TOWARDS FOSSIL-FREE STEELMAKING 2

FFS2

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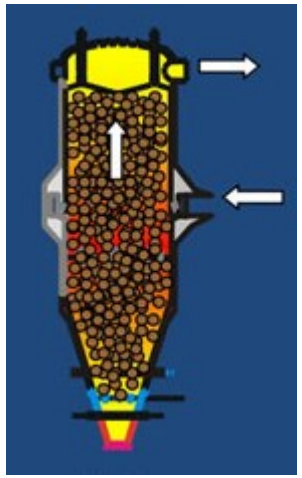
Process and System Engineering @ ÅA

- Strong background in process engineering, including termodynamics, heat and mass transfer, fluid dynamics, process design and control as well as advanced modelling and simulation.
- 40 years of experience in mathematical modelling of iron- and steelmaking processes, documented in about 150 publications in the field
- Main collaboration: Norteastern University, Shanghai University, IIT Bhubanewsar, Purdue University

FFS2 tasks at ÅA

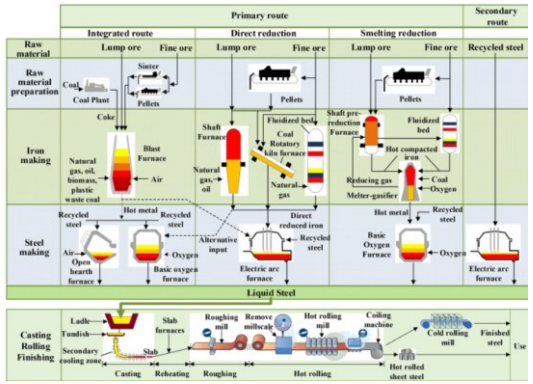


WP1:

- Modelling of hydrogen-based direct reduction shaft furnaces

WP3:

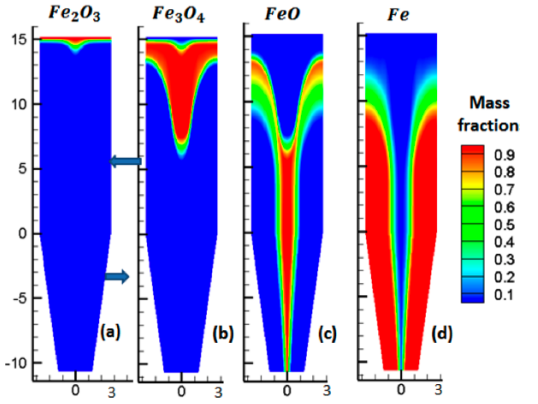
- Fossil-free reheating furnace operations

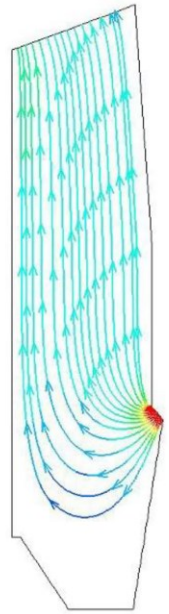


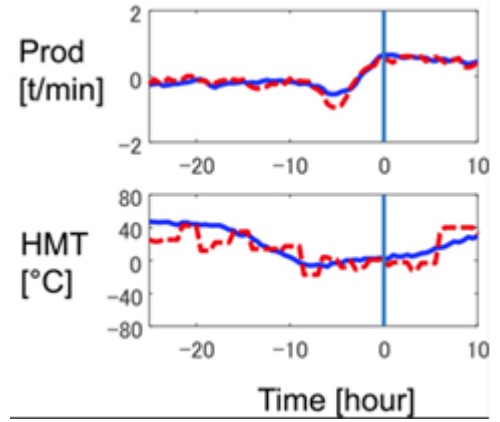
Hydrogen-based DRI shaft modelling

Models of hydrogen-based DRI production

- Two-dimensional static model of DR shaft
  - Gas and burden distribution
  - Gas penetration, reduction & cooling gas interaction
  - More realistic performance estimates
- One-dimensional dynamic model of DR shaft
  - Automation
  - Flexible operation
  - Opportunities for demand-side response





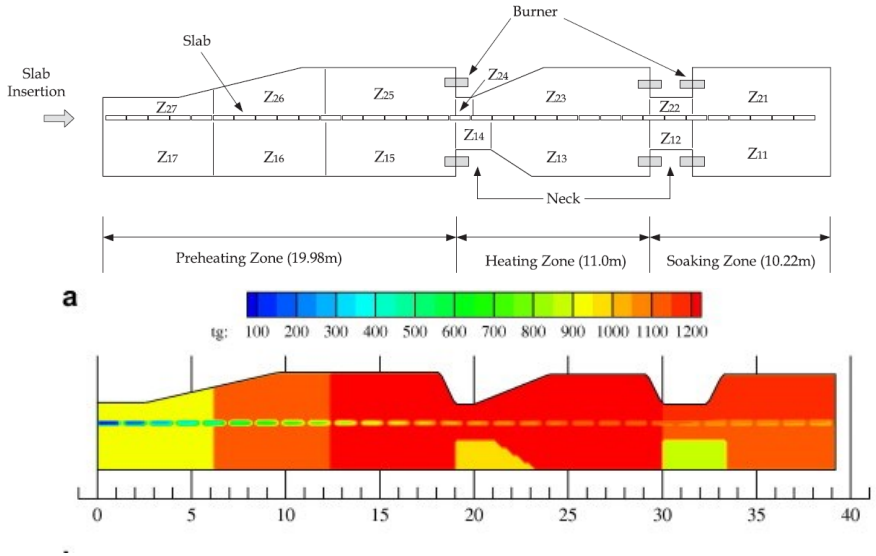


Main partners: SSAB, OY, Northeastern university, Shanghai university, IIT Bhubaneswar

Fossil-free slab/coil reheating

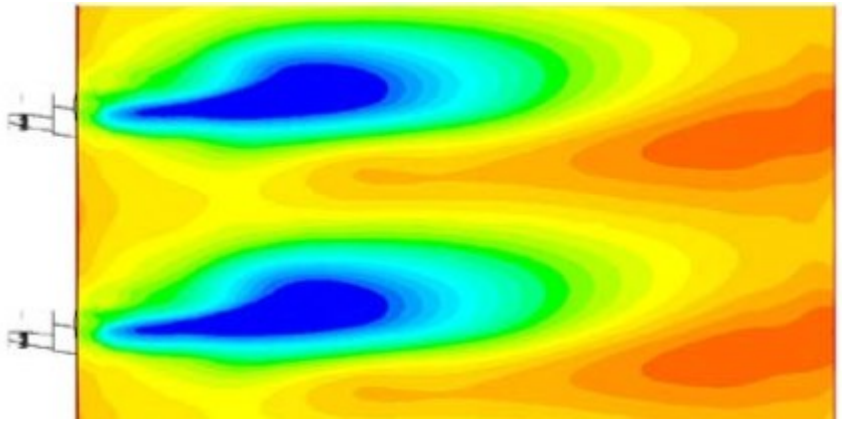
Zonal model of reheating furnace

- Transition to fossil-free operation
- Thermal control
- Energy-efficient operation



Flame & emission modelling

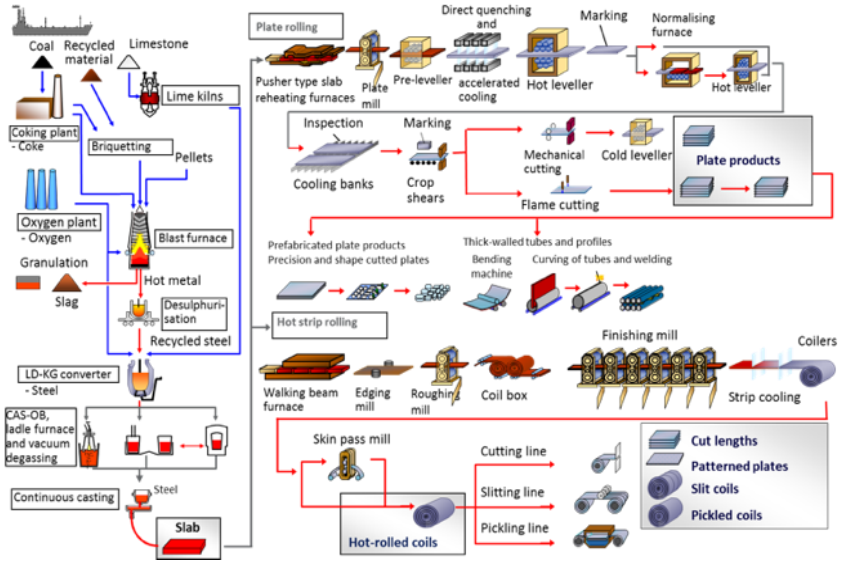
- Combustion zone analysis for fuel mixes
- NOx limitations of different concepts
- Preheating options



Main partners: SSAB, Ovako, VTT, Purdue university

Energy-efficient steel plant operation

- Energy mix in steel plant will radiaclly change
  - No BFG, COG
  - No own electricty
  - Still heating requirements
- System to be developed supports
  - Strategic long-term decisions
  - Dynamic short-term scheduling



Main partners: SSAB, Sant'Anna University

Planned schedule

WP/Task	2024				2025			
WP1: Steelmaking								
Task 1.1 Static 2D DR shaft model								D1.1
Task 1.2 Dynamic 1D DR shaft model								D1.2
WP3: Green energy								
Task 3.1 Combustion emission model				D3.1				
Task 3.2 Dynamic slab reheating model								D3.2
Task 3.3 Steel plant energy optimization								D3.3
WP5: Dissemination & coordination								

D1.1 Static two-dimensional DR shaft model ready and verified

D1.2 Dynamic one-dimensional DR shaft model ready and verified

D3.1 Report on thermal field and NO_x emissions from burner under carbon-lean or carbon-free operation

D3.2 Zonal model of reheating furnace ready

D3.3 Plant-wide model of energy flows: static and dynamic aspects

Expected scientific output

Type of output	Quantity	Time frame	Comment
Conference papers	4-6	2024-2025	Papers to be presented at Scanmet, ESTAD, SteelSim, ICSTI, ECOS and ESACPE
Journal papers	5-7	2024-2025	For instance, Steel research international, ISIJ International, Applied Thermal Engineering, and Metallurgical and Materials Transactions B
Doctoral degrees	1-2	2025	Emiliano Salucci, NN
Software	2-3	2025	Software for DR furnace 2D and dynamic simulation. Reheating furnace model.

International collaboration

Partner	Form	Duration	Topic
IIT Mumbai and IIT Bhubaneswar (India)	Researcher visits	4-6 months	Hydrogen reduction, DR furnace data
Northeastern University (China)	Researcher visits	4-6 months	Hydrogen reduction, DR furnace modelling
Shanghai University	Researcher visits	2 years	DR furnace modelling
University of Science and Technology, Beijing (China)	Researcher visits	1-2 weeks	Sustainable steelmaking
Scuola Superiore Sant'Anna (Italy)	Researcher visits	1-2 weeks	Modelling of energy systems in steelmaking
TU Clausthal (Germany)	Researcher visits	1-2 weeks	Combustion and heat transfer, CFD modelling
Purdue University (USA)	Researcher visits	2-4 months	CFD modelling, DRI and RH furnaces

Budget

Post	WP1	WP3	Total
Salaries	86713	158375	245088
Indirect employee costs	43356	79188	122544
Overhead costs	105366	192426	297781
Travelling	6000	12000	18000
Materials	0	0	0
Services (incl. SW licenses)	4000	8000	12000
Other costs (OA publications)	3000	3000	6000
Grand total	**248424**	**452988**	**701413**
Business Finland support (80%)	198739	362391	561130
Own funding (17.35%)	43097	78585	121683
Company funding (2.65%)	6588	12012	18600

Project personnel

Supervision

- Profs. Henrik Saxén & Anders Brink, dos. Frank Pettersson

Research staff

- Dr. Carl Haikarainen
- M.Sc. Emiliano Salucci (PhD student at ÅA since 2022)
- M.Sc. Ramin Khademi (new PhD student at ÅA)

Visiting scientists

- Dos. Lei Shao (visiting scientist, Northeastern University, China)
- Dr. Snigdha Ghosh (IIT Bhubaneswar, India)
- M.Sc. Lei Zan (Shanghai University,China)
- NN (Purdue University, USA)

Åbo Akademi

Supporting Projects

- Horizon Europe: MaxH2DR (2022-2026), AgiFlex (2024-2027)
- EU RFCS: H2TransBF2030 (2022-2025)
- Academy of Finland: IRONH2 (2023-2027)
- FICORE Indian networking project.