Translator training – Reflections from an industrial research angle

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NORCE Norwegian Research Centre AS

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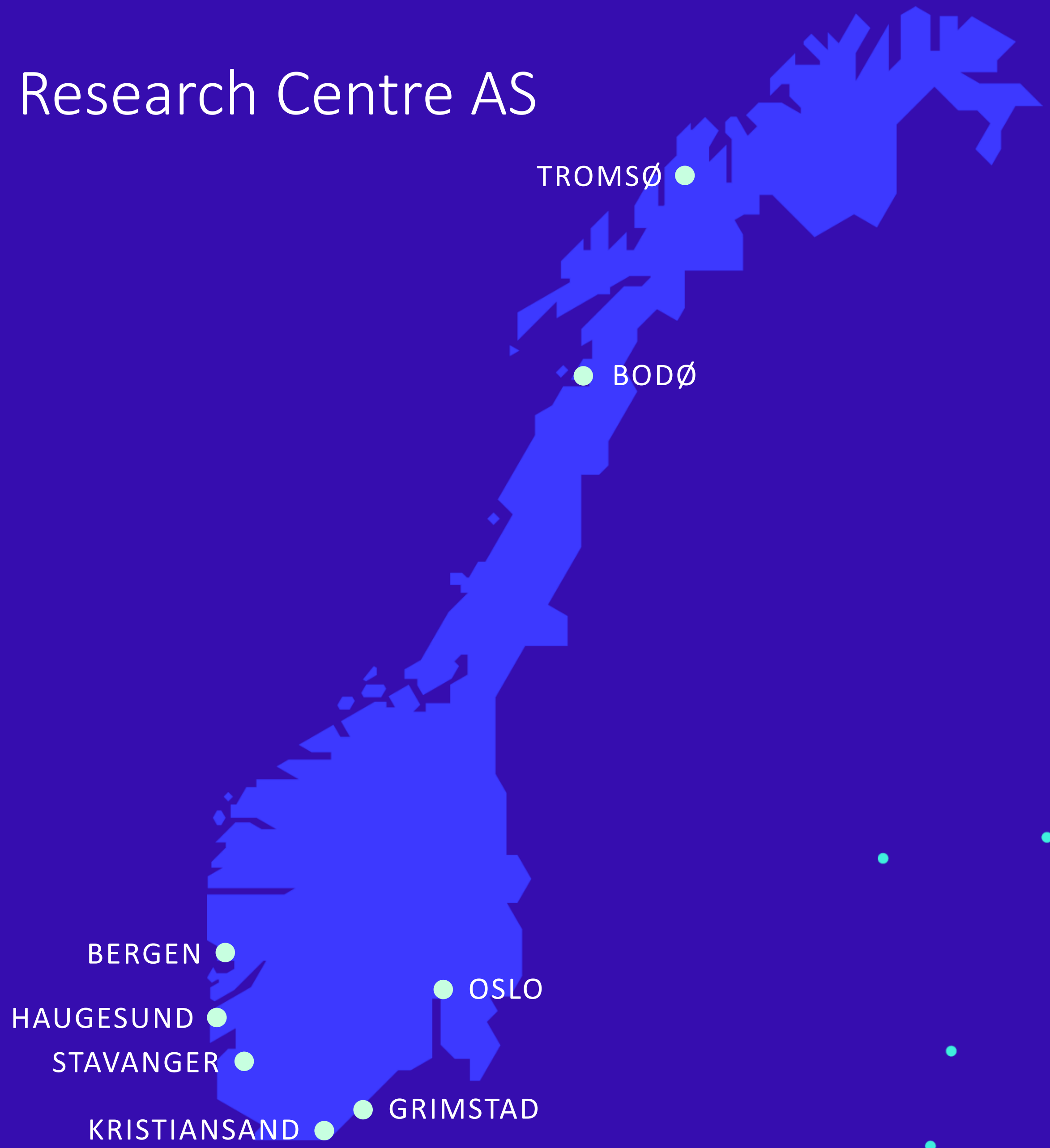
Social Science
Environment
Health
Climate
Energy
Technology



Svenn Anton Halvorsen

- 1978 MSc in Technical Physics, NTNU, Trondheim
- 1981 PhD in Numerical Mathematics, NTNU, Trondheim, Norway
- 1981-2001 Elkem ASA (Research, Technology, Carbon, …)
  - Mathematical Modelling of Metallurgical Processes
  - **Translator Skills Required**
- 2001-2008 Industrimatematikk AS (Consultancy)
  - Various Modelling, Advanced Excel, …
- 2008-2018 Teknova AS
- 2018- NORCE Norwegian Research Centre AS

Tasks of the Translator

NORCE

1) Understands the business case

2) Understands the industrial case

3) Analyse the data (experimental and modelling) available within the client

4) Translate to (preferably more than one) modelling workflows

5) Propose to the client modelling executor(s) and strategy for model validation

6) Translate the modelling results to information that is understandable, reliable and usable by the client

- Understand business/industry
- Understand modelling
- Ability to Translate – Both ways

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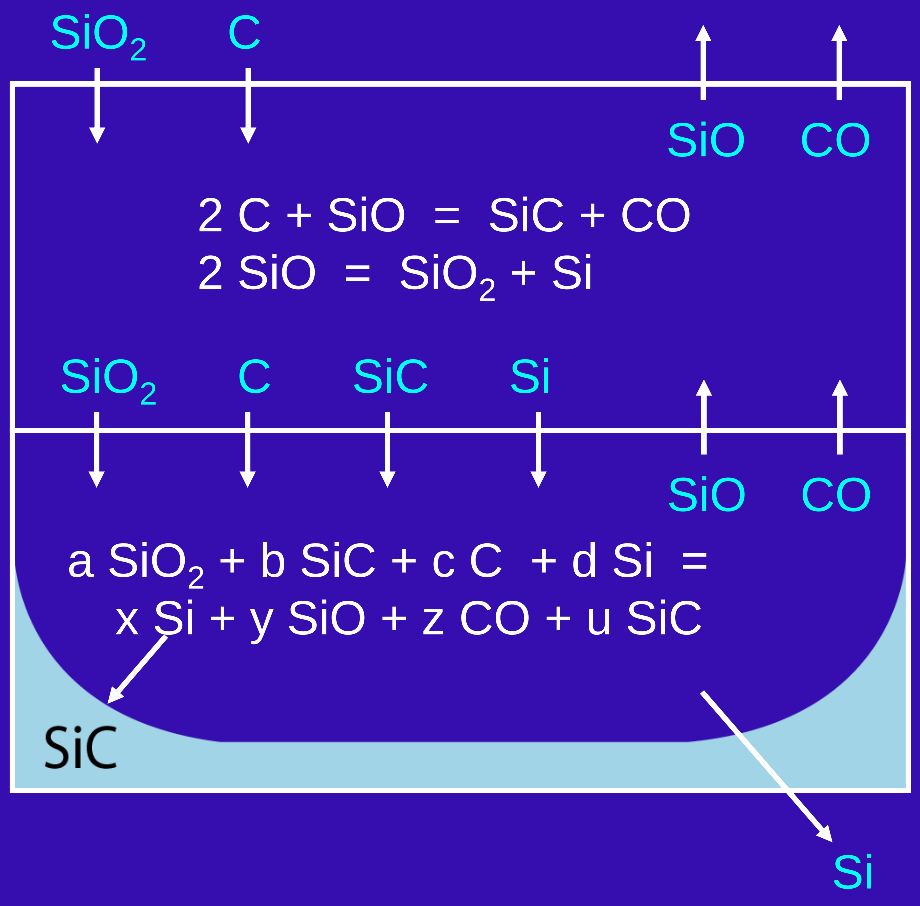
Stoichiometric Model for the Silicon Process



Inside a 50 kW pilot furnace – Experiment at Elkem Technology

Stoichiometric Model
Elkem University

Excel Implementation

Suitable Exercises

- Your furnace
- Typical situations
- Hands-on training

Translator

Understand your audience

Inside a 50 kW pilot furnace – Experiment at Elkem Technology

Special Elkem University
For Leaders and Economists

Non-technical personnel

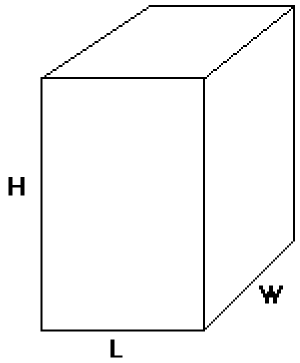
- What is degree K?
- What is a mole?

Translator

Understand your audience

Inside a 50 kW pilot furnace – Experiment at Elkem Technology

Explain concepts – Example
Heat Equation, non-dimensionalize



$$\rho c_p \frac{\partial T}{\partial t} = \frac{\partial}{\partial x}(k\frac{\partial T}{\partial x}) + \frac{\partial}{\partial y}(k\frac{\partial T}{\partial y}) + \frac{\partial}{\partial z}(k\frac{\partial T}{\partial z}) + Q$$

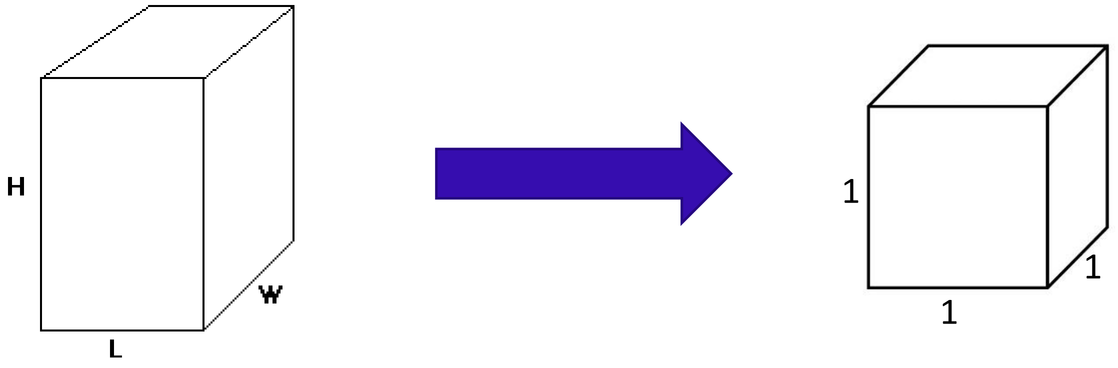
Change in local T

Heat flow in three directions

Heat source

$$x = L\tilde{x},\ \ y = W\tilde{y},\ \ z = H\tilde{z},\ \ t = \tau\tilde{t},\ \ T = T_0 + (T_m - T_0)\tilde{T}$$

Why?

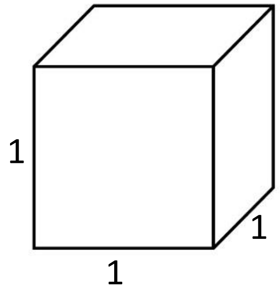


Far more complex equation!

$$\left(\frac{L^2 \rho c_p}{k\tau}\right)\frac{\partial \tilde{T}}{\partial \tilde{t}} = \frac{\partial^2 \tilde{T}}{\partial \tilde{x}^2} + \frac{L^2}{W^2}\frac{\partial^2 \tilde{T}}{\partial \tilde{y}^2} + \frac{L^2}{H^2}\frac{\partial^2 \tilde{T}}{\partial \tilde{z}^2} + \frac{L^2}{k(T_m - T_0)}Q$$

Why?

Correct scaling:
Strength of term given by
the relevant non-dimensional
number!

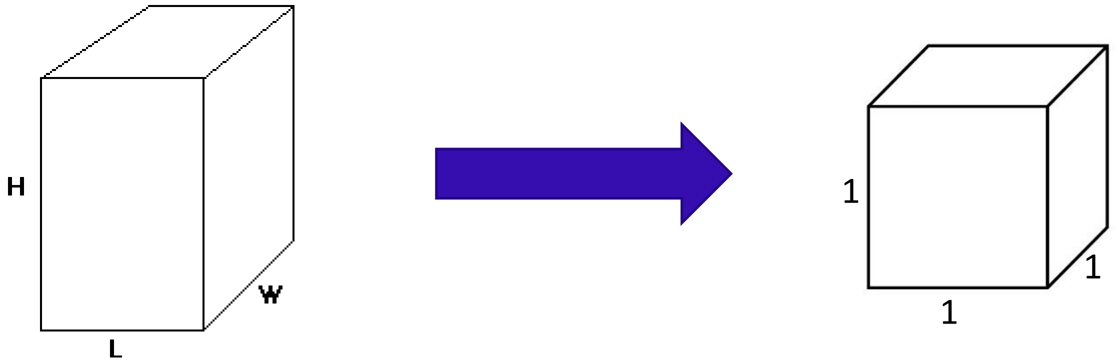


Same structure of equation!

$$(\ldots)\frac{\partial \tilde{T}}{\partial \tilde{t}} = \frac{\partial^2 \tilde{T}}{\partial \tilde{x}^2} + (\ldots)\frac{\partial^2 \tilde{T}}{\partial \tilde{y}^2} + (\ldots)\frac{\partial^2 \tilde{T}}{\partial \tilde{z}^2} + (\ldots)$$

Change in local T | Heat flow in three directions | Heat source

Why?



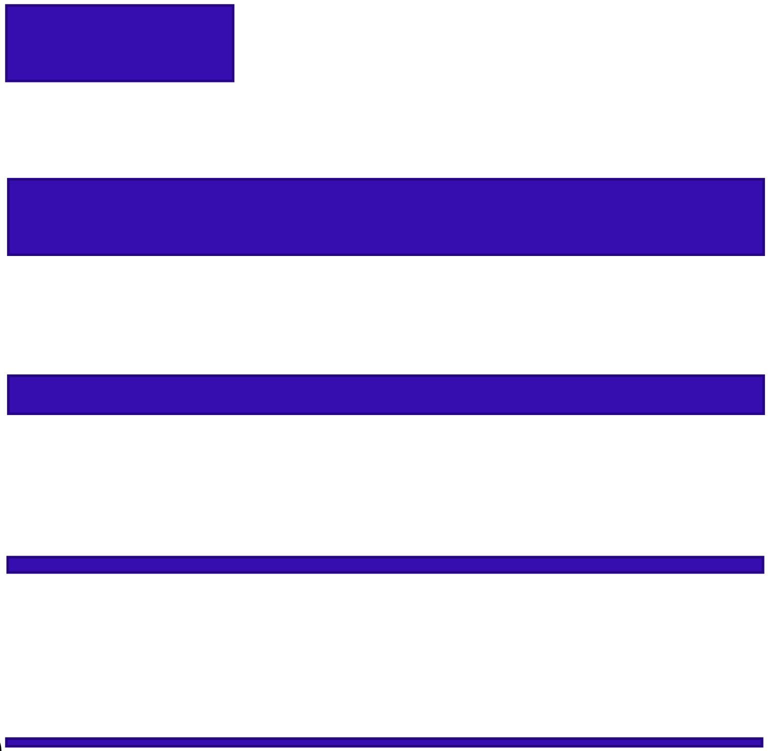
Aspect ratios 1:3 – Reasonable approximation

$$(\ldots)\frac{\partial \tilde{T}}{\partial \tilde{t}} = \frac{\partial^2 \tilde{T}}{\partial \tilde{x}^2} + \frac{L^2}{W^2}\frac{\partial^2 \tilde{T}}{\partial \tilde{y}^2} + \frac{L^2}{H^2}\frac{\partial^2 \tilde{T}}{\partial \tilde{z}^2} + (\ldots)$$

$$\rho c_p \frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) + Q$$

What is thermally long and thin?

- Reasonable approximation 1:3
- Good approximation 1:10
- Very good 1:20
- Better 1:50
- Best 1:100



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Example – Advanced Excel Model
Simple and Robust Interface

NORCE

	Heat Surpluss	26.3	%

MASS & HEAT BALANCE FOR KLAR ROASTING Today's Date 23-mar-19

Controlled Input Parameters:

Item #	Variable	Value	Units
1.	Roaster Bed Temperature	890	°C
2.	Temp Differential (Bed-freeboard)	50.0	C°
3.	Windbox Air enriched to:	39.0	% O_2
4.	Windbox air temp (preheat)	130	°C
5.	Roaster diameter	340.0	cm
6.	Excess Air	10.0	%
7.	Filtercake % moisture	20.0	%
8.	Slurry: % solids	65.0	%
9.	Free Space Velocity	1.00	m/s
10.	CuS oxidized to Cu_2O	2	% of Cu
11.	Propane addition	25.0	kg/h
12.	Cooling Water	0.0	L/h
13.	Recycled cyclone dust	3.0	t/h
14.	Cyclone dust recycle temp	300	°C
15.	Cu electrolyte specific gravity	1.295	g/ml
16.	Volume of electrolyte to 1part H_2O	2.5	vol/vol
17.	Copper throughput (2 roasters)*	37 000	t/y
18.	Roaster Heat losses	100	Mcal/h
19.	Air-cooled roaster off-gas temp	410	°C

Calculated Inputs:

Item #	Variable	Value	Units
20.	Vol. gas required: air + O_2 @ 0°C	7672	m^3/h
21.	Atmospheric air supply @)°C	5917	m^3/h
22.	Pure Oxygen supply @)°C	1756	m^3/h
23.	Total O_2 supplied @)°C	2992	m^3/h
24.	Spent Cu electrolyte dilution factor	0.7143	
25.	Diluted Cu electrolyte bleed sol'n	1.532	m^3/h
26.	Diluted Electrolyte S.G.	1.2107	g/ml
27.	Slurry Specific Gravity	2.044	kg/L
28.	Dry KLAR Feed Rate	6.429	t/h
29.	Slurry Feed Rate	9.891	t/h
30.	Slurry Feed Rate	4.071	m^3/h
31.	Recycle ratio: cyclone dust/KLAR	0.467	t/t

Calculated Outputs:

Item #	Variable	Value	Units
32.	Excess heat	269.0	kcal/kg
33.	Excess heat	26.3	%
34.	O_2 in dry, SO_2-free roaster off-gas	5.45	%
35.	Product calcine weight	709.3	kg/t feed
36.	H_2SO_4 made from electr sulphates	13.64	t/d, 100%
37.	Required operating time	259	d/y
38.	Cooling gas required	15 044	m^3/h

Table I: Klar & Calcine Comp'n

Material ->	KLAR	Calcine
Element	%	%
Ni	6.93	9.8
Cu	46.3	65.3
Co	1.28	1.80
Fe	1.58	2.23
As	0.13	0.18
Ag	0.19	0.27
S(tot)	43.51	
S^{SO4}	0.00	
O (in oxides)		20.12
Total	99.9	99.7

Mineralogical Assumptions:

Assign S to Ni, Co, Fe & As first to form NiS, CoS, FeS & As_2S_3
Then apportion S to Cu as CuS.
Remaining sulphur is elemental

*Copper throughput (item 17.) does not include Cu in recycled cyclone dust or electrolyte bleed solution

Table II: DRY Feed Density Calculations

Mineral	density g/L		moles/kg		moles/L
NiS	5.40	x	1.18	=	6.38
CuS					
CoS					
FeS					
As_2S_3					
S					
Totals					

Weighte
This figu
filtercake

Table III:
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Calculat
H_2O in fi

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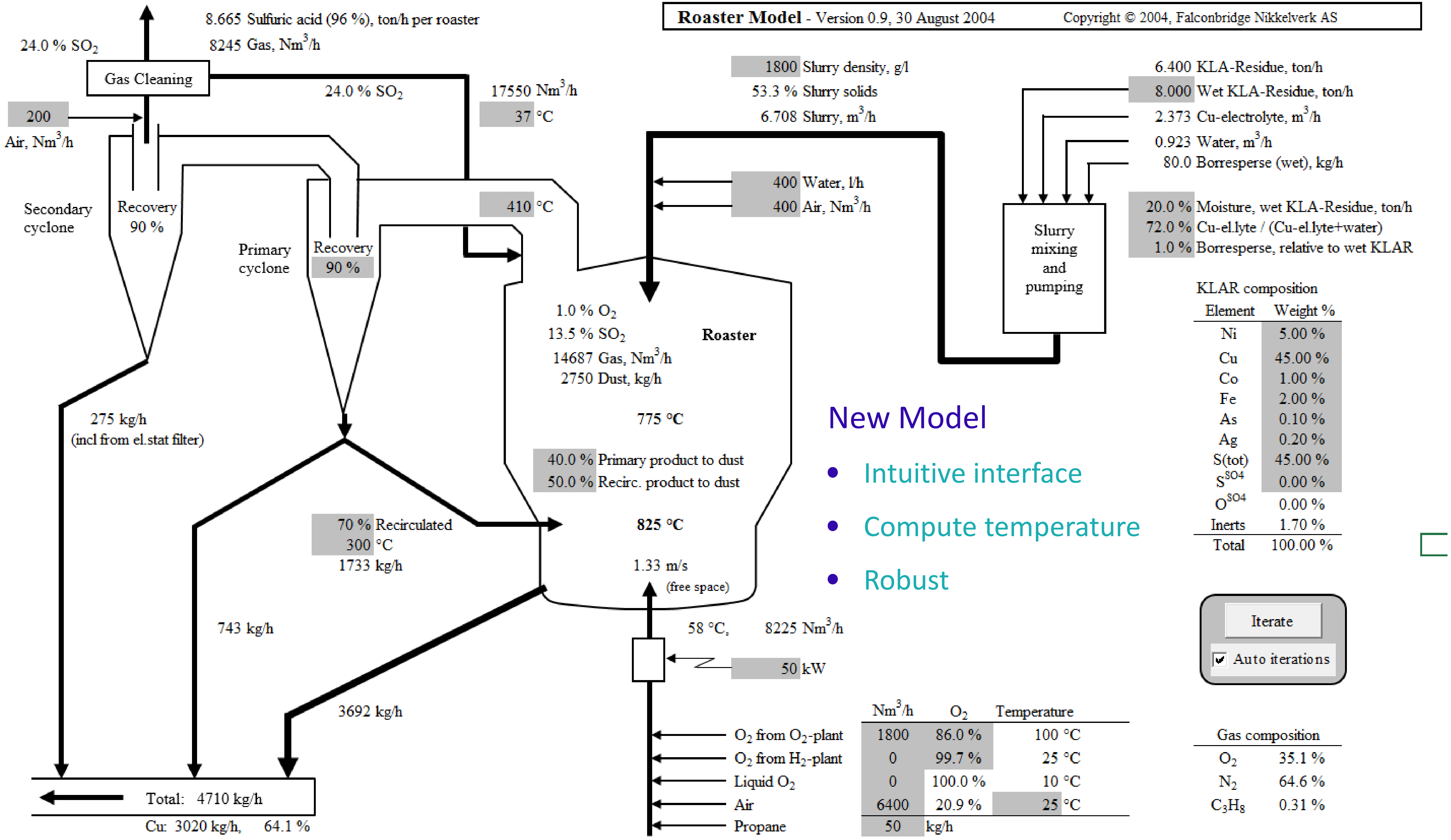
Wt of sc
Wt of wa
E

Table IV: Heat Balance Summary for roasting 1.000 t dr

Inputs (Supplied Heat)			
Heat of Combustion of KLAR			
Heat of Combustion of propane			
Sensible Heat in preheated Air			
Outputs (Required Heat)			
Sensible Heat in Calcine			
Sensible Heat in recycle calcine			
Heat of vaporization of liquid water @ 25°C			
Sensible Heat in off-gases			
Decomposition of sulphates in electrolyte		-41.9	4.09
Calcine sensible Heat from electrolyte decomposition		-3.0	0.29
Roaster Heat losses		-15.6	1.52
Totals	1292.4	-1023.4	100.00
Net Heat Surplus = 26.28 %	268.96		

- Old: Heat balance model
  - Standard Excel calculations in one spreadsheet
  - Not adapted to current process
  - Guess process temperature
  - Iterate **manually** until no heat surplus or deficit



New Model

- Intuitive interface
- Compute temperature
- Robust

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Translator – Various Groups

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- **Academic, modelling experts**
- Software owners/engineers
- Independent Translators
- Industrial researchers
- **Internal employees**

Translator – Modelling Background

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- Solid modelling knowledge
- Good modelling *overview* – Not necessarily expert on everything
  - Physics based modelling
  - Data driven modelling
  - EMMC: Describe state of the art, proper overview
- Multidisciplinary attitude
- Technical insight – know relevant "Tribal language"
  - Some basic education
  - Internships, sabbatical in industry, …
- Communication skills

Translator – Internal Employees

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- Technical insight – within own business
- Need modelling *overview* – Some *basic* modelling knowledge
  - "Tribal language"
  - Type of models
  - Some examples on proper and improper model use
  - Relevance of some approximations
  - "All models are wrong, but some are useful" (George Box)
- Multidisciplinary attitude
- Communication skills

Some Communication Skills

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- Understand the (modelling) needs
- Ability to propose a suitable model

- What is needed?
- What is wanted?
- What is observed?
- What is an interpretation?

- Integrity

Swearing in the Church?

NORCE

- BALA sales model http://salgssucces.dk/bala-modellen/
- "BALA modellen er en de mest effektive salgsmodeller der nogle sinde er lavet …"
  "The BALA model is one of the most effective sales models that exists …"

• **B**ehov	Need
• **A**ccept	Acceptance
• **L**øsning	Solution
• **A**ccept	Acceptance

- Understand the (modelling) needs
- Ability to propose a suitable model

- What is needed?
- What is wanted?
- What is observed?
- What is an interpretation?

- Integrity

Translator Training – What is needed?

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- Modelling knowledge
- Business knowledge
- Industrial/technical knowledge
- Know your limitations
- Know where to find help
- Communication skills
  - Active listening
  - Questioning techniques
  - Presentation skills (make it simple)
- Integrity