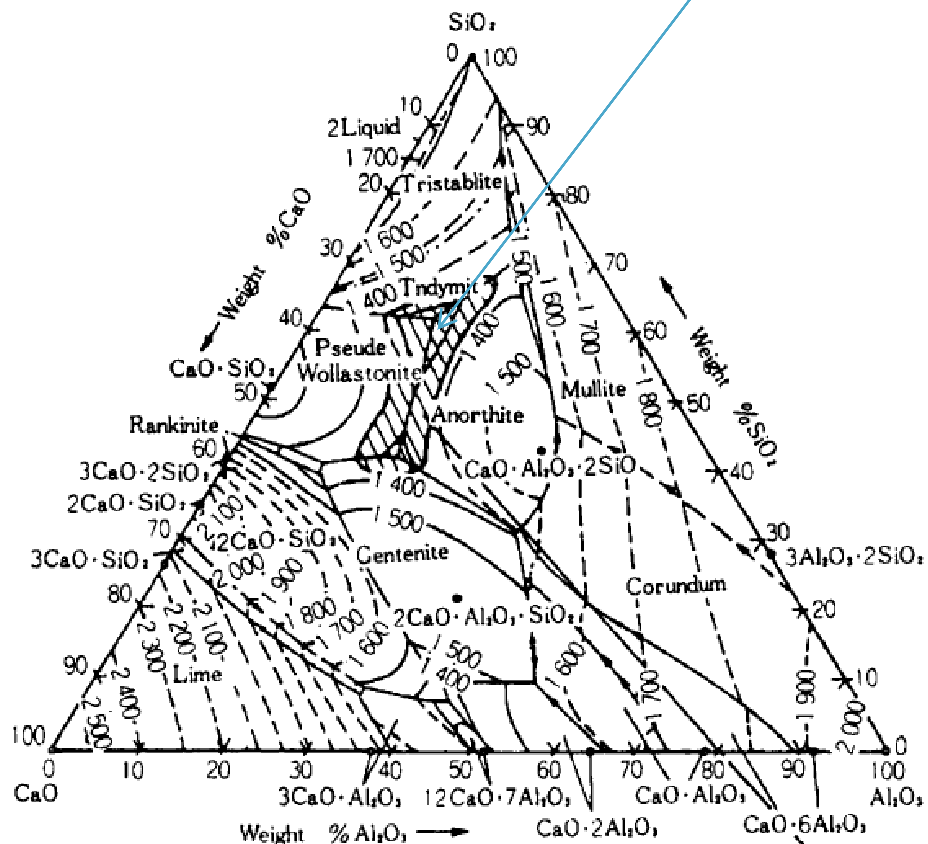
Modification of the NMI

target composition



- NMI composition is near the eutectic depression (Anorthite-Wollastonite-Tridymit)
- NMI-Size:
  - As less as possible and small (<5µm) NMI

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Starting conditions variation 1

Parameters:

- pressure variation between 1 and 0.001 bar
- 1600°C
- O_{tot} = 120 ppm

Databases and Solutions

- FSstel
  - FSstel-Liqu
- FToxid
  - FToxid-SlagA
  - FToxid-bC2S
- FactPS
  - pure solids
  - gas

steel analyse						
C	Si	Mn	Cr	Al	Ca	Mg*
w%	w%	w%	w%	ppm	ppm	ppm
0.53	1.60	0.65	0.65	15	1	0.5

*accepted

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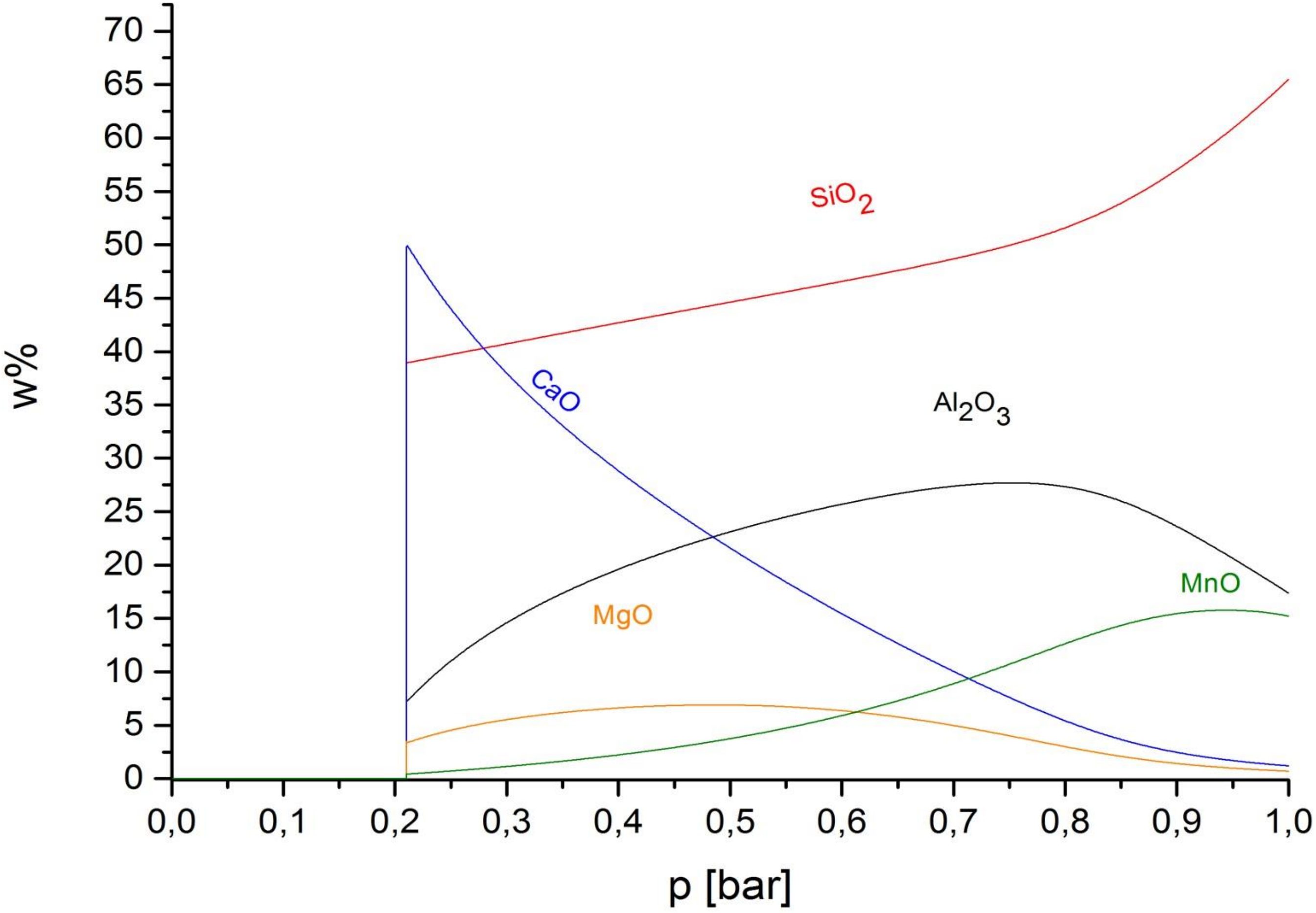
Result variation 1



Starting condition variation 2

Parameters:

- variation of the O_{tot}-content between 120 and 5 ppm
- 1600°C
- 1 bar !!!

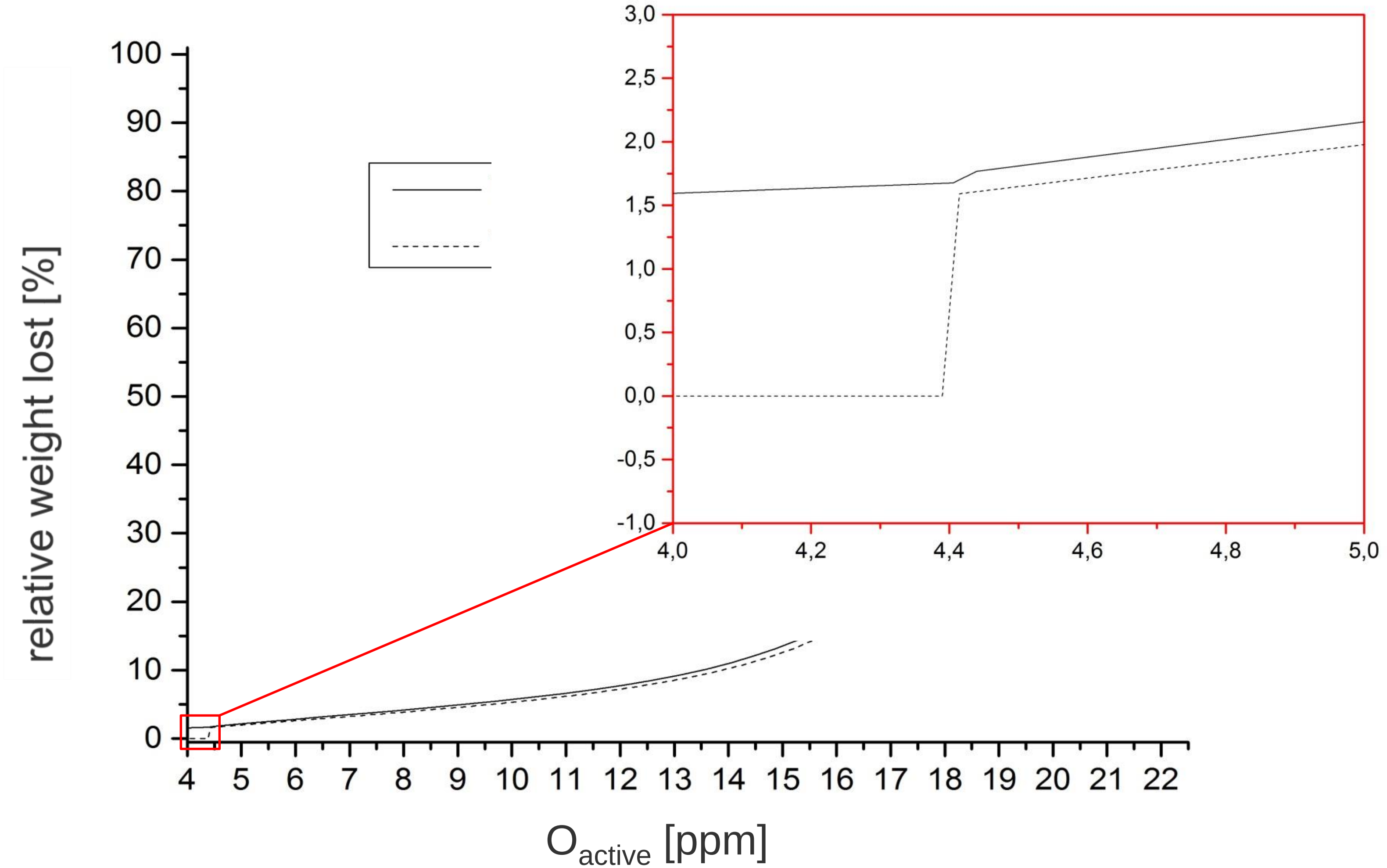
Databases und Solutions

- FSstel
  - FSstel-Liqu
- FToxid
  - FToxid-SlagA
  - FToxid-bC2S
- FactPS
  - pure solids

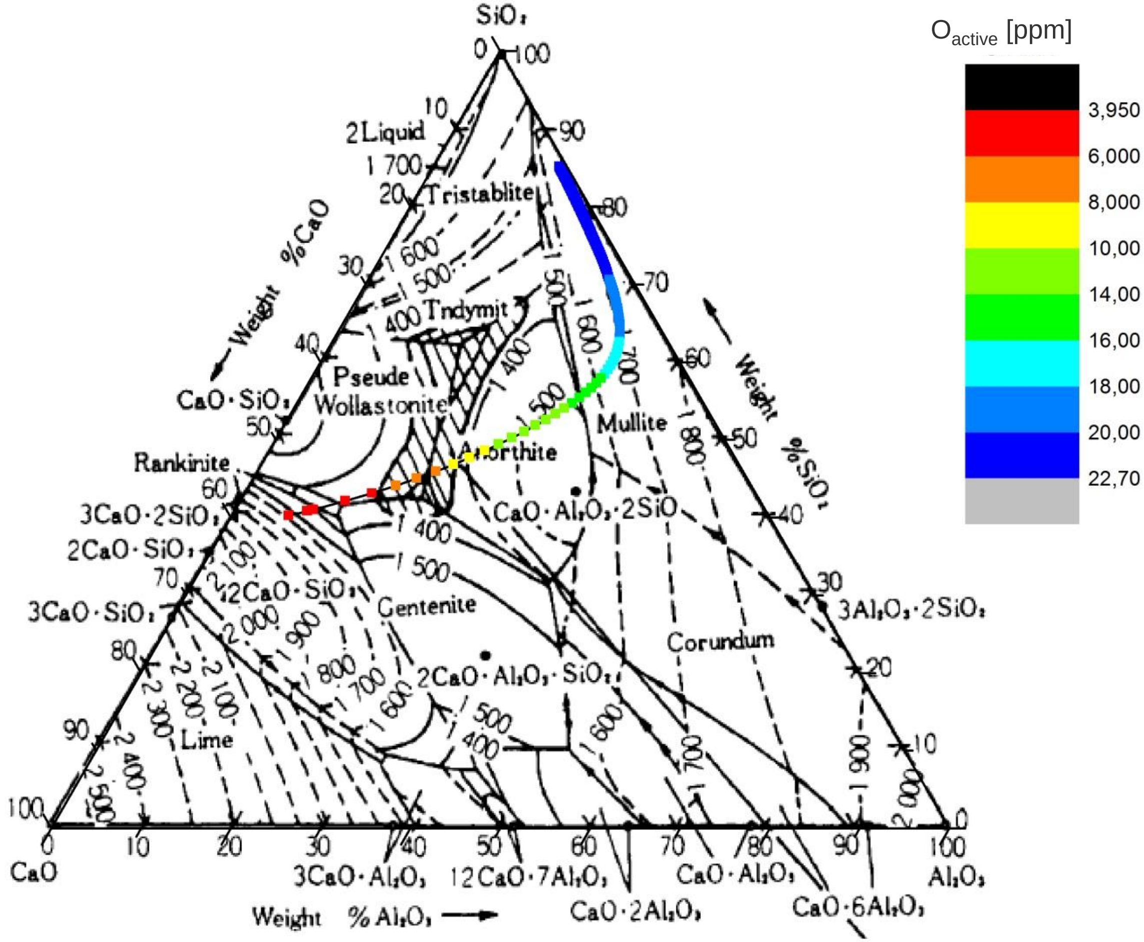
steel analyse						
C	Si	Mn	Cr	Al	Ca	Mg*
w%	w%	w%	w%	ppm	ppm	ppm
0.53	1.60	0.65	0.65	15	1	0.5

*accepted

Comparison of Variation 1 and 2



Results and comparison of the modification

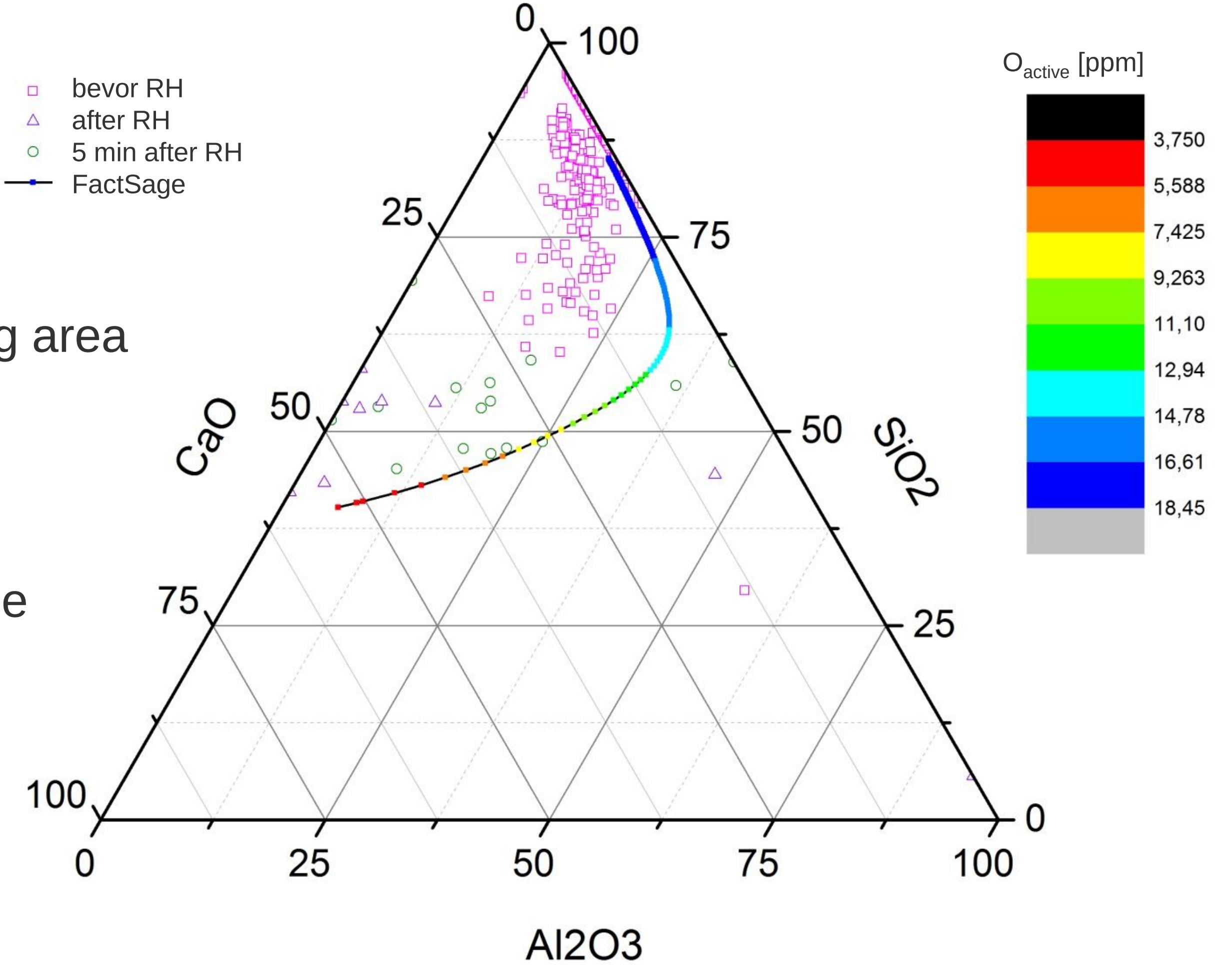


Results and comparison of the modification

Particle analyses:

- ca. 21.4mm² measuring area
- NMI > 1µm ECD
- Elementes:

  O,Na,Mg,Al,Si,P,
  S,Cl,K,Ca,Ti,V,Cr,Mn,Fe



Starting conditions variation 3

Parameters:

- variation of the O_{tot}-content between 120 and 5 ppm
- 1600°C
- 1 bar !!!
- $a(Al_2O_3(S6))=0,03 \cong 0.015kg_{FF}/t_{steel}$ chemical refractory wear
- total refractory wear $\cong 0.6\ kg_{FF}/t_{steel}$

Databases und Solutions

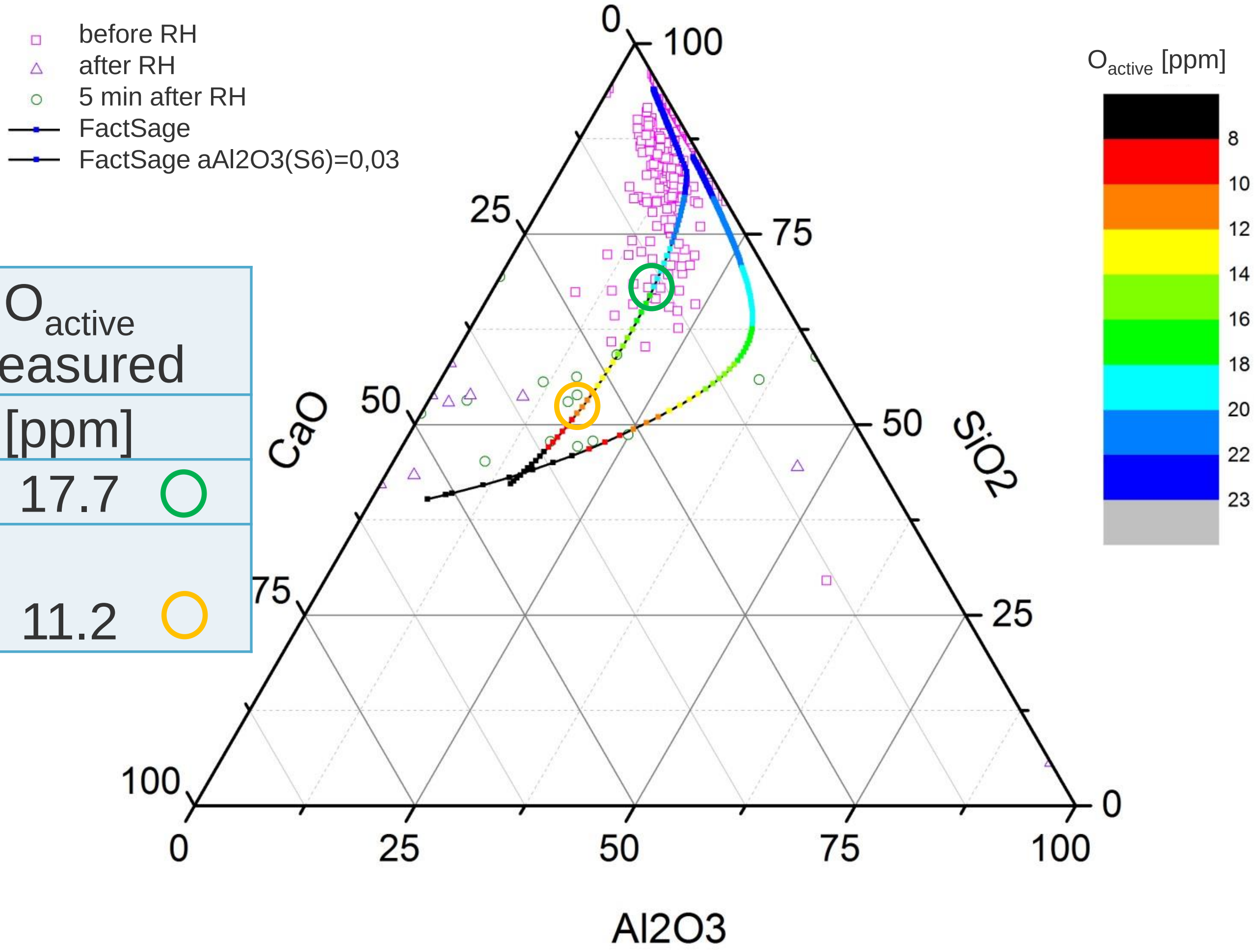
- FSstel
  - FSstel-Liqu
- FToxid
  - FToxid-SlagA
  - FToxid-bC2S
- FactPS
  - pure solids

steel analyse						
C	Si	Mn	Cr	Al	Ca	Mg*
w%	w%	w%	w%	ppm	ppm	ppm
0.53	1.60	0.65	0.65	15	1	0.5

*accepted

Results and comparison of the modification

	O_{active} measured [ppm]
End of LF	17.7
5 min after RH	11.2



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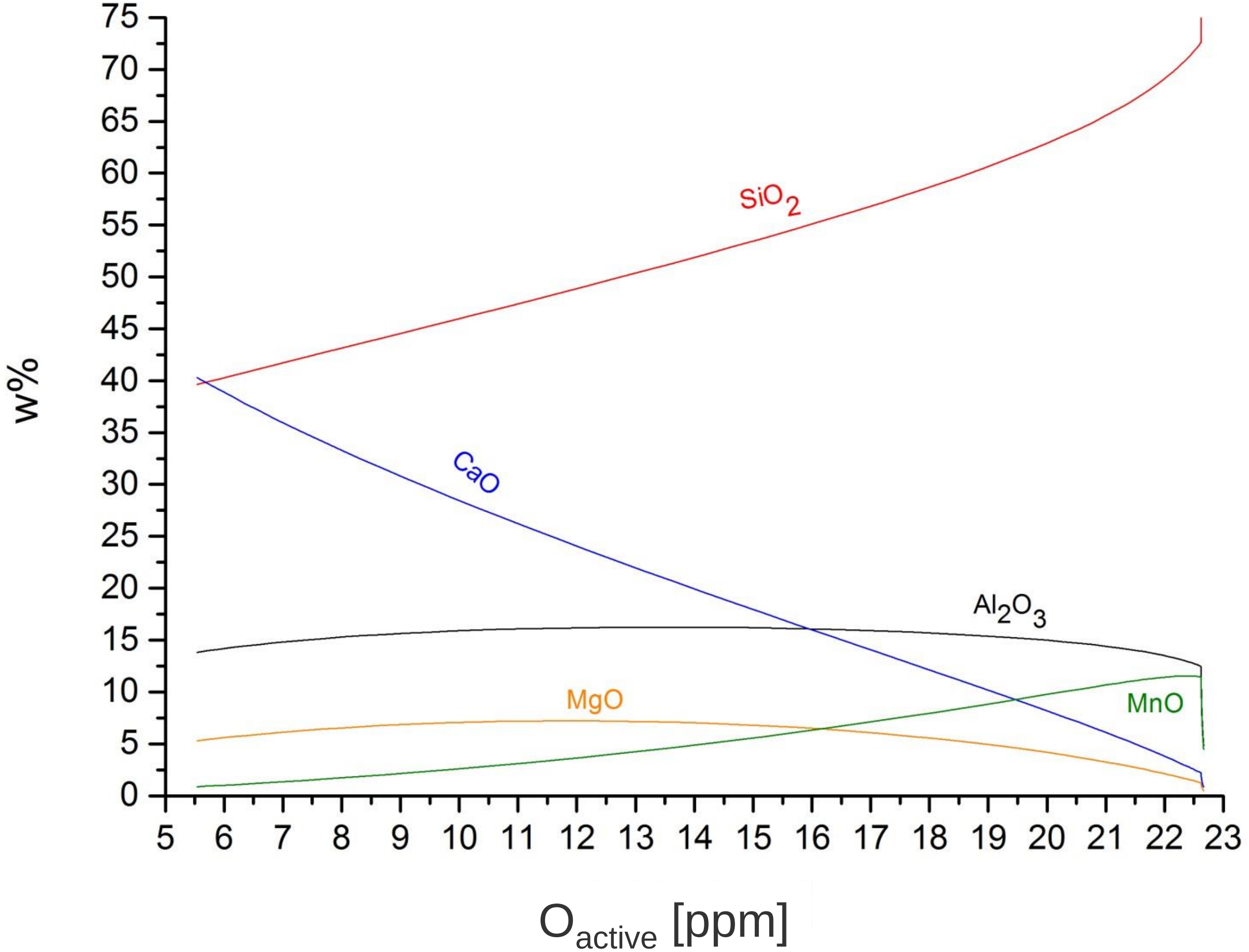
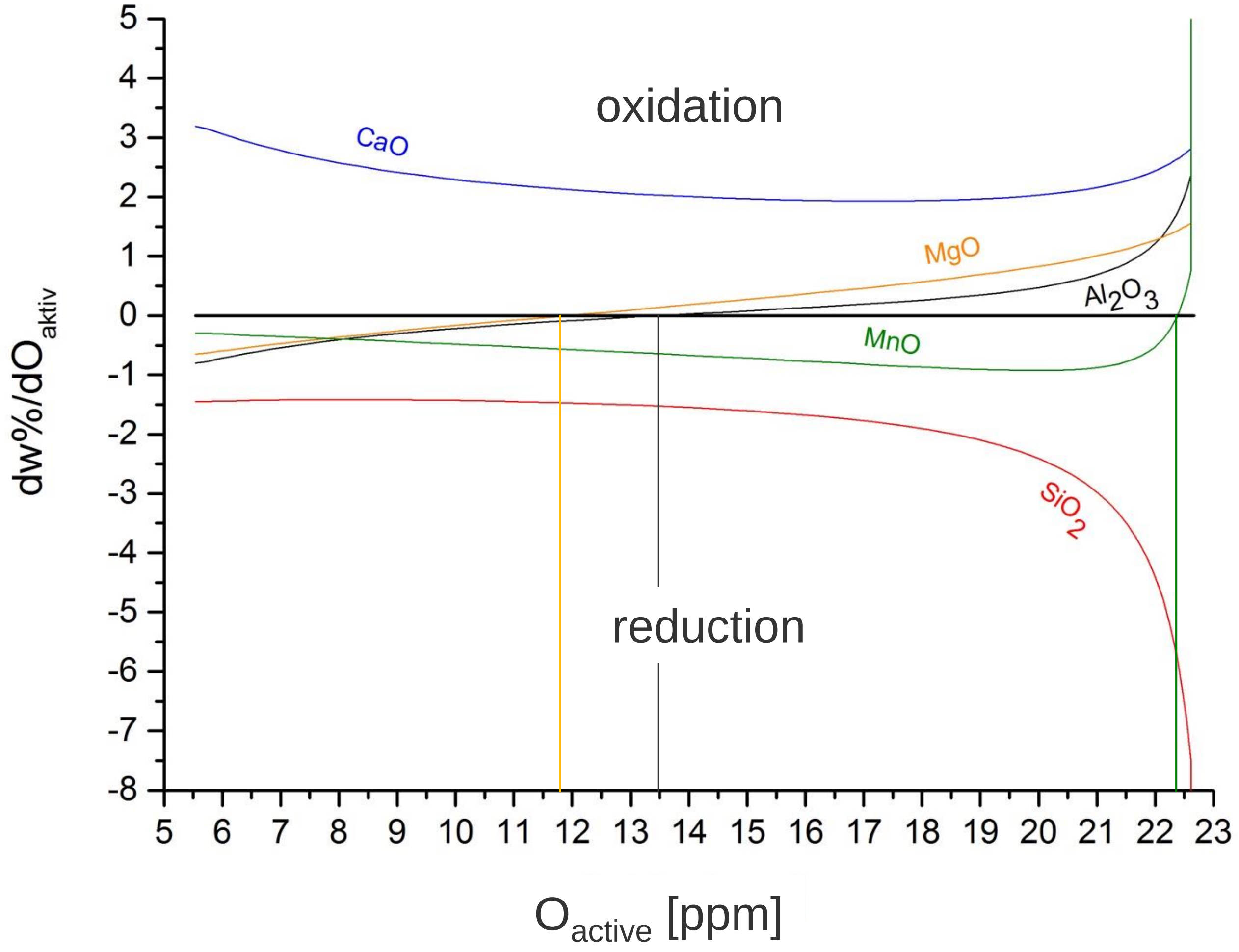
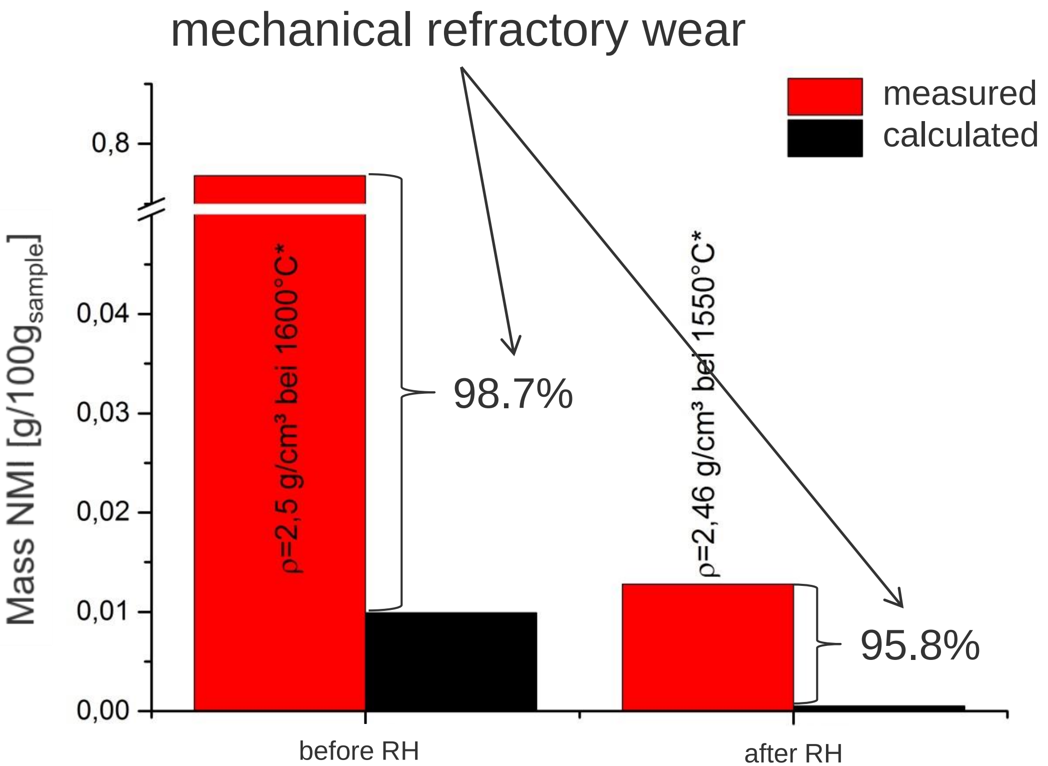
Devolution of the oxide phases



Devolution of the oxide phases



Results and comparison of the NMI-mass



*source: slag atlas

acceptation for measured NMI

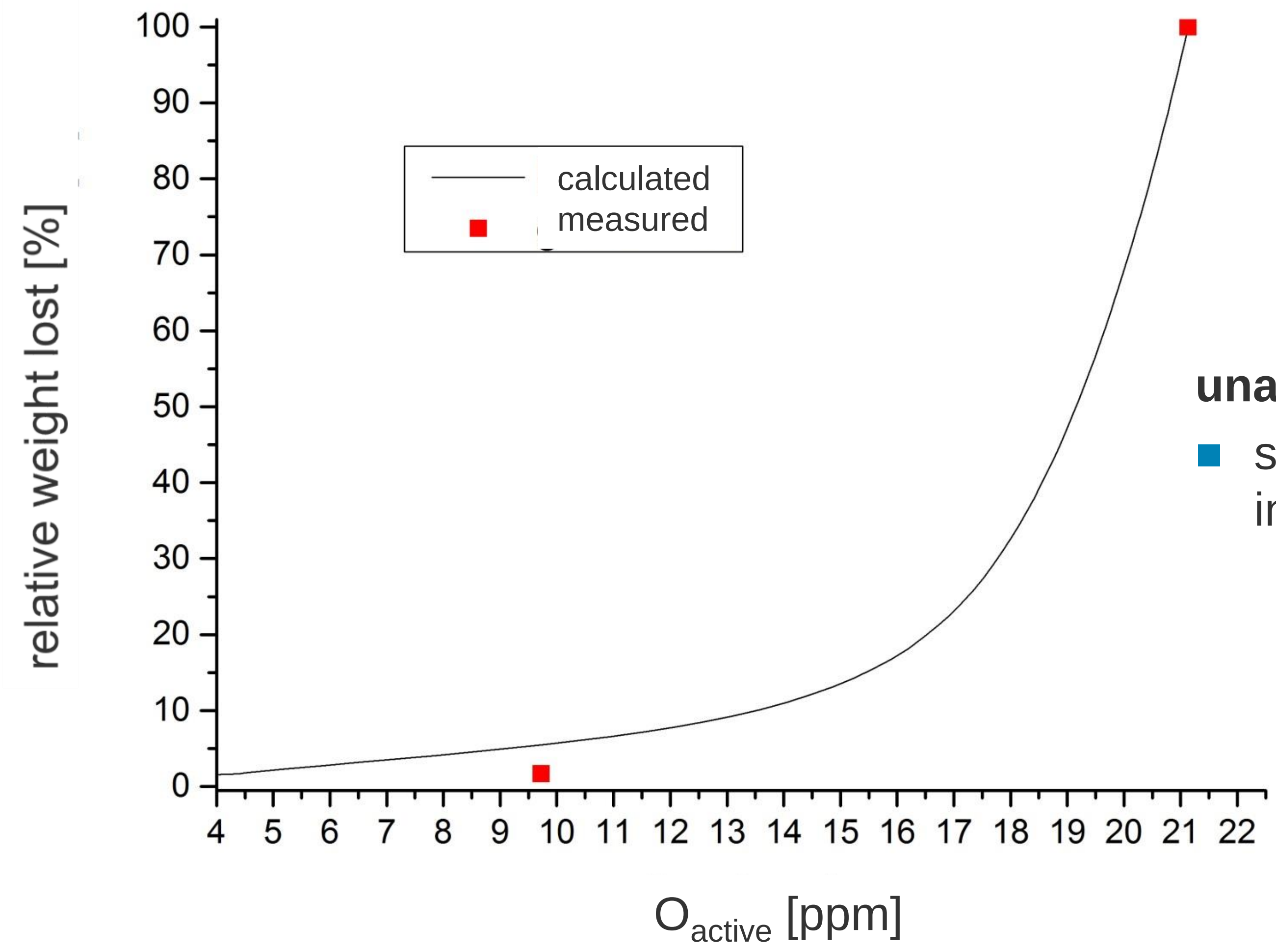
- spherical NMI
- density related to the average composition

unaccounted

- refractory wear (mechanical)
- reoxidation effects

Average chemical refractory wear 0.016 kg/t_{Stahl}

Relative weight lost



unaccounted:

- separation of the NMI into the slag!!!

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Summary

- The active oxygen content influences significantly the NMI modification.
- The variation of the system pressure leads to the desolution of the NMI below 0.21 bar (4.4 ppm O_{active}).
- The variation of the total oxygen content leads to the formation of $2CaOSiO_2$ at O_{active} < 4.4 ppm (without refractories)
- The influence of the refractory material can be described by fixing the activity of Corundum.
- At low active oxygen contents below 10 ppm, the fixing of the activity of Corundum lost it’s validity.

Thank you!

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