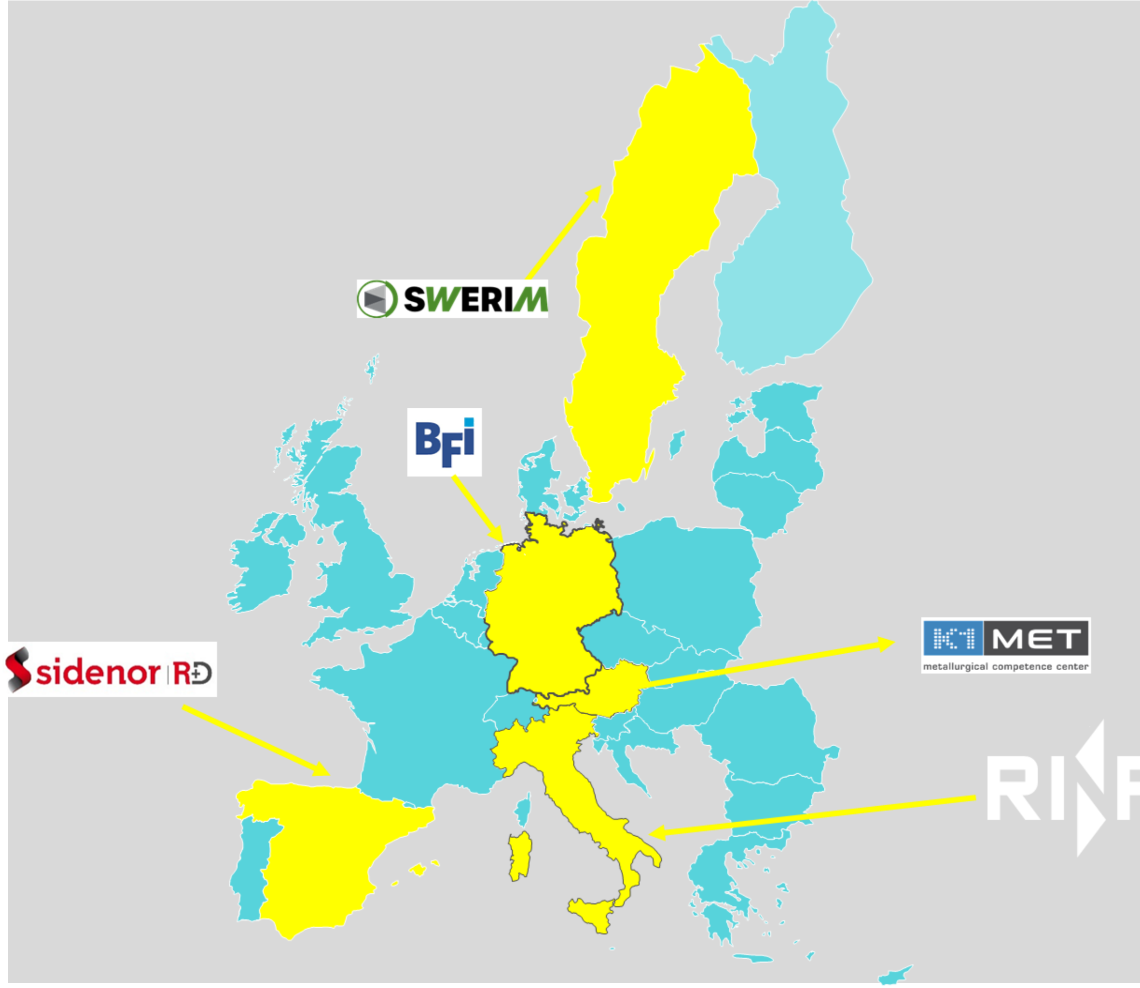
Experiences with modelling at Sidenor

21/10/2025

The project receives funding from the European Union's Research Fund for Coal and Steel research program under grant agreement number: 101155952.

METACAST PROJECT

- **Mapping, Educating, Training, Applying models in continuous CASTing.**
- The role of modelling in problem-solving issues in continuous casting of steel: **CFD modelling in continuous casting.**

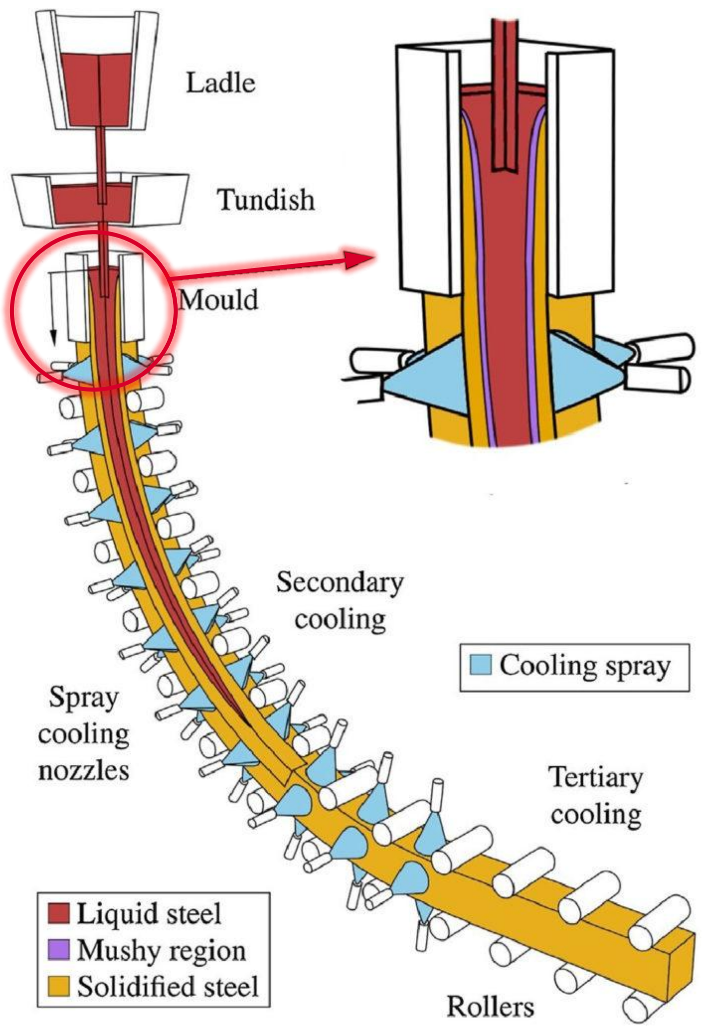


- ***Diana Mier Vasallo (SIDENOR R&D)***
- *Raquel Arias Pérez (SIDENOR R&D)*
- *Nora Egido Pérez (SIDENOR R&D)*
- *Pavel Ramirez López (SWERIM)*
- *Sailesh Kesavan (SWERIM)*

Overview

- Improve **surface product quality**, with focus on defects associated with the **mould**.
- Advanced numerical modelling of the continuous casting process → **CFD Ansys-Fluent**.
- Work developed between **Swerim** and **Sidenor** within the framework of two **European RFCS projects**.

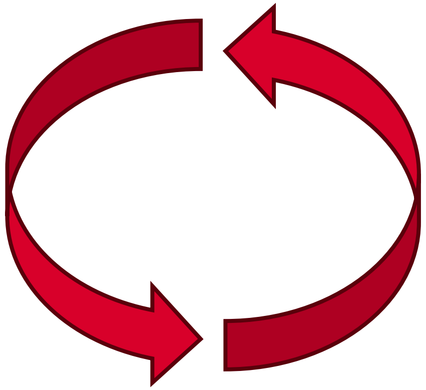
SUPPORT-CAST	NNEWFLUX
Surface cracks Microalloyed steel grade 37MnSiV6R 240x240 mm^2	**Mould powder entrapments** Microalloyed steel grade 37MnSiV6R 185x185 mm^2



Methodology

Methodology for numerical and physical modelling in continuous casting:

1. Exchange of information between steelmaker and simulator
2. Modelling
3. Simulation
4. Model adjustments
5. Parametric study design, results and validation
6. Proposal of improvement
7. Industrial trials and results



1. Information exchange

- Data required for continuous casting simulations:
  - Caster specifications & drawings
  - Casting conditions
  - Chemical composition and properties of the steel
  - Chemical composition and properties of the casting powder
  - Cracks and/or defects information

A5.2 Steel Composition

Chemical composition	Steel grade

A5.3 Steel properties

Property	Nomenclature	Notes
Temperatures	T	
Solidus temperature	T_{sol}	
Liquidus temperature	T_{liq}	
Zero Strength Temperature	T_{ZST}	
Zero ductility Temperature	T_{ZDT}	
Liquid Impenetrable Temperature	T_{LIT}	
Physical props		
Viscosity	ν_{steel}	
Heat capacity	Cp_{steel}	
Thermal conductivity	λ_{steel}	
Surface tension	σ_{steel}	
Density	ρ_{steel}	
Enthalpy	H_{steel}	
Latent heat	L_{steel}	

A5.4 Casting powder chemical analysis

Element / compound	ideal/supplied composition	Measured
Chemical components		

A5.5 Powder properties

Property	Nomenclature	Powder
Temperatures		
Softening point °C	T_{soft}	
Melting point °C	T_{melt}	
Fluidity point °C	T_{fluid}	
Crystallisation temperature	T_{crys}	
Break temperature	T_{break}	
Physical props (available data in datasheet from supplier)		
Viscosity	η	
Heat capacity	Cp_{slag}	
Thermal conductivity	K_{slag}	
Surface tension	σ_{slag}	
Density	ρ_{slag}	
Latent heat	L_{slag}	
Basicity, CaO/SiO2	B_{slag}	

A5.1 Caster specs and casting conditions

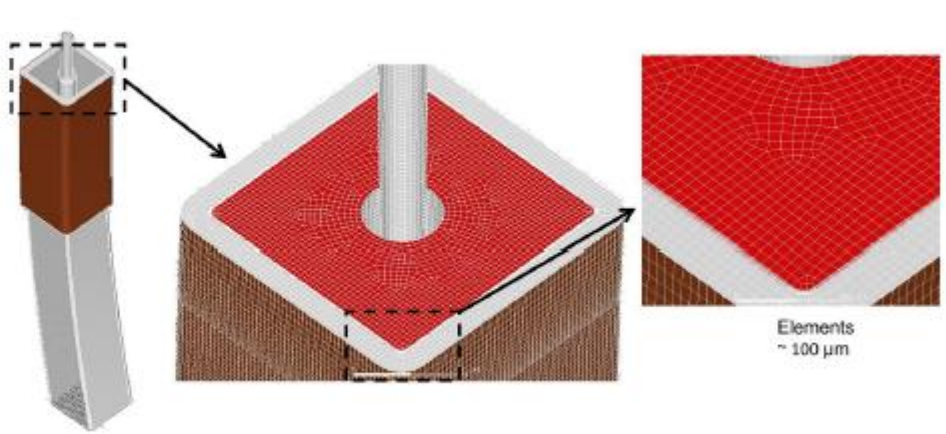
Casting Speed
Ar injection flowrate
Superheat
Immersion depth
Mould level sensor position
Taper
Mould oscillation
Frequency
stroke
n-sin factor
% negative strip time
Water flow rate in channels
Inlet & outlet cooling water temperatures
Water flow rate and spray performance in the secondary cooling region
Thermocouple-temperature readings
Heat fluxes
Friction measurements
Oscillation marks depth and spacing
Electro-Magnetic Stirring (EMS) or Electro-Magnetic BRaking (EMBR)

2. Modelling

- Development of 3D numerical and physical models of the configuration of Sidenor's continuous caster for 240x240 mm^2 and 185x185 mm^2 billet format.
- Model includes heat transfer and solidification by taking iso-thermal flows.

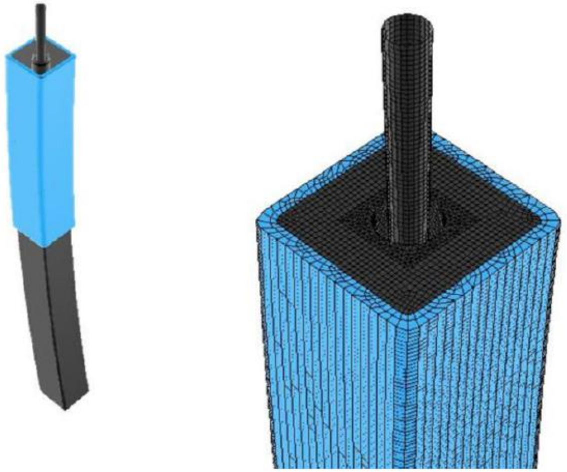
SUPPORT-CAST

240x240 mm^2



NNEWFLUX

185x185 mm^2

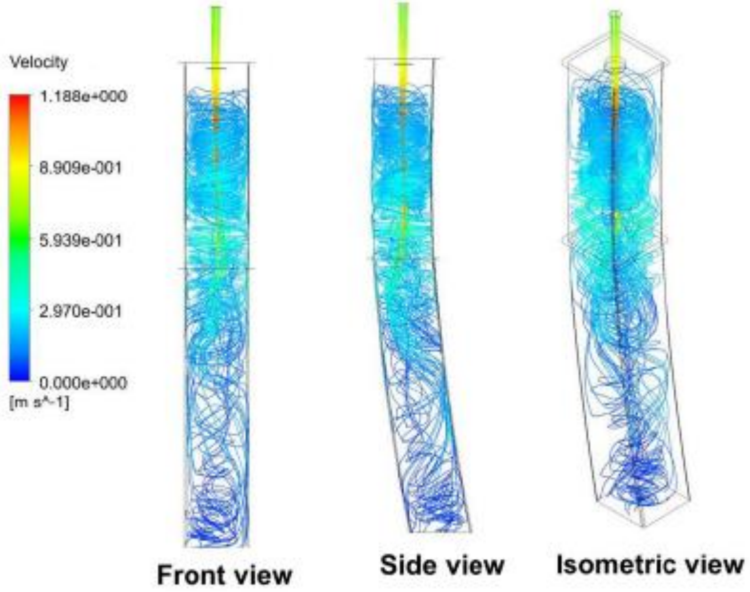


3. Simulation

- The model predicted information like mould temperature, shell growth, slag infiltration...

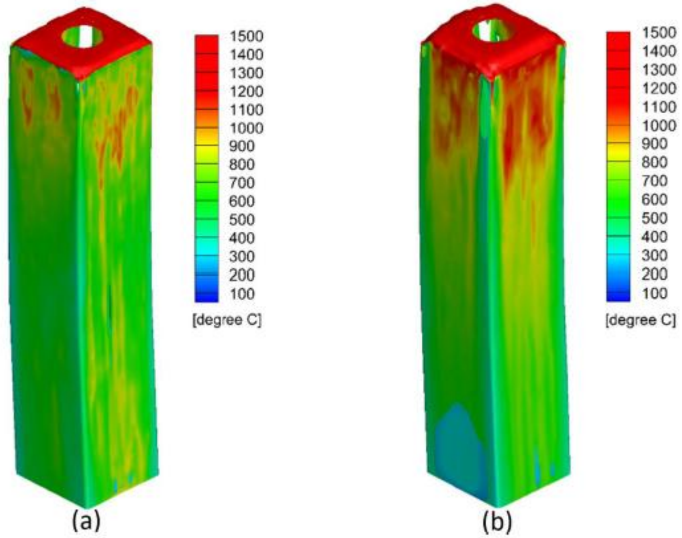
SUPPORT-CAST

EMS implementation with rotational/spiral flow.



NNEWFLUX

Modelling friction to predict slag infiltration in the mould.

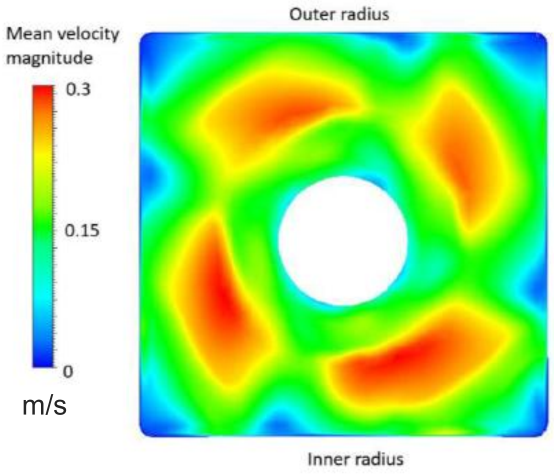


Break T = 1178 ºC

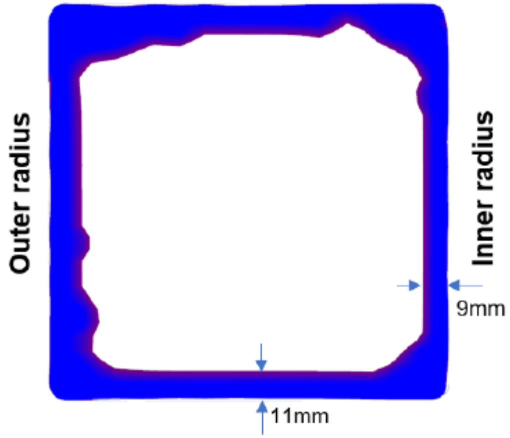
Break T = 1120 ºC

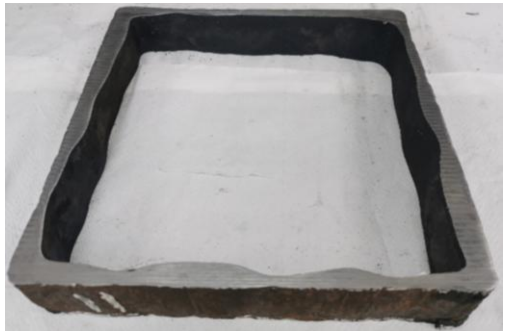
4. Model adjustments

- **Slag-metal surface velocity**
  ↳ Nail board experiments



- **Shell thickness and profile**
  ↳ - Macroetching of transversal billet samples
  - Breakouts





5. Parametric study design

- The parametric study an optimization technique that varies one or more parameters while keeping others constant to explore design alternatives.

SUPPORT-CAST

Relative values

Casting speed (m/min)	Melt height (mm)	Water flow rate (l/min)
1	**1**	**1**
1	0.75	1
1	1.17	1
1	1	0.90
1	1	1.1
0.86	1	1
1.10	1	1

NNEWFLUX

Relative values

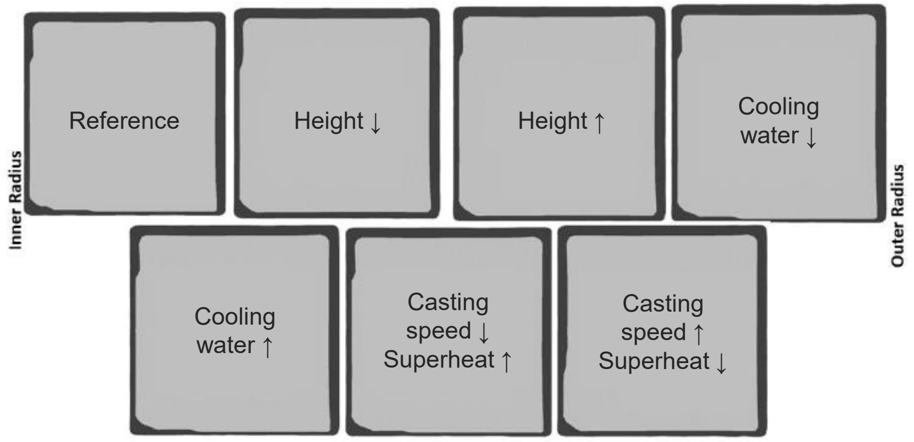
Casting speed (m/min)	EMS current (A)	Inmersion depth (mm)
1.03	0.83	0.75
1.01	0.83	1
1	0.83	1.17
1.02	1	0.75
1	**1**	**1**
0.99	1	1.17
1.01	1.17	0.75
0.99	1.17	1
0.98	1.17	1.17

5. Parametric study results

- The parametric study gives an operational map of the diferent conditions evaluated.

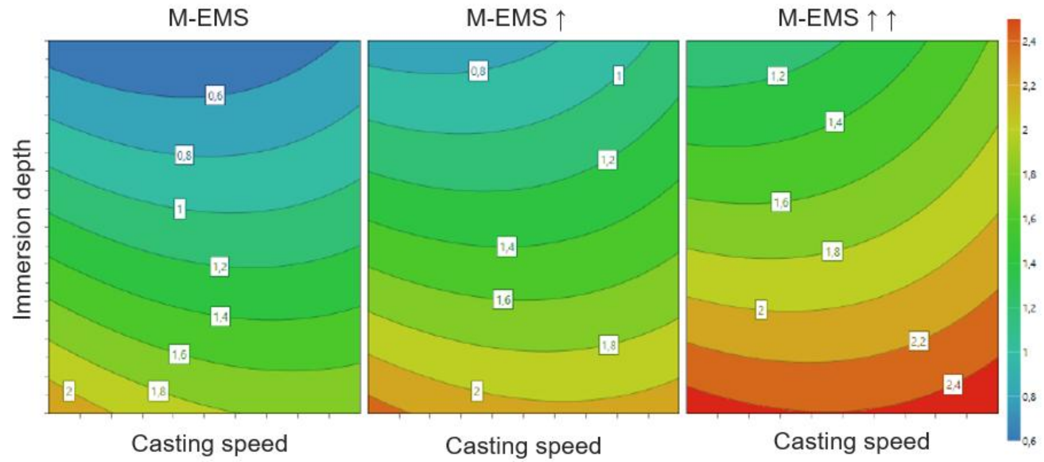
SUPPORT-CAST

EMS has significant impact on the shell. Casting speed (together with superheat), melt height and water flow rate can be improved compared to reference casting practice.



NNEWFLUX

To elucidate operating windows for best as-cast quality with minimal slag entrapment but good lubrication, focused on slag entrainment under different casting conditions including casting speed, immersion depth and electro-magnetic current.

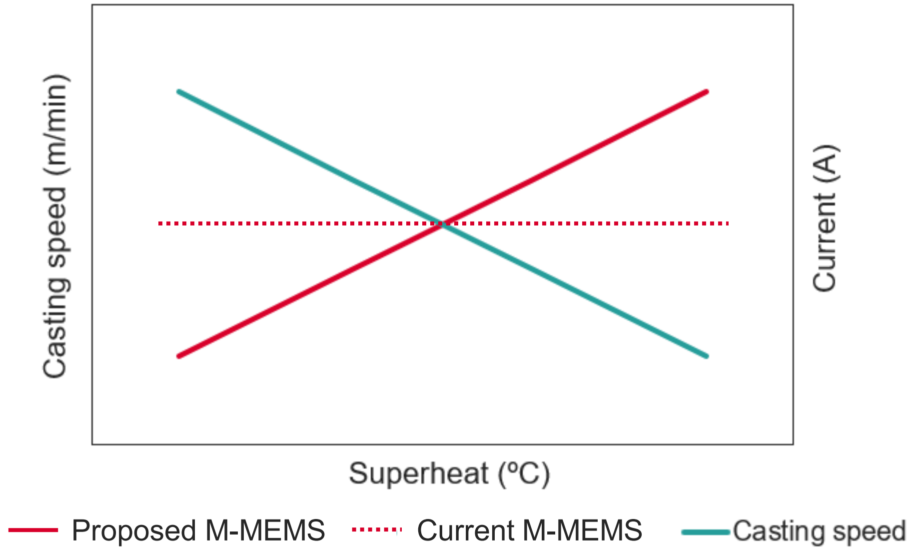


6. Proposal of improvement

- A proposal of improvement is suggested by the Simulators.

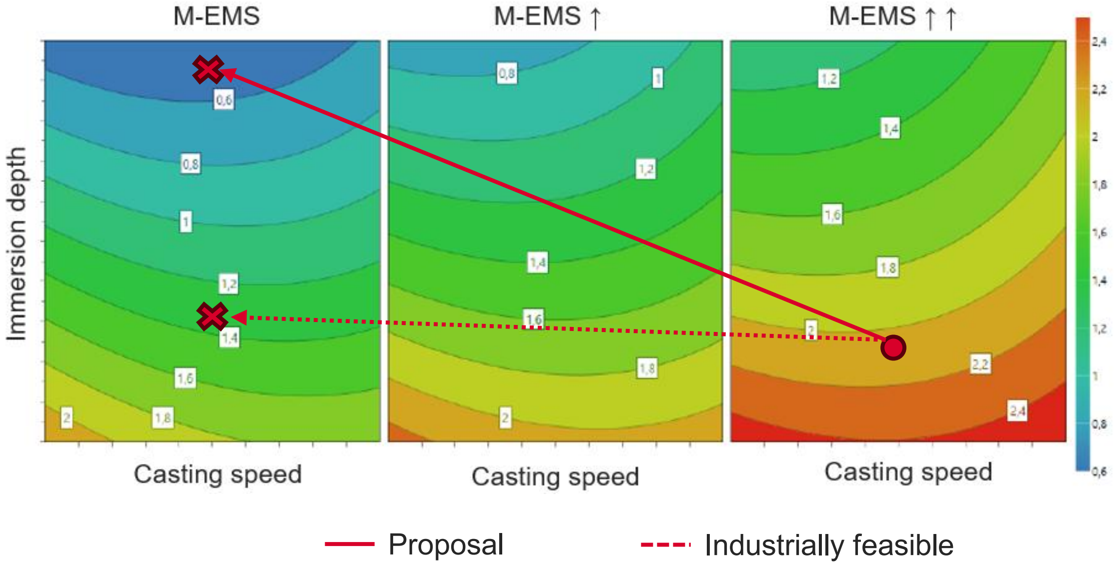
SUPPORT-CAST

To compensate fluxes in mould varying stirring with velocity.



NNEWFLUX

Low stirring for decreasing superficial velocity and therefore minimizing mould powder entrapments.



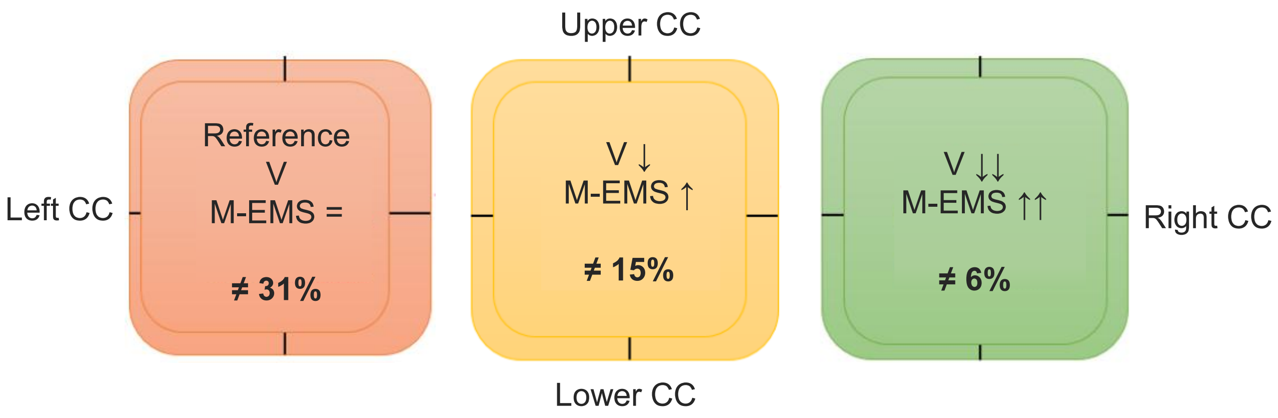
7. Industrial trials

METACAST   Sidenor steel R+D

- Industrial trials for testing the proposal of improvement are organized.

SUPPORT-CAST

Sidenor predicted asymmetric shell thickness due to the slightly higher tangential velocities.



NNEWFLUX

Less entrapments were noticed in the quality control of the finishing units.

Reference
M-EMS ↑↑
Immesion depth

6% rejected material

M-EMS ↑
Immesion depth

4% rejected material

M-EMS ↓
Immesion depth

3% rejected material

Thank you!

Sidenor steel | R+D

STEEL TECH25
CONGRESS & EXPO
21-23 / OCTOBER

VISIT US AT LUXUA HALL !

STAND LU 10

Sector Partner: UNESID

Institutional Partners: Bizkaia foru aldundia diputación foral; Gobierno de España, Ministerio de Industria, Comercio y Turismo; ICEX España Exportación e Inversiones; Grupo spri taldea; Eusko Jaurlaritza Gobierno Vasco

Organizers: SIDEREX; BEC! Bilbao Exhibition Centre