H-ACERO R&D Project - Climate neutrality of the steel industry based on new technologies and processes with intensive application of hydrogen

- Funding program: HAZITEK Strategic Projects
- Project Schedule: 2021 - 2023
- Leader: Sarralle Environment&Energy
- Budget ≈ 9 M€

6 TECHNOLOGY PROVIDERS	5 STEELMAKING COMPANIES	4 R&D ENTITIES
sarralle (Steel Melting Plant, Rolling Mill, Environment&Energy)	ACERALAVA TUBACEX GROUP	ceit MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
Calcinor QUÍMICA NATURAL	ArcelorMittal (Olaberria)	tecnalia MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
insertec Furnaces & Refractories	CELSA GROUP NERVACERO	Sidenor I+D
NIPPON GASES The Gas Professionals	sidenor	TUBACEX INNOVACIÓN
	TUBOS REUNIDOS GROUP TUBOS · PRODUCTOS	

STEEL CLUSTER ASSOCIATION

SIDEREX

HAZITEK is a Basque Government's aid program to support the implementation of Industrial Research Projects and co-financed by the European Regional Development Fund (ERDF).

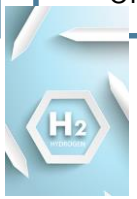
Europar Batasuna Unión Europea — Fondo Europeo de Desarrollo Regional (FEDER) "Una manera de hacer Europa" — Eskualde Garapenerako Europar Funtsa (EGEF) "Europa egiteko modu bat"

EUSKO JAURLARITZA GOBIERNO VASCO

H-ACERO R&D Project – Project description

Strategic objective → contribute to the **decarbonization of the steel sector**, using hydrogen as an alternative energy source.

EQUIPMENT	CONSUMABLES	PROCESS	SAFETY
Development of **technology and new equipment** that allow the use of hydrogen in steel processes.	**Advanced refractories** that allow the use of hydrogen in the steel industry, ensuring the useful life of the different equipment.	Development of **technological knowledge for** application of H_2 on the steel production process.	**Safety requirements and procedures** associated with the use of H_2 as an alternative source to conventional energy.



CFD Simulations
Furnace Simulators
Prototypes (technology at scale)

Current equipment and materials with 10-30-50% H_2/NG mixtures

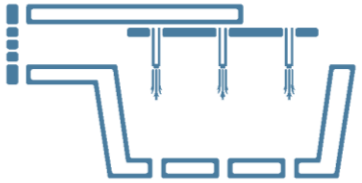
New developed equipment and materials with 100% H_2

H-ACERO R&D Project – Replacement of natural gas by green hydrogen

Ladle Heater

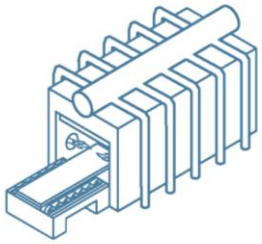
Ladle Heater

Tundish Heater



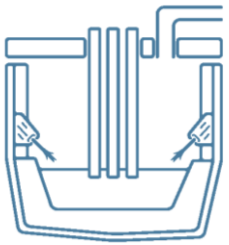
Tundish Heater

Reheating Furnace



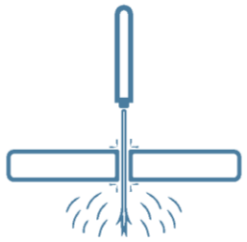
Reheating Furnace

EAF – Injector



EAF Gas Burner

Oxyfuel Cutting



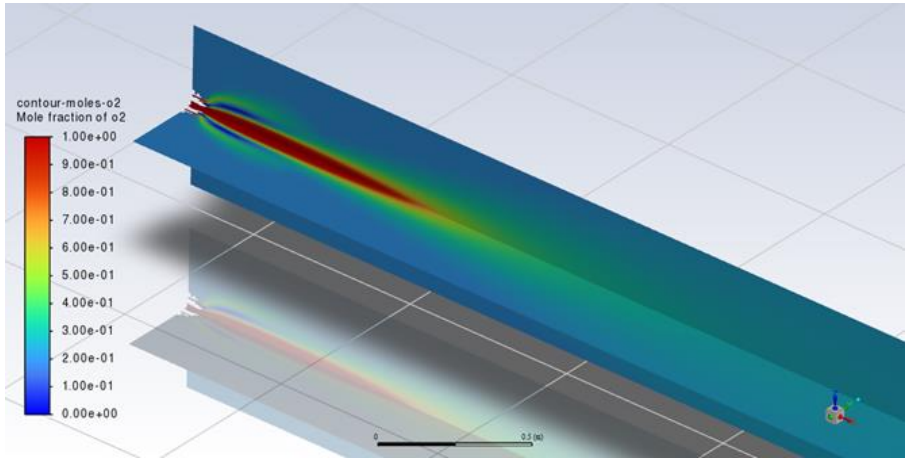
Oxyfuel Cutting

H-ACERO R&D Project – Ongoing activities

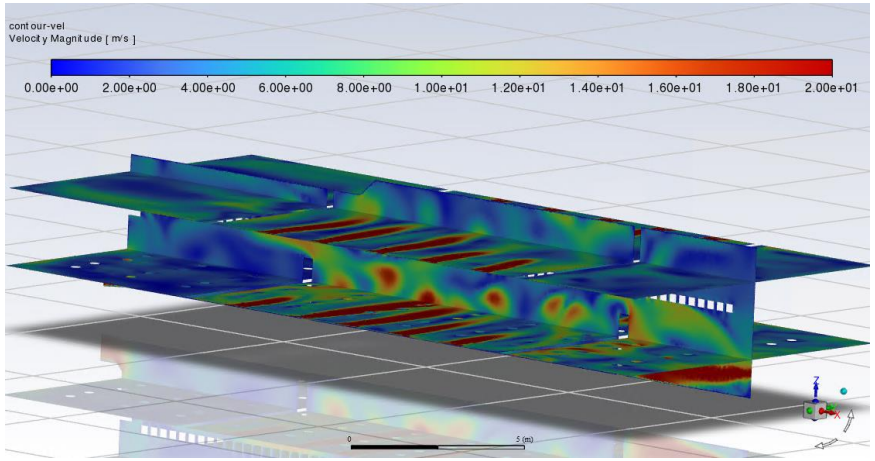
CFD Simulations

Electric Arc Furnace Injectors		
Equipment	Scope	Mode of operation
Current Injectors	NG/O_2	Burner/Lance
	H_2/O_2	Burner/Lance (Determine accepted H_2 %) $10\%H_2 + 30\%H_2 + 50\%H_2$
New Injectors	H_2/O_2	Burner/Lance 100% H_2/O_2

Reheating Furnace		
Equipment	Scope	Mode of operation
Furnace with current burners	NG/air	Current furnace operating conditions
	$NG+H_2/air$	(Determine accepted H_2 %) $10\%H_2 + 30\%H_2 + 50\%H_2$
Furnace with new burners	$NG+H_2/O_2$	100% NG/O_2 100% H_2/O_2



O_2 molar fraction

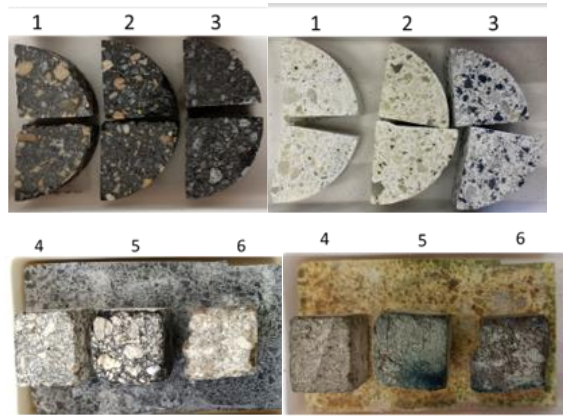


Velocity profile inside furnace

H-ACERO R&D Project – Ongoing activities

Research in refractory materials

Investigate the effect the application of hydrogen combustion has on the refractory materials

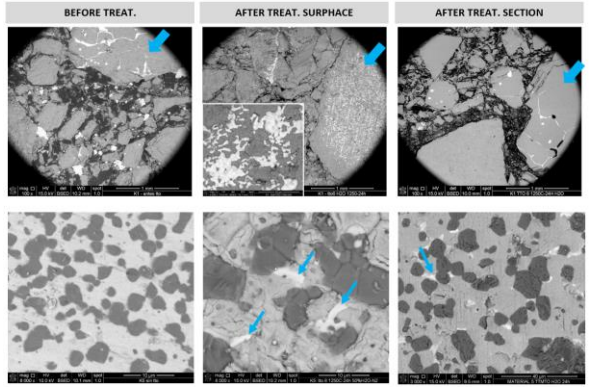


Refractory samples obtained from refractory manufacturer partners in project.

- Thermal treatments in pure H_2 atmosphere
  100% H_2 → 1400ºC-8h

- Thermal treatments in water vapor atmosphere to reproduce expected H_2 conditions
  1250ºC – 24h & 1050ºC – 12h

  NG/air combustion: 8.0% CO_2; 3,4% O_2; 72.7% N_2; **16,0% H_2O**
  NG/O_2 combustion: 33.3% CO_2; 0% O_2; 0% N_2; **66,7% H_2O**
  H_2/air combustion: 0% CO_2; 3,1% O_2; 67,3% N_2; **29,6% H_2O**
  H_2/O_2 combustion: 0% CO_2; 0% O_2; 0% N_2; **100% H_2O**



All samples characterized before and after thermal treatments:

- Microstructural analysis → SEM (surface and section)
- Compositional analysis → XRD, EDX

H-ACERO R&D Project – Ongoing activities

Research in process metallurgy

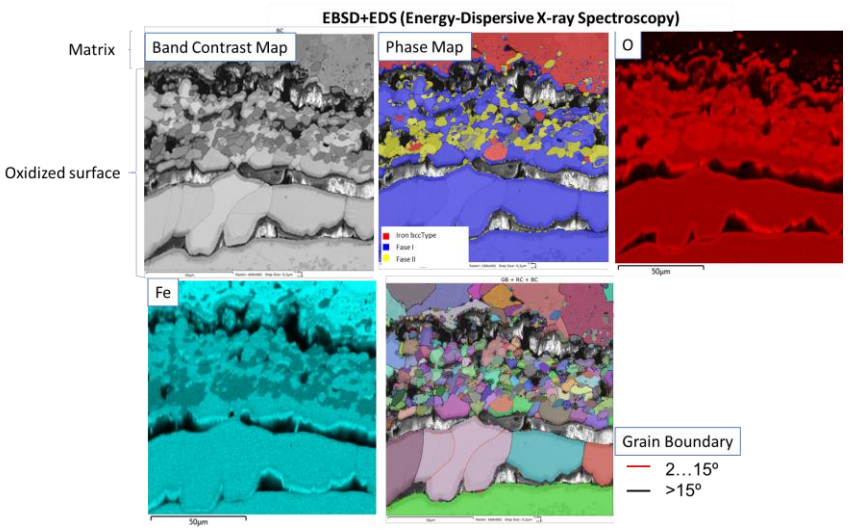
Investigate the effect the application of hydrogen combustion has on the metallurgy of the steels

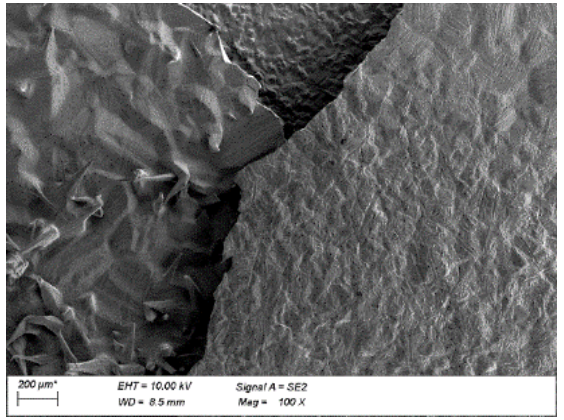
Several steel grades obtained from steelmaking companies in project.

- Industrial thermal cycles on laboratory scale under reference and new expected hydrogen combustion atmospheres
- Analysis of the oxidation kinetics of steels under reference and hydrogen combustion atmospheres by means of TGA tests (thermogravimetry)

All samples characterized before and after thermal treatments:

- Microstructural/oxide characterization after reheating cycles in reference and hydrogen combustion atmospheres produced at industrial level and in laboratory.
- Evaluation of the possible embrittlement of the steel through laboratory simulations of the first stages of processing (hot working).





H-ACERO R&D Project – Ongoing activities

Process heating monitoring for steel grades

Objective → Measure the evolution of temperature of the product to be heated under the usual operating conditions in the reheating furnace

Obtained results → Temperature profile of each of the monitored points throughout the heating cycle.

H-ACERO R&D Project – Ongoing activities

Construction of reheating furnace prototype

- Gas supply (NG, H_2, O_2, air ; 150-200 kW)
- Safety systems for handling combustible gases (NG, H_2, CO)
- Combustion chambers (approximate dimensioning 1,5x1,5x3 m)
- Equipment for the characterization of combustion gases, composition, temperatures
- Fumes extraction system

2022 Q4 finalize construction of reheating furnace prototype

2023 Q1 trials on prototype with H_2 burners