

Dynamic on-line monitoring and end-point control of dephosphorisation in the BOF

SimuSage Modelling, Part I

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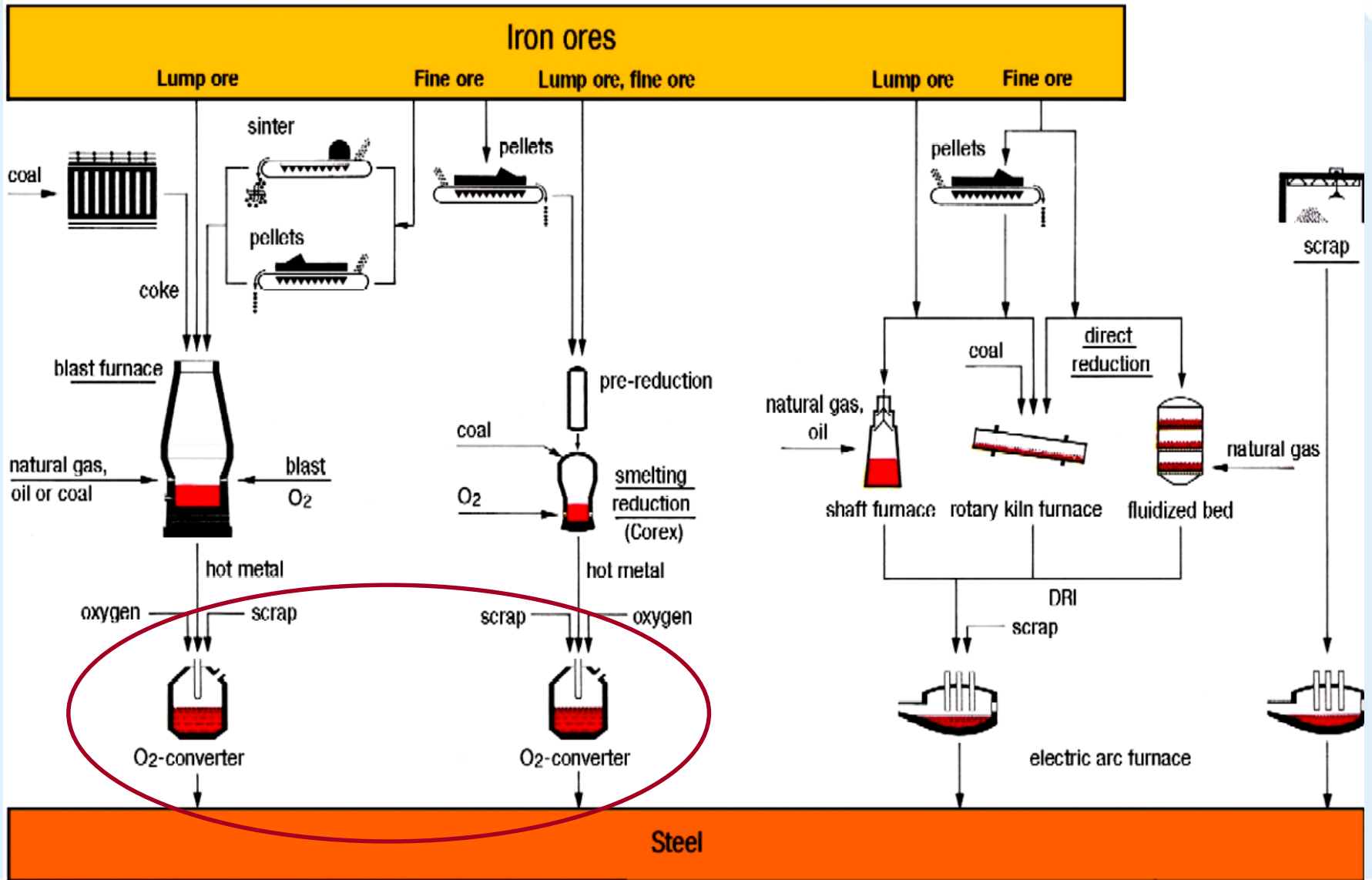
Fundamentals / Models



- **BOF process**
 - Steelmaking routes
 - Operational steps in BOF
 - Oxidation reactions & emulsion generation in BOF-converter

- **Revision of existing LD-Sage converter model**
 - Modelling concept - equilibrium model
 - The materials flow scheme
 - The model user interface
 - Data preparation for the model input
 - Model results

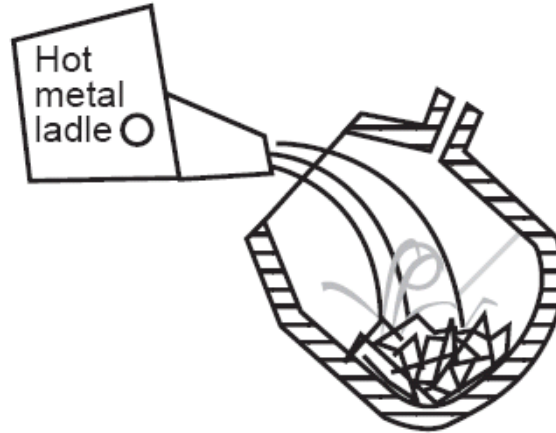
- **Outlook**



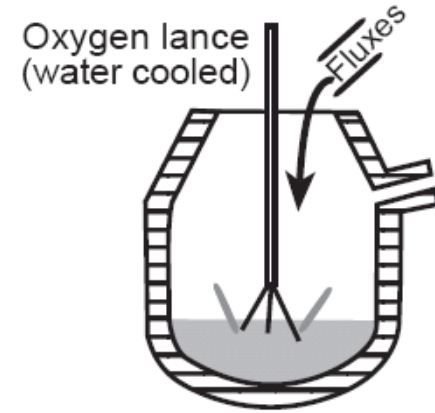
Operational steps in BOF



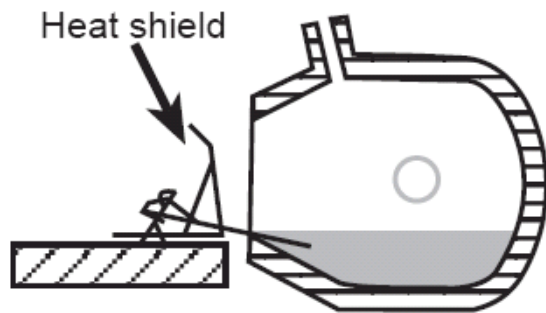
Charging scrap



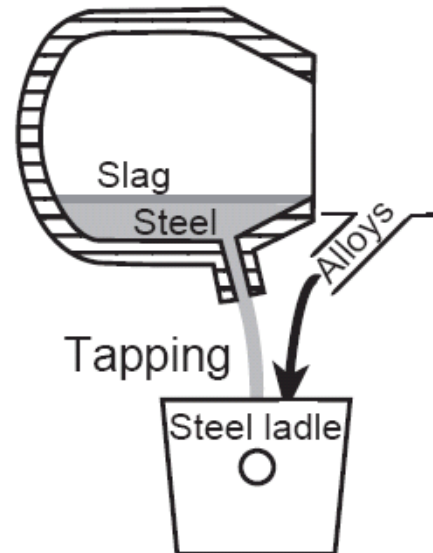
Charging hot metal



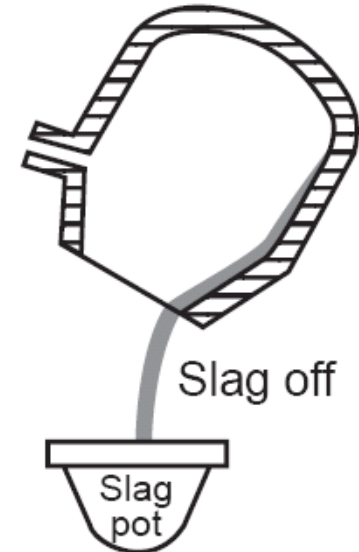
Main blow



Sampling

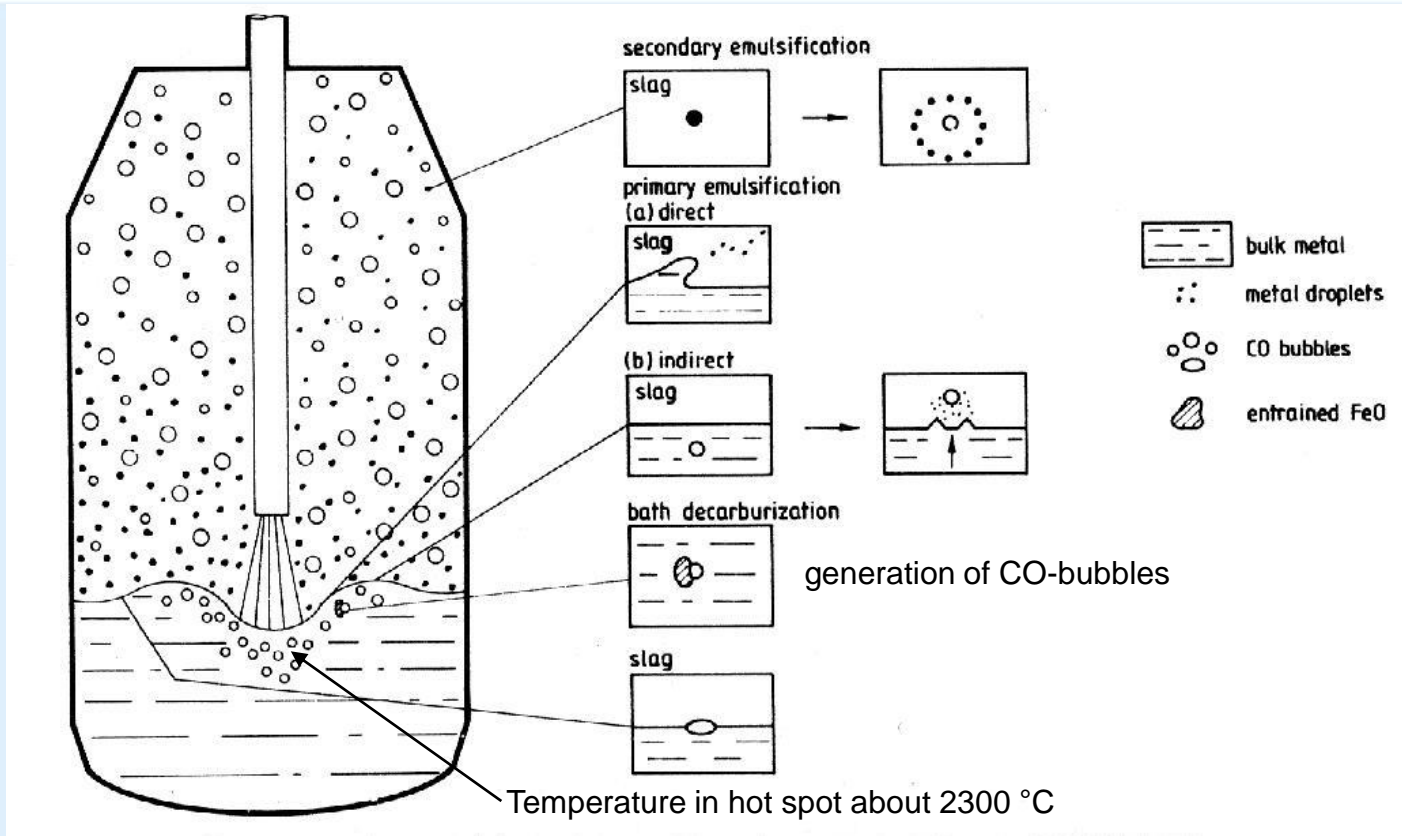


Tapping

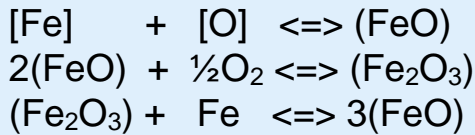


Slag off

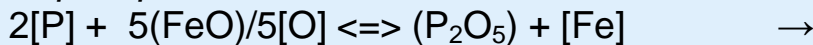
Oxidation reactions & emulsion generation in BOF-converter



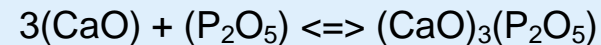
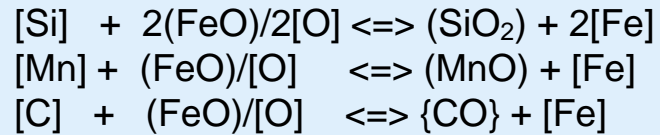
Iron slagging & slag enrichment with the oxygen:



Dephosphorisation:

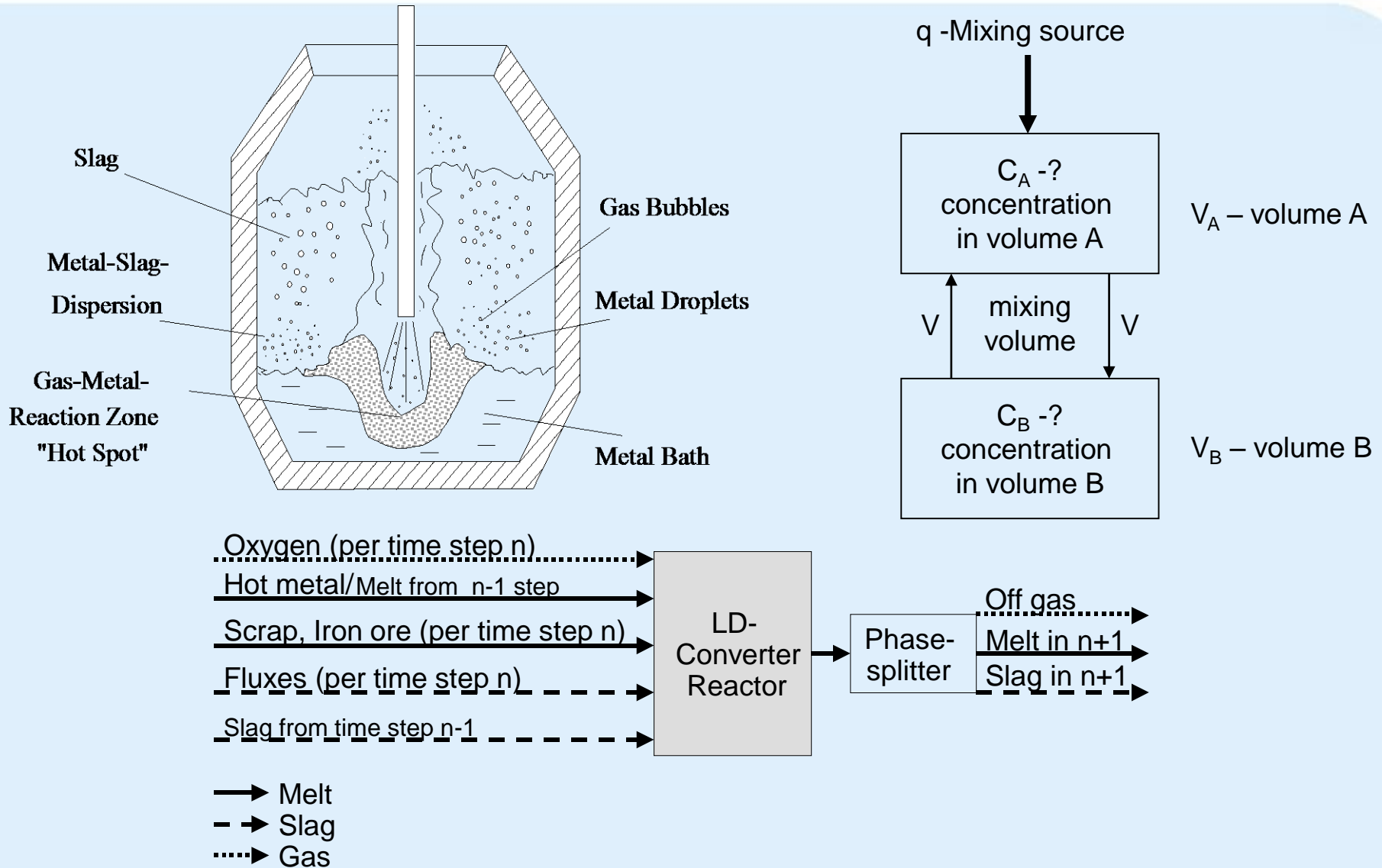


Slagging of tramp elements:



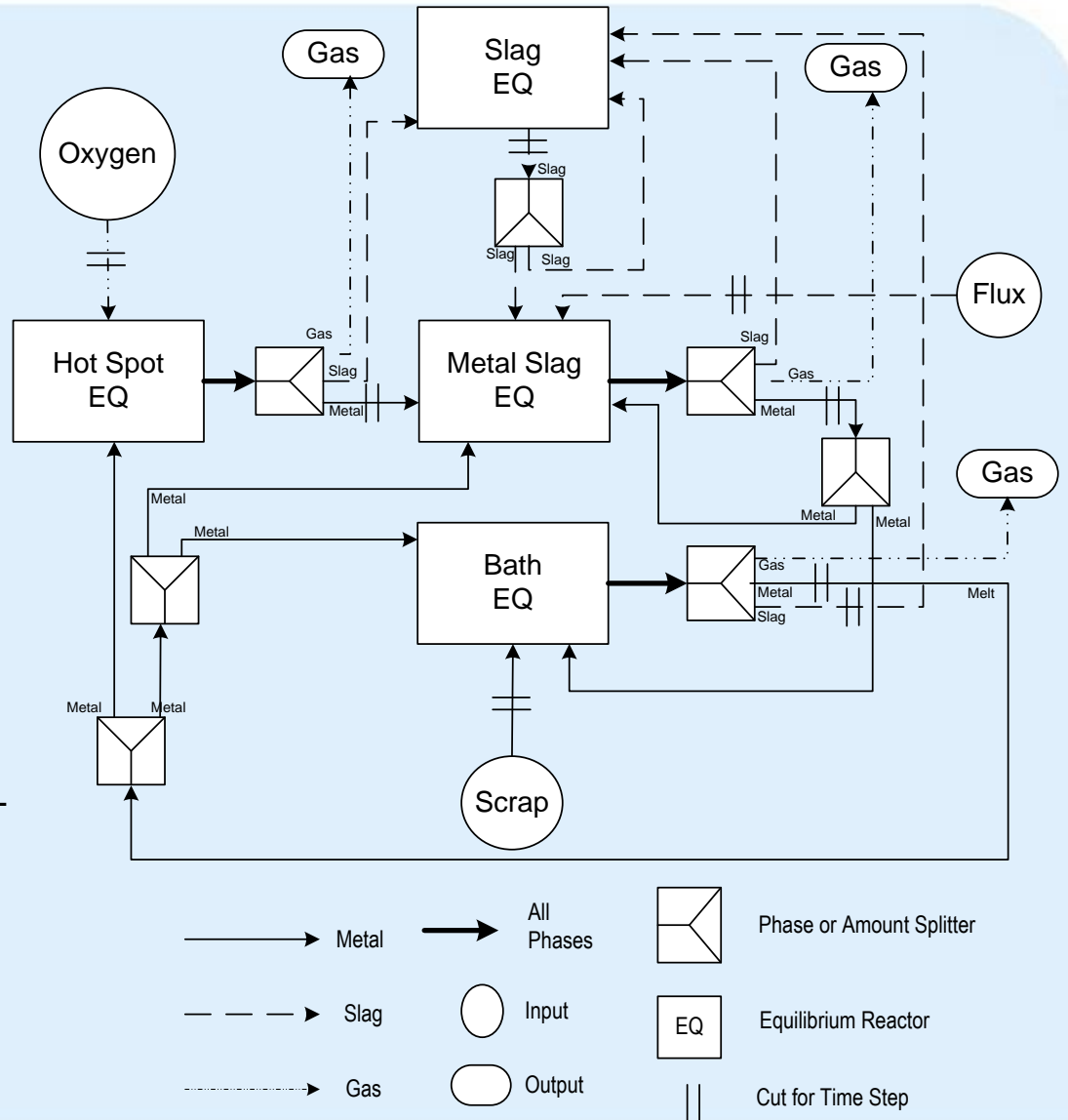
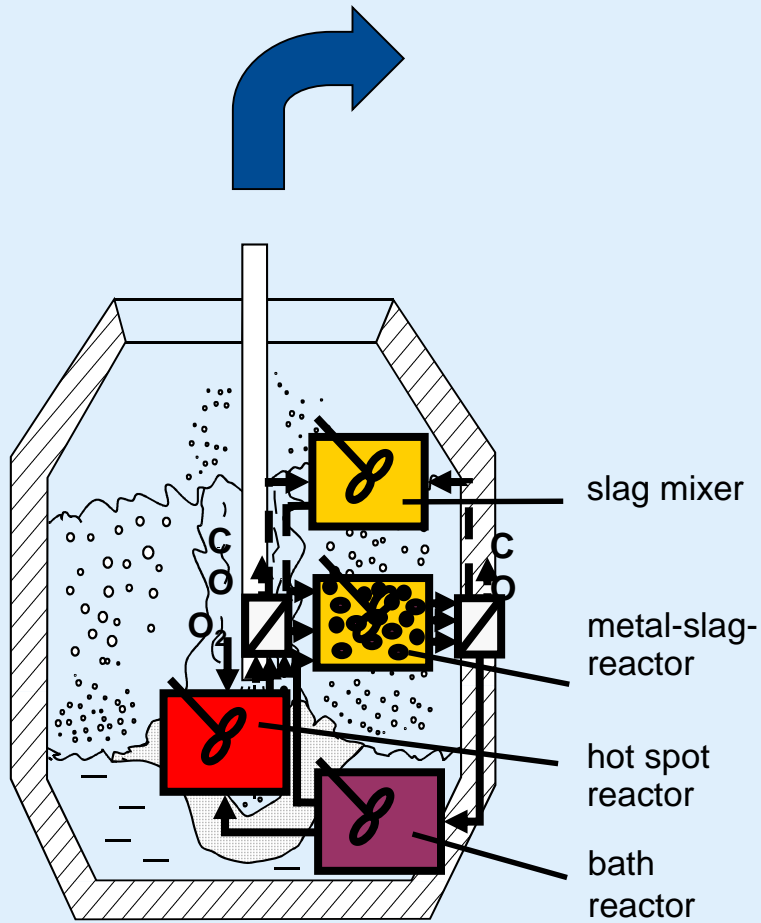
[] : metal phase
 () : slag phase
 { } : gas phase

Modelling concept - equilibrium model

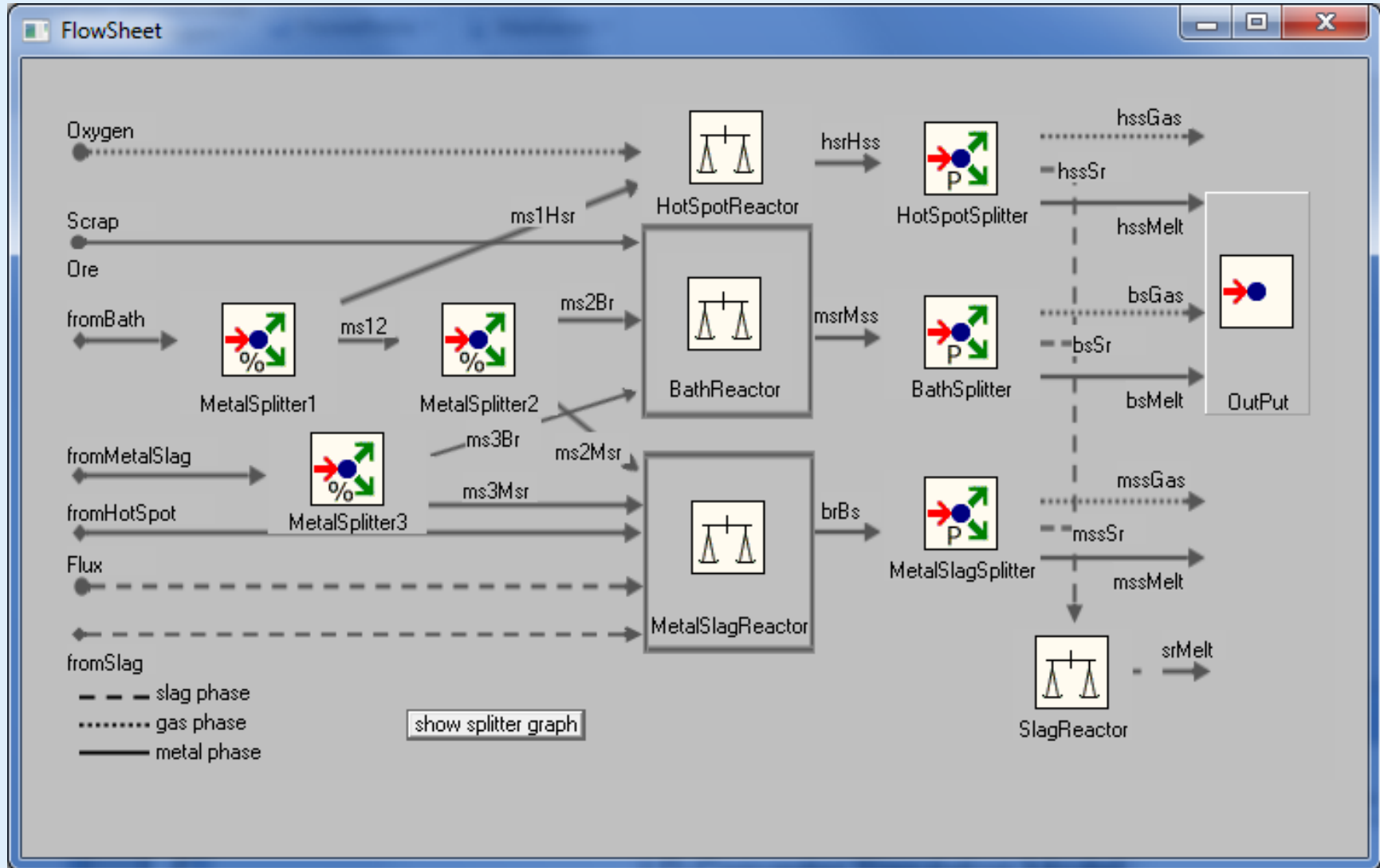




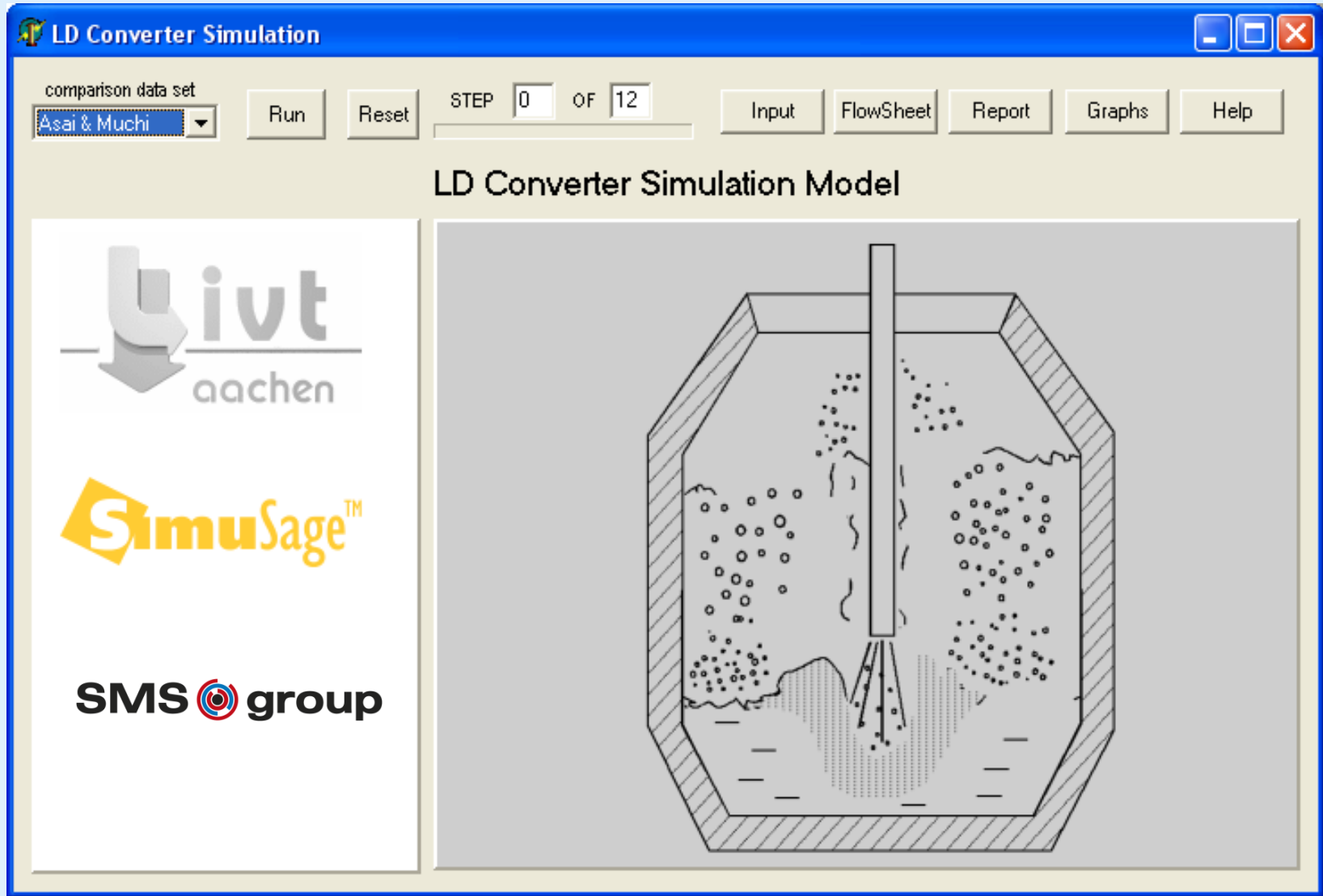
The materials flow scheme



The flowsheet „translated into SimuSage“



The model user interface



The model user interface: input amount window

Input
- □ ×

Initial Melt Composition:

| | kg | wt.-% |
|--------------------|-----------|---------|
| Total Mass: | 0294809 | |
| Iron (Fe): | 924.09359 | 94.951 |
| Carbon (C): | 12853.672 | 04.3600 |
| Silicon (Si): | 825.4652 | 00.2800 |
| Phosphorus (P): | 241.74338 | 00.0820 |
| Manganese (Mn): | 913.9079 | 00.3100 |
| Sulphur (S): | 50.11753 | 00.0170 |
| Temperature: | 1294 | °C |

Duration of process 16.4 min

Accept Changes

Oxygen and Allowences

Blowrate 1: 21

Blowrate 2: 21

[kg / s]

Blowrate Change before Step: 1

Mass Oxygen (kg): 20664

* scrap Composition

| | |
|-----|--------|
| Fe | 0.8987 |
| C | 0.0014 |
| Mn | 0.0027 |
| FeO | 0.0877 |

| step / time | blown Oxygen | cooling * scrap | flux (CaO) | ore (Fe2O3) |
|-------------|--------------|-----------------|------------|-------------|
| 1 / 1.36666 | 1722 | 60000 | 14950 | 0 |
| 2 / 2.73333 | 1722 | 0 | 0 | 0 |
| 3 / 4.1 | 1722 | 0 | 0 | 0 |
| 4 / 5.46666 | 1722 | 0 | 0 | 0 |
| 5 / 6.83333 | 1722 | 0 | 0 | 0 |
| 6 / 8.2 | 1722 | 0 | 0 | 0 |
| 7 / 9.56666 | 1722 | 0 | 0 | 0 |
| 8 / 10.9333 | 1722 | 0 | 0 | 0 |
| 9 / 12.3 | 1722 | 0 | 0 | 0 |
| 10 / 13.666 | 1722 | 0 | 0 | 0 |
| 11 / 15.033 | 1722 | 0 | 0 | 0 |
| 12 / 16.4 | 1722 | 0 | 0 | 0 |

- Heat number: 66668
- Converter number: 1

Data preparation for the model input

The input data can not be suited completely for the model input because of:

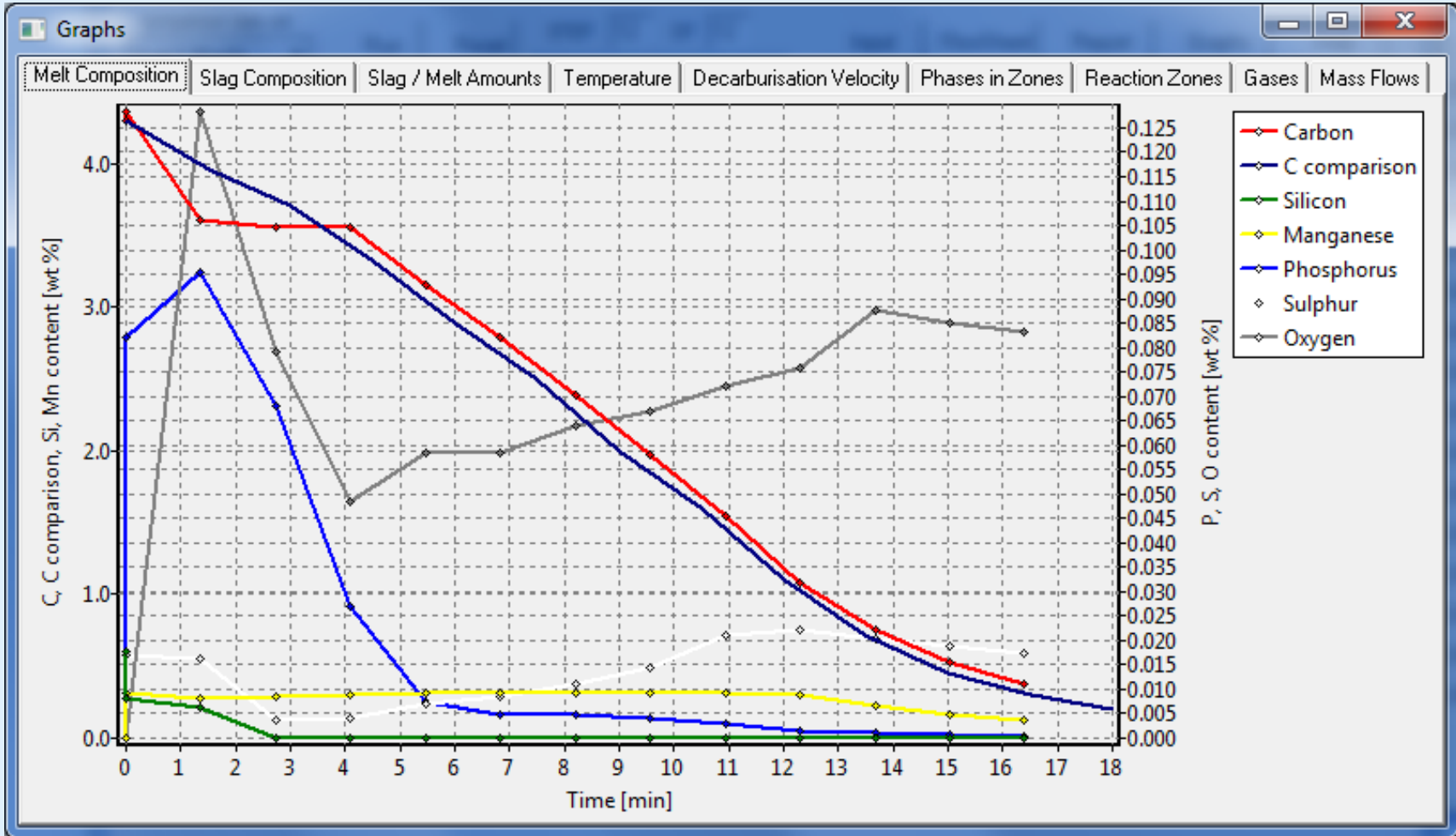
- Predefined scrap analysis by the LD-Sage model
Fe=89.87 wt.%, C=0,14 wt.%, Mn=0,27 wt.%, FeO=8,77 wt.%
- Predefined flux analysis by the LD-Sage model
Only pure lime/CaO
- Predefined coolant analysis
Only iron ore with Fe₂O₃



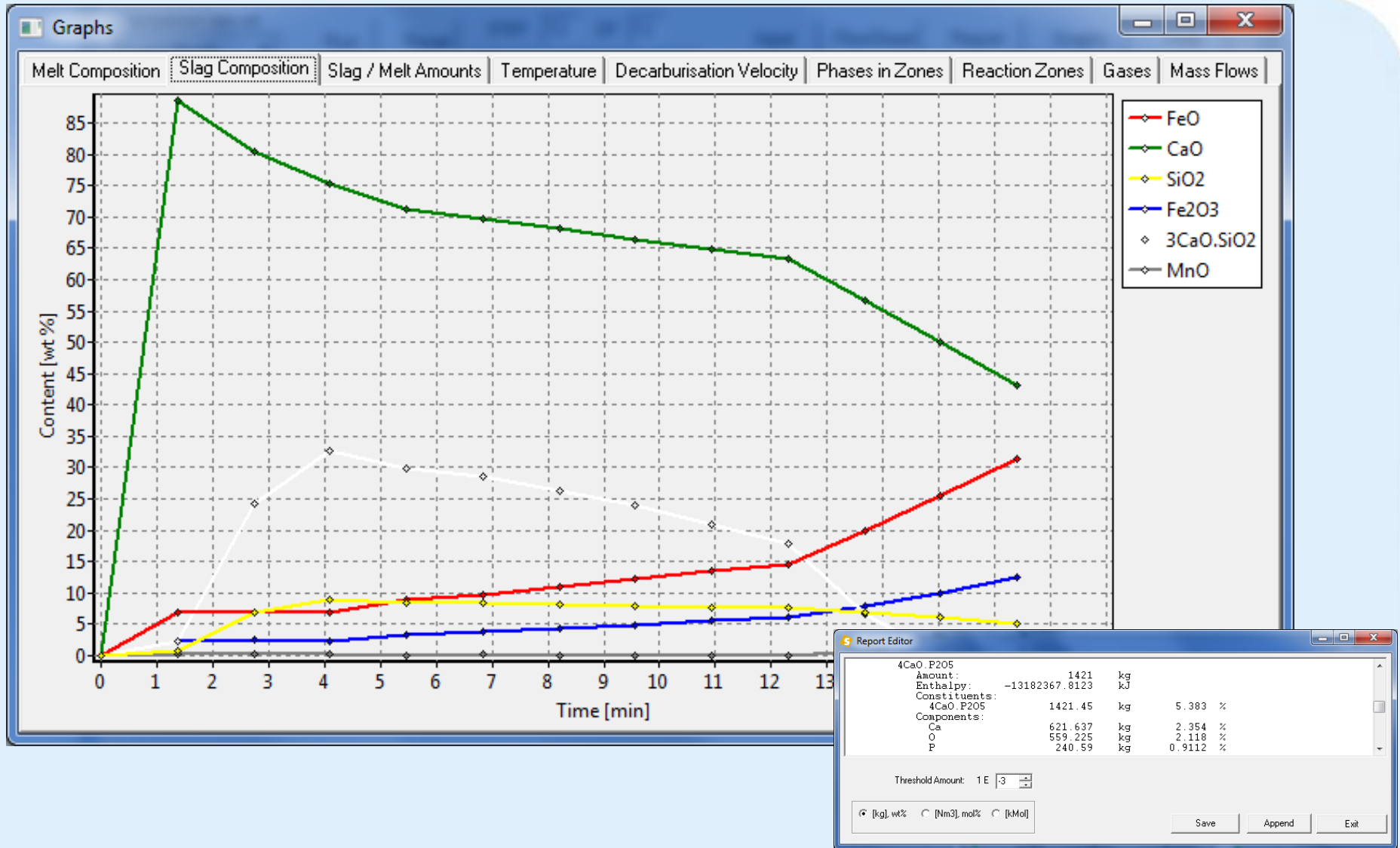
The heats, suited for the model input, were chosen:

- Scrap types “E,F,G,P” with high carbon content were excluded
- The heats only with “Dolomet” and “Lime” additions were taken
- “Dolomet” were accepted as Lime additon

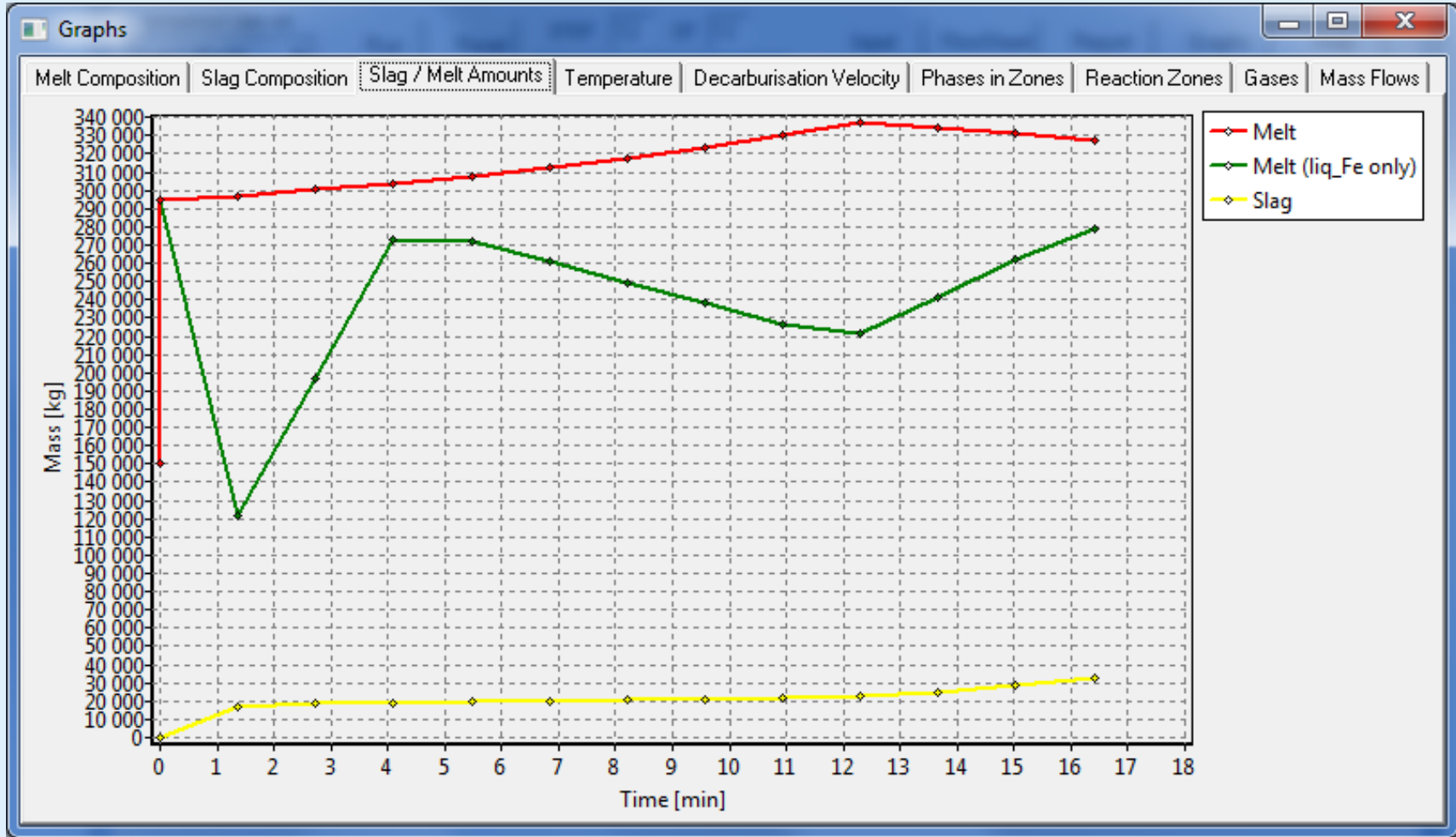
Model results: melt composition



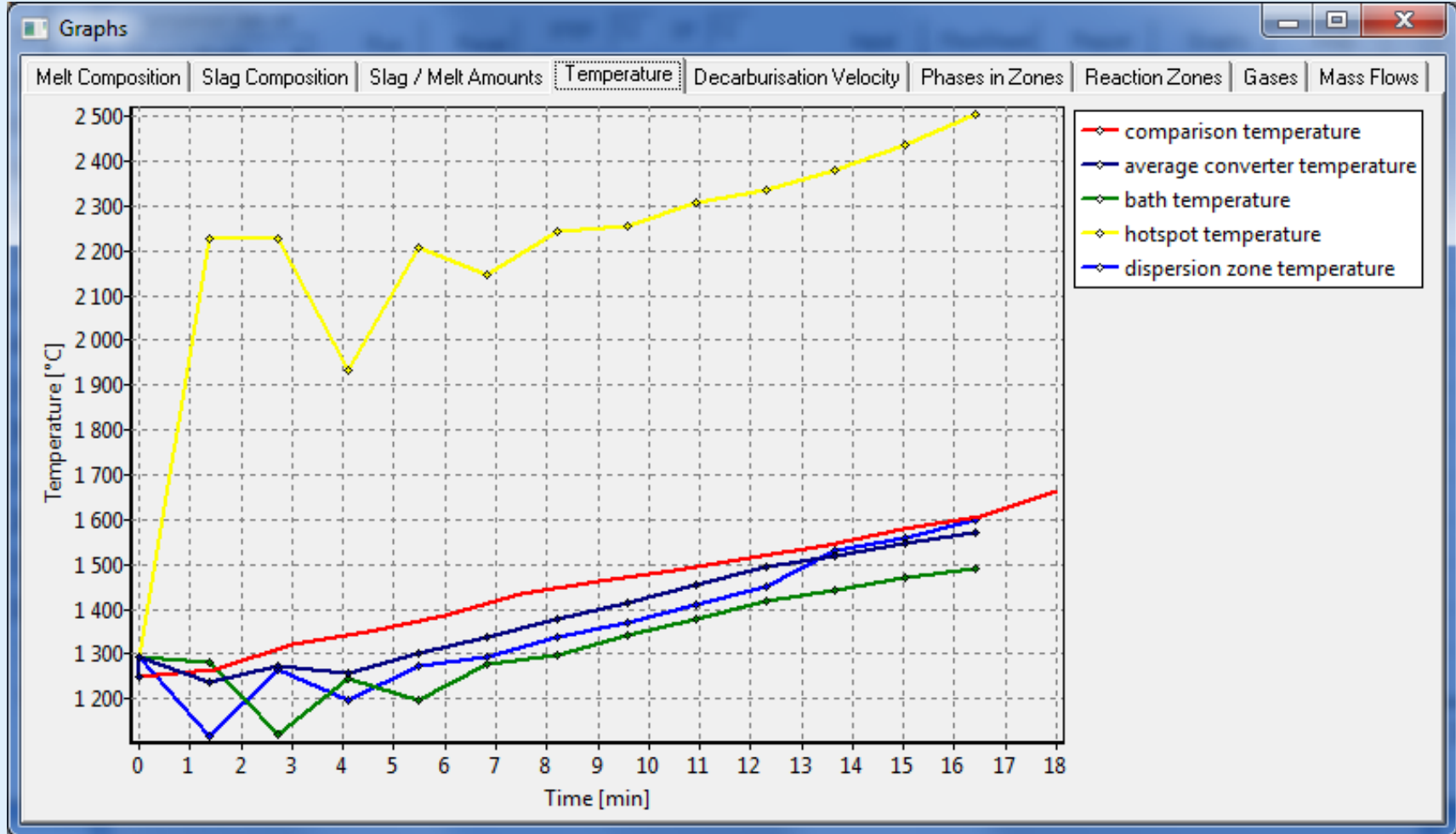
Model results: slag composition



Model results: slag/melt amounts



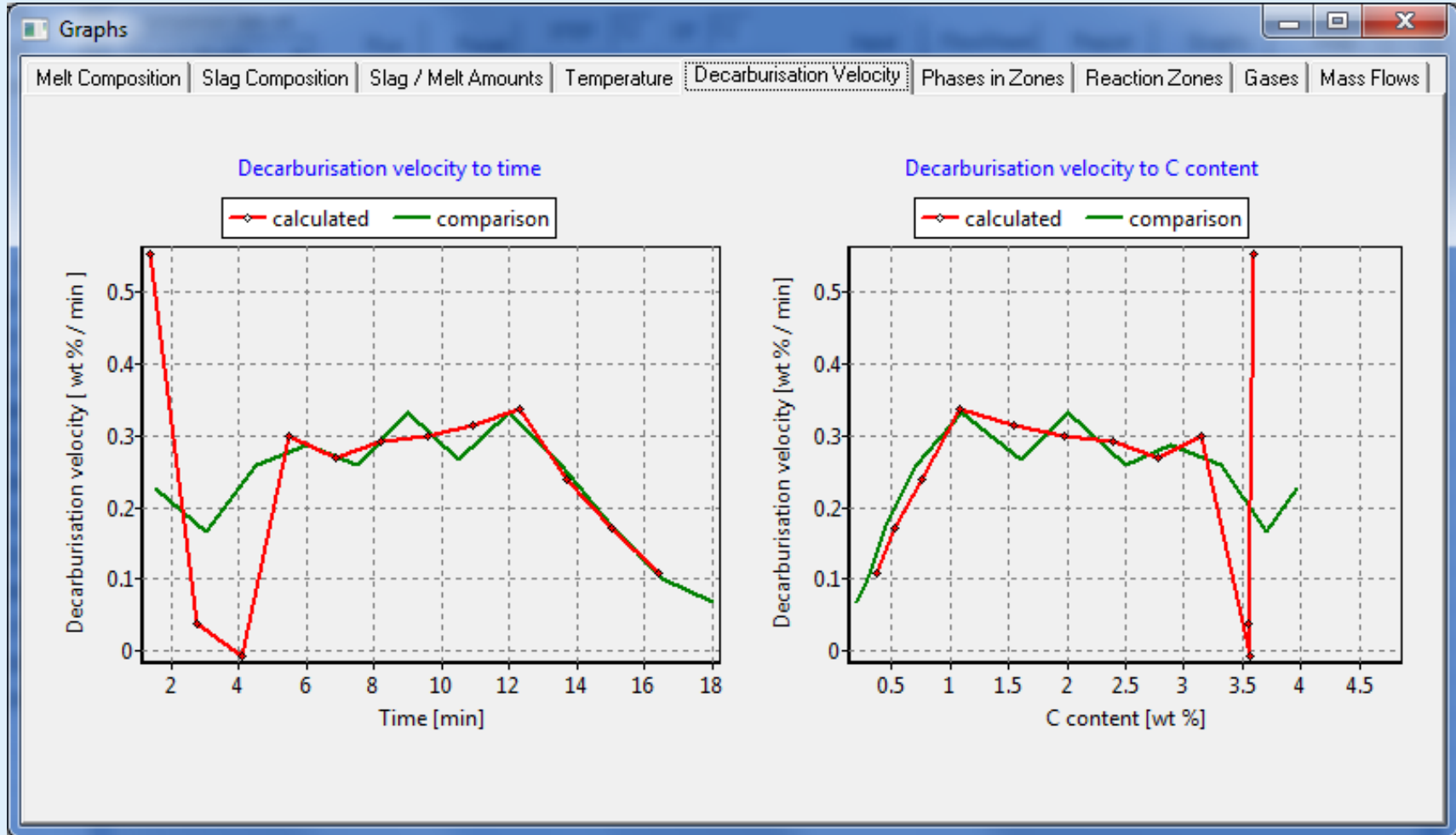
Model results: temperature in converter



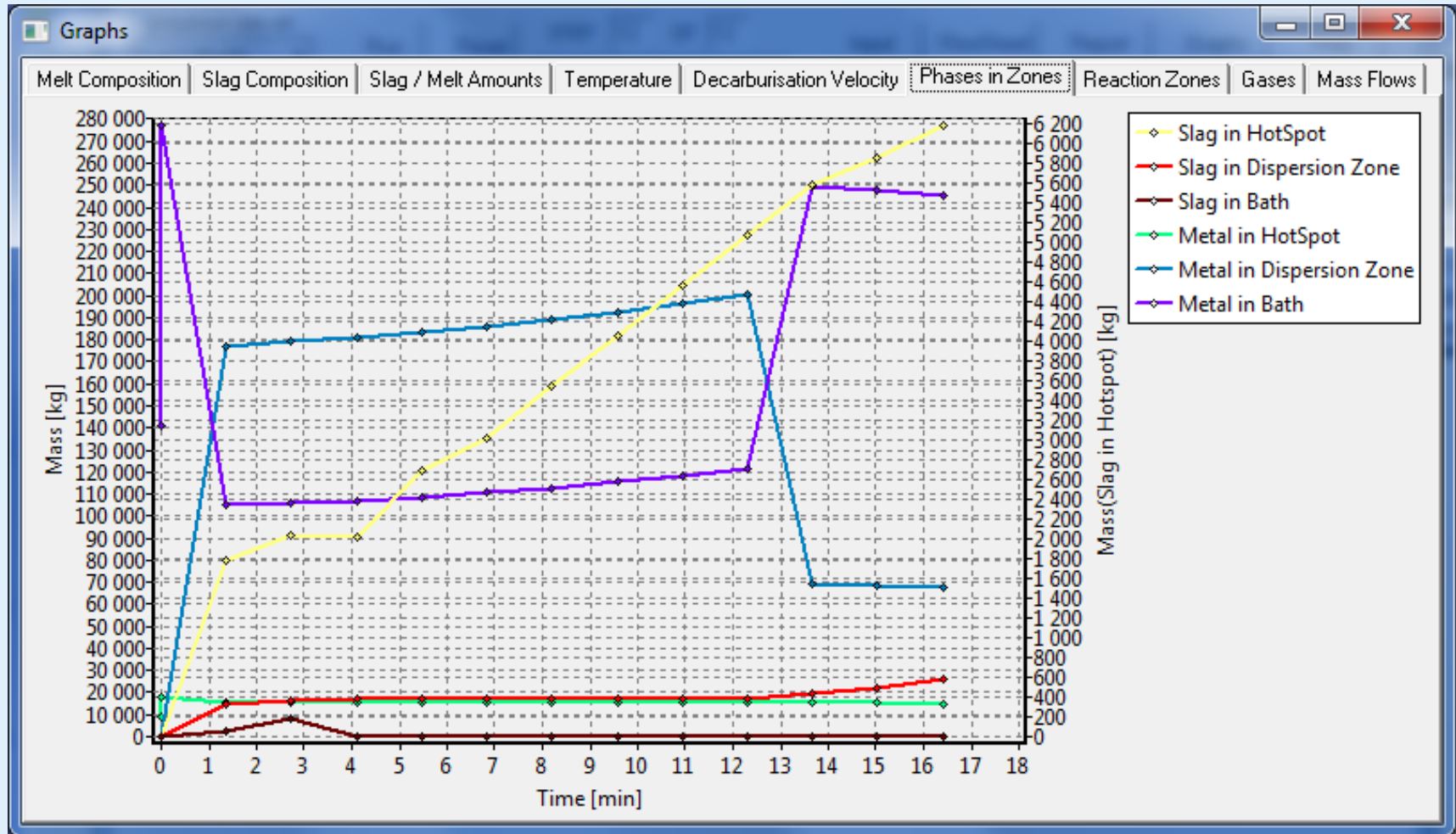
eb_bath_t

1686.1

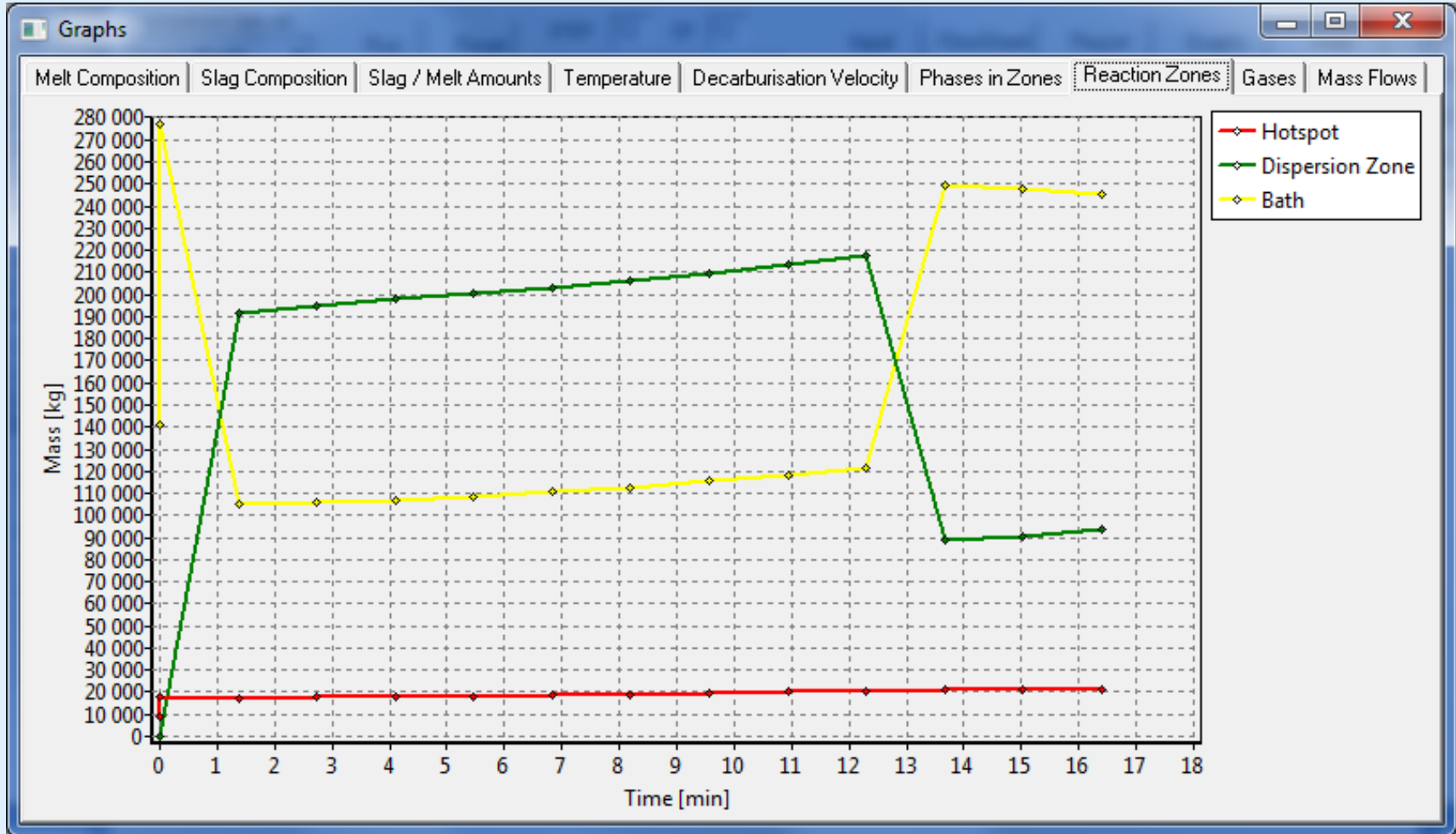
Model results: decarburisation velocity



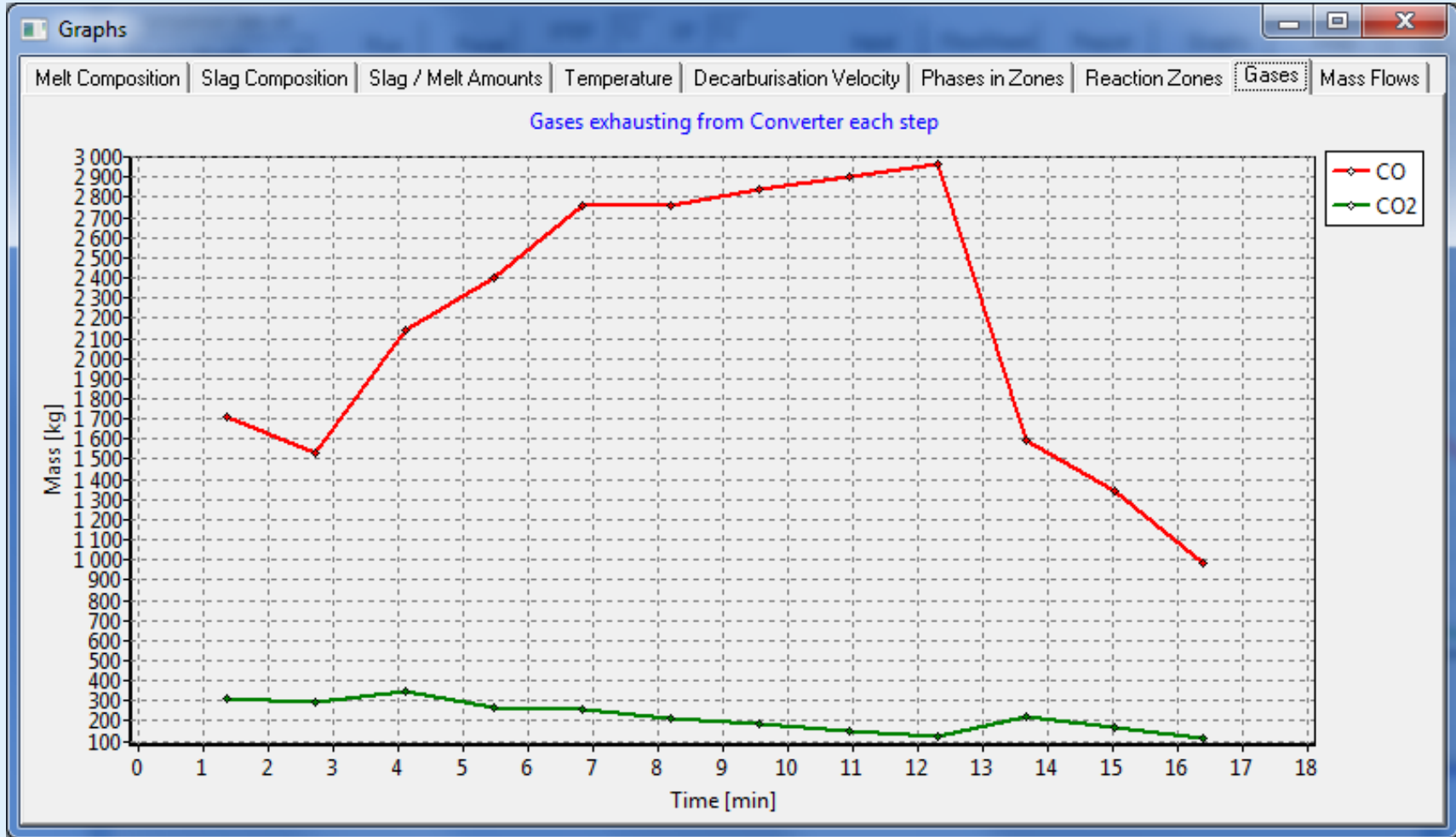
Model results: phases in zones



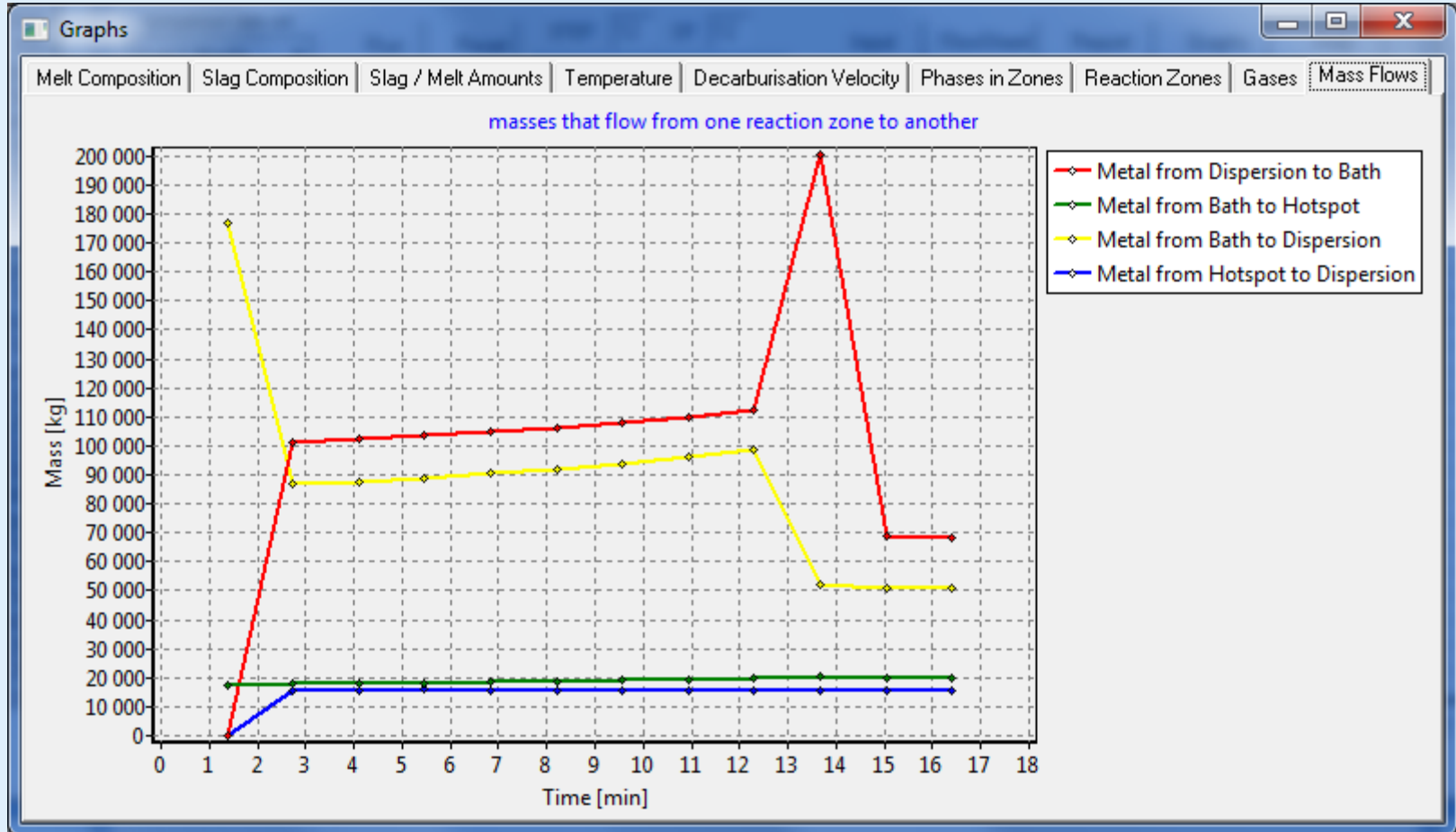
Model results: reaction zones



Model results: total gas flow



Model results: mass flows





Present state of the LD-Sage model

- LD-Sage converter model uses the concept of interlinked local equilibria based on thermodynamic data
- The model produces results in very good agreement with the literature information, but adaptations of the model to Tata data require further efforts
- The model gives information about temperature, melt, slag and gas composition/weight
- Furthermore it gives information about details of the process which are experimentally not accessible

Further development of the LD-Sage model

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