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Minor Elements in Copper Converting

Andreas Lennartsson, Fredrik Engström,
Bo Björkman and Caisa Samuelsson

Luleå University of Technology

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Background

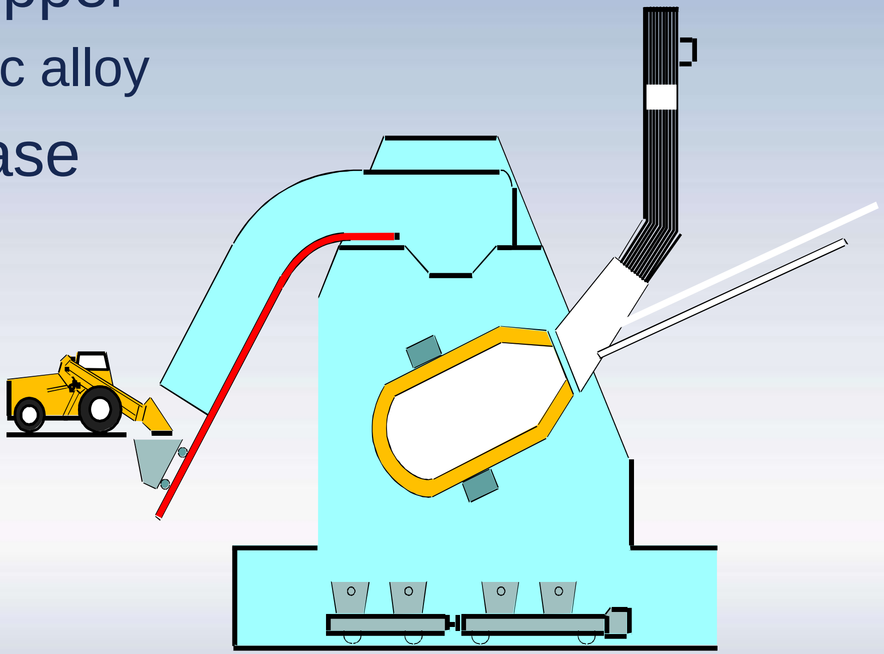
- Increasing complexibility of raw material
  - New mines with complex mineralization
  - Lower copper grade
  - Secondary material
- Waste Electric & Electronic Equipment (WEEE)
  - E-scrap for recycling
- Joint project together with Boliden Mineral AB
  - Dynamic model of Peirce-Smith Converter
  - Influence of treating WEEE

WEEE

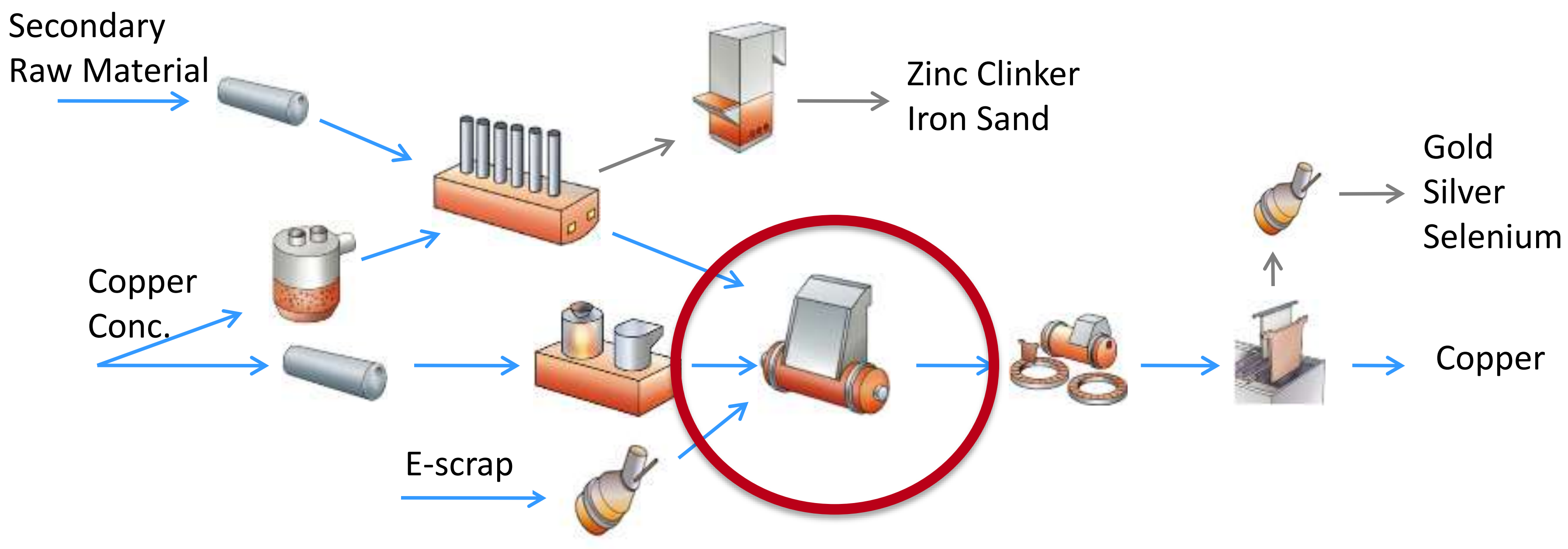
E-Scrap

E-scrap smelting

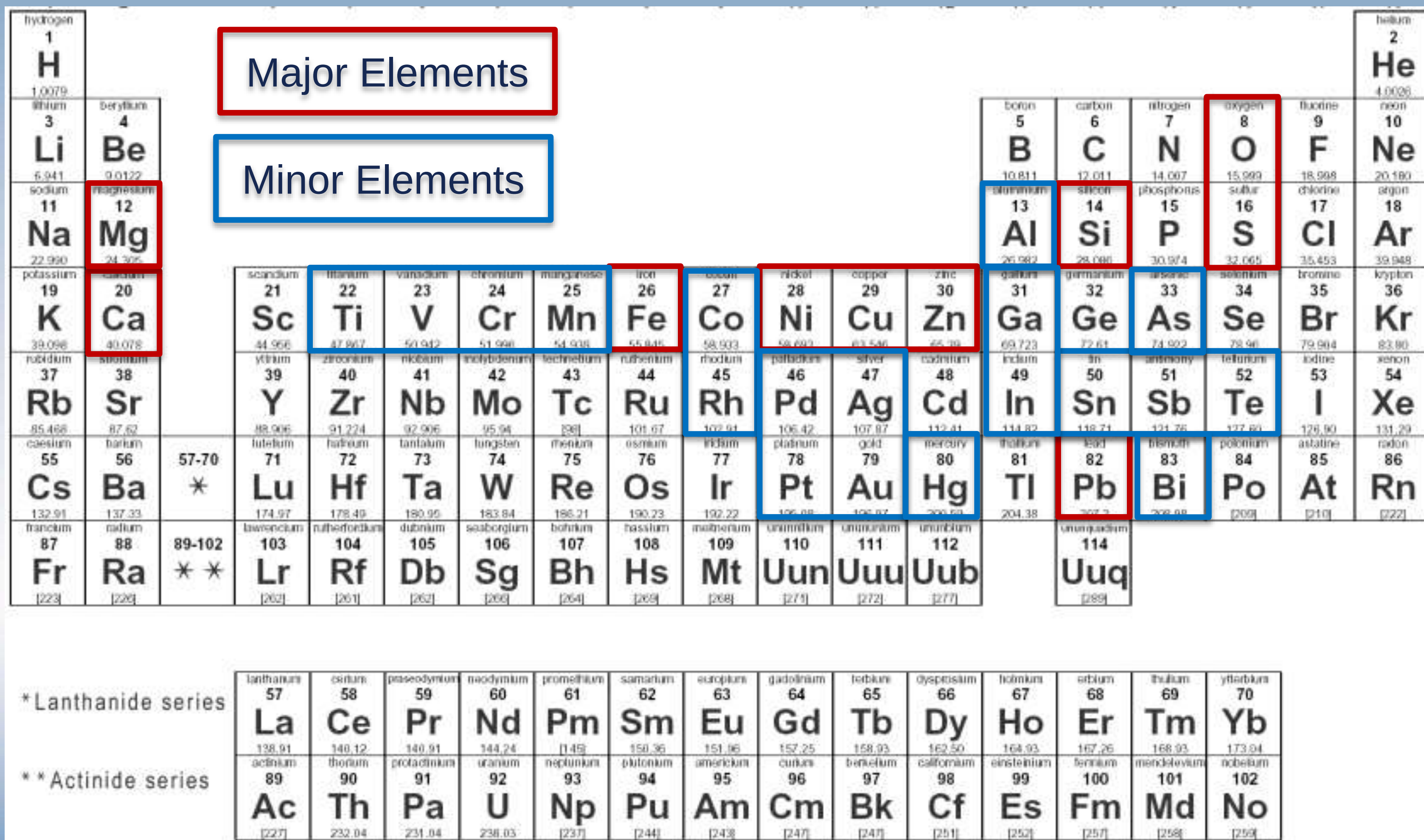
- The KALDO
  - Black copper
    - Metallic alloy
  - Slag phase



Copper flow at Rönnskär Smelter



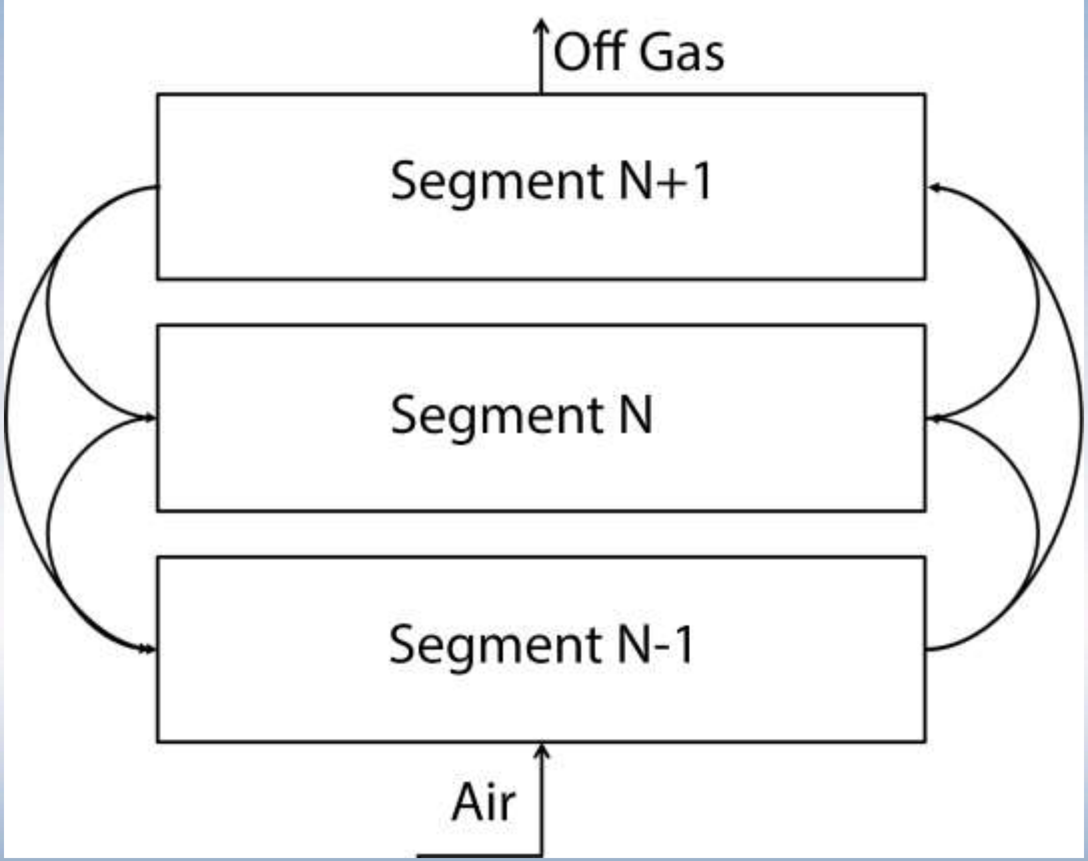
Element present at a copper smelter



Challenges in PS-Converter simulation

- Non-equilibrium process
- Minor elements not assessed for the system
  - Ftmisc-MAT2B (S-Cu-Fe-Ni)
  - Ftmisc-MATTE (S-Cu-Fe-Ni-Co-Pb-Zn-As)
  - What about Bi, Sb, Sn, In, etc
- Focus on Bi and Sb
  - Dilute components in matte, slag and metal phase

Non-equilibrium model



Simulation result
Charge No.860 Slag blow

	Liquid slag							
wt-%	Fe	Cu	Pb	Zn	S	SiO2	CaO	MgO
Plant data	31.2	6.1	6.5	6.6	-	29.9	0.6	0.3
Model	34.4	5.0	4.0	9.5	0.0	30.0	0.3	0.1
Equilibrium	36.1	2.1	3.2	9.8	0.1	32.7	0.3	0.1

	White metal				
wt-%	Fe	Cu	Pb	Zn	S
Plant data	0.4	75.9	0.5	0.1	17.8
Model	1.1	75.9	1.7	0.6	19.9
Equilibrium	1.0	75.9	1.7	0.5	20.0

Bismuth and Antimony in Charge 860

wt-%	Liquid slag		White metal	
	Bi	Sb	Bi	Sb
Plant data	0.006	0.11	0.02	0.10
Model prediction	0.006	0.04	0.03	0.11
Equilibrium	0.001	0.04	0.05	0.11

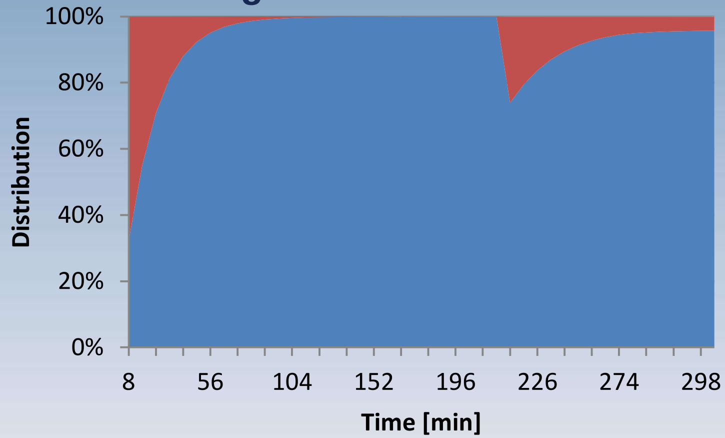
	$L^{Matte/Slag}$	
	Bi	Sb
Plant data	3.3	0.9
Model prediction	3.9	3.1
Equilibrium	95.8	2.6

Case Study

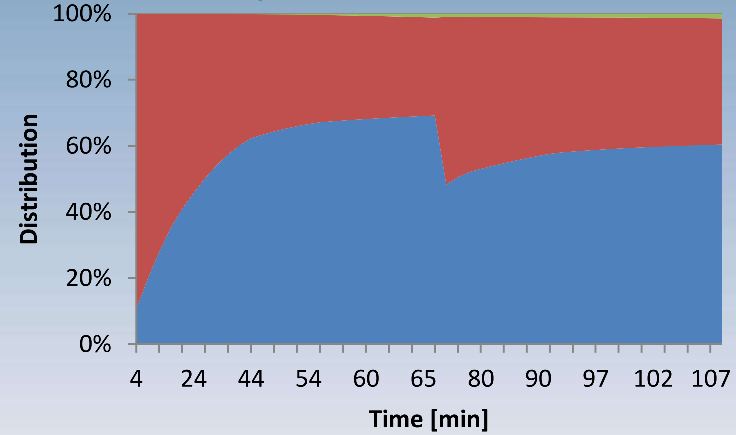
- Addition of black copper during the slag blow
  - Matte grade
  - Point of addition
  - Isothermal
  - Constant Fe/SiO_2 ratio
- Focused on Bi and Sb

Bismuth distribution

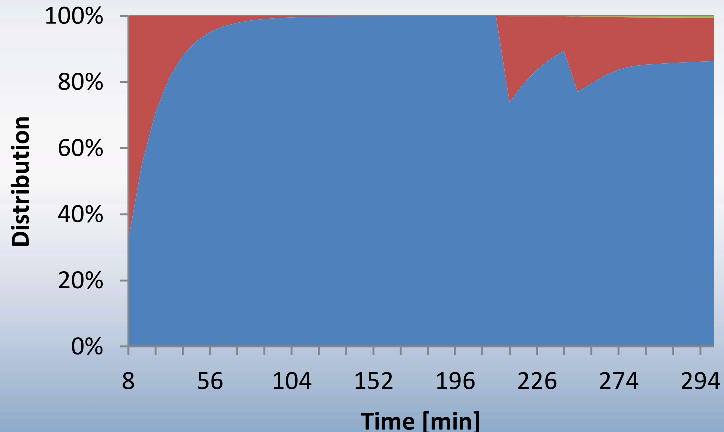
Matte grade 45 wt-% Cu



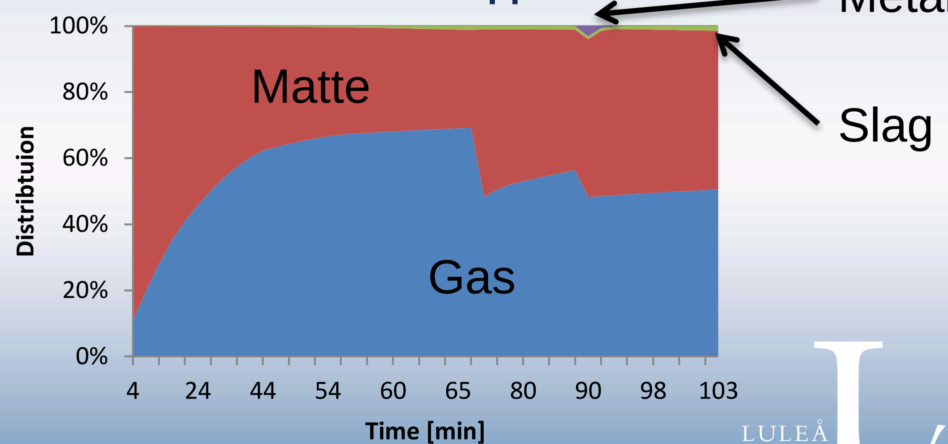
Matte grade 65 wt-% Cu



Matte grade 45 wt-% Cu addition of black copper

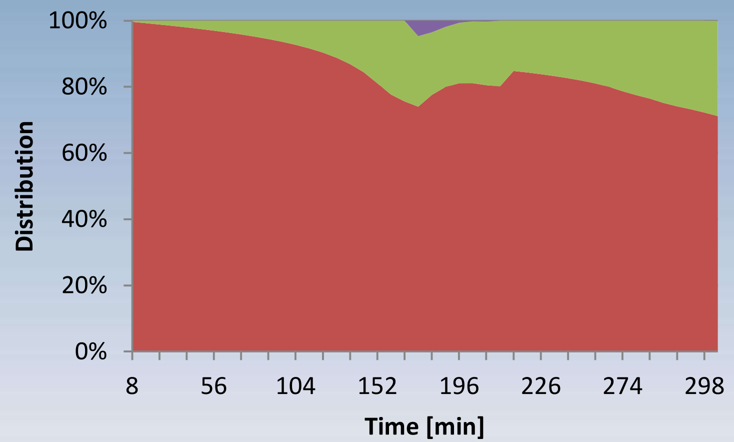


Matte grade 65 wt-% Cu addition of black copper

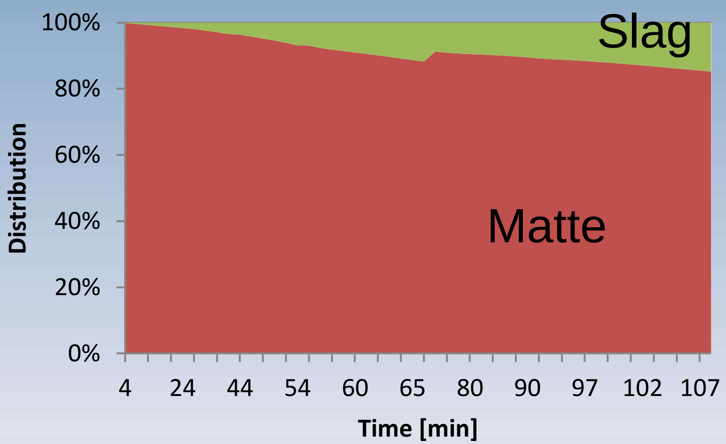


Antimony distribution

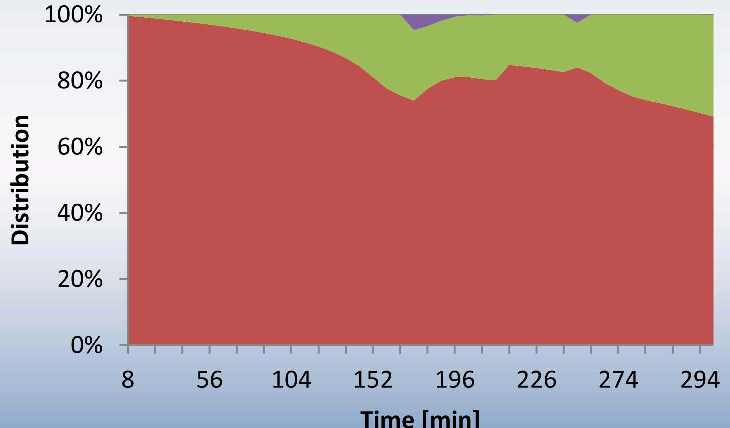
Matte grade 45 wt-% Cu



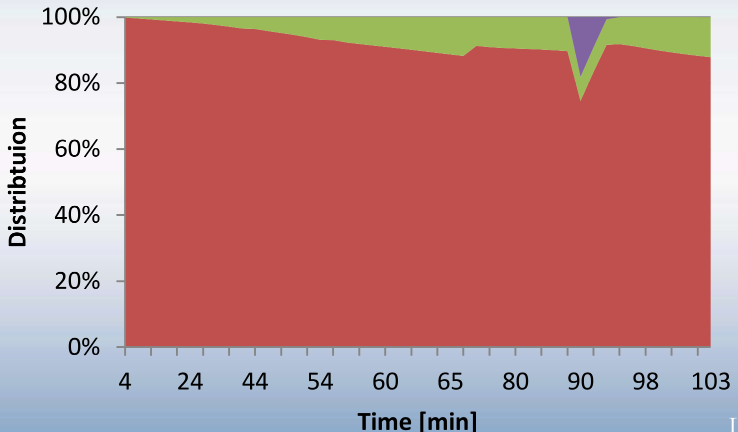
Matte grade 65 wt-% Cu



Matte grade 45 wt-% Cu addition of black copper



Matte grade 65 wt-% Cu addition of black copper



Conclusions

- A non-equilibrium model based on segments has been realized with SimuSage
- Adding Bi and Sb as dilute components works
- The vaporization of Bi and slagging of Sb is influenced by matte grade
- Addition of black copper
  - negative influence on the vaporization of bismuth
  - Slightly positive influence on slagging of Sb when low grade matte
  - Slightly negative influence on slagging of Sb when high grade matte

Thank you for the attention

Questions

Non-equilibrium model