Investigation of convertor slag properties and their influence on steel refining

GTT user meeting 2018

Lotte De Vos
Lotdevos.devos@ugent.be
Outline

Introduction
Background
Topics of the PhD
Highlight: Phase diagram
Conclusion
Introduction: Involved partners

Academic partner:

Research group Sustainable Materials Science (SMS)
Department of Materials, Textiles and Chemical Engineering
Ghent University

Industrial partner:

ArcelorMittal Gent
Background: **BOF Steelmaking**

**Goal:**
Decrease carbon content & remove impurities
→ Production of steel

**How:**
Liquid hot metal + scrap + fluxes into converter
Next oxygen is blown through it

**Formation of 3 “phases”:**
1. Steel
2. Gas
3. Slag
Background: **Slag in BOF steelmaking**

Slag present in converter has 3 important roles:

1. **Refining**
   Decrease [C], [P] and [Si]

2. **Protection refractory**
   less aggressive slag increases the lining life.

3. **Shielding through foaming**
   act as a barrier for e.g. metal droplets ➔ decreasing losses.
Background: Goal

Gain fundamental and scientific insights about the influence of different slag components (MgO, Al₂O₃, V₂O₅, etc.) upon the slag ‘functions’
Topics of the PhD

General understanding influence of components
  ➔ Construction Phase Diagrams

Effect on refining
  ➔ Equilibrium calculations

Interaction Refractory
  ➔ Equilibrium calculations

Foaming behaviour
  ➔ Physical parameters
Equilibrium calculations

Investigation of effect of different ‘slag’ components

Find way to ‘simulate’ process
   Closed calculations
   Open calculations
   Complexer approaches ?? (e.g. EERZ Model concepts proposed by Van Ende and Jung (*))

V_{2}O_{5} ??

Physical parameters

Foaming behaviour

1. Viscosity ➔ Model exists
2. Density ➔ Model exists
3. Surface tension ➔ ??
Topics of the PhD

General understanding influence of components

→ Construction Phase Diagrams

Effect on refining

→ Equilibrium calculations

Interaction Refractory

→ Equilibrium calculations

Foaming behaviour

→ Physical parameters
Highlight: Phase diagram

Base ternary diagram: CaO-SiO$_2$-FeO$_n$

Equilibrium with ‘Pure Fe’

Addition of extra components

Step 1: “Reproduction” base diagram

CaO-FeO-SiO$_2$-Fe @ T = 1650°C

Fe/(CaO+FeO+SiO$_2$)=Cte

⇒ approach to calculate equilibrium
Step 2: Additions of components

Components of interest:

\[ \text{Al}_2\text{O}_3, \text{MgO}, \text{MnO}, \text{Cr}_2\text{O}_3, \text{TiO}_2, \text{V}_2\text{O}_5 \]

Addition:

\[ \text{CaO} + \text{SiO}_2 + \text{FeO} = 100\% \]

\[ \frac{x}{(\text{CaO} + \text{SiO}_2 + \text{FeO})} = \text{value} \]

@T = 1650°C
Example: Effect MgO and link industry

Most important: MgO saturation line!

+2% MgO $\rightarrow$ No real influence

+5% MgO $\rightarrow$ Clear MgO saturation line

Existence certain threshold value also observed in industry
Conclusion

Opportunities to integrate thermodynamic databases in steel industry

Still a lot to learn: Suggestions and advice?
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