La decarbonizzazione dell'industria siderurgica

organizzato in partnership da

AIDIC / Associazione Italiana di Ingegneria Chimica

Sapienza Università di Roma — Dipartimento Ingegneria Chimica Materiali Ambiente

Università di Pisa

RINA

I progetti europei di R&I

- Prosynteg
- Biocode
- DevH2forEAF

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Egidio Zanin

ProSynteg

RFCS-02-2021-PDP

Project n. 101057965

01/07/2022 – 31/12/2025

Production of hot hydrogen-rich syngas in integrated plants for efficient injection in the blast furnace and CO2 mitigation.

The research leading to these results has received funding from the European Union's Research Fund for Coal and Steel research program under grant agreement number: 101057965

Partners

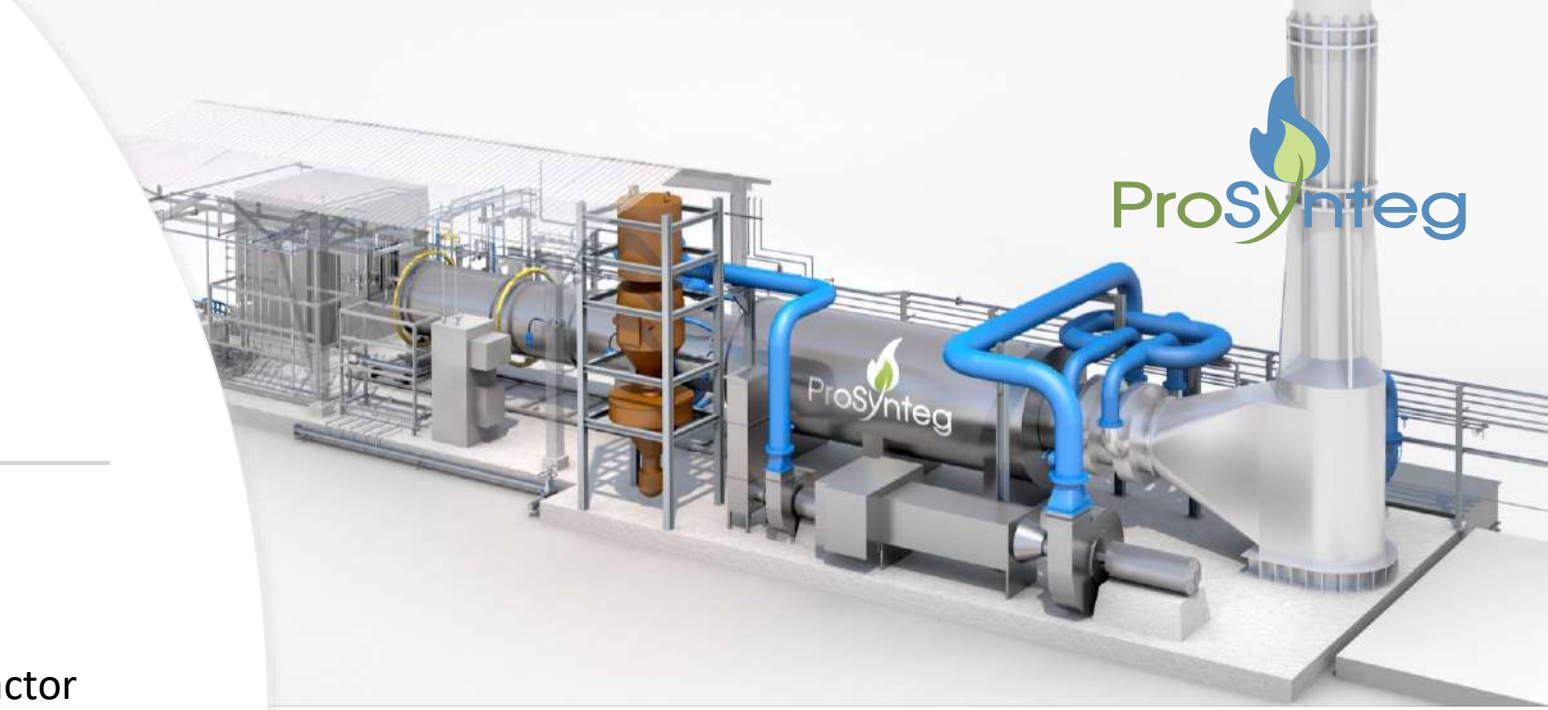
- RINA CONSULTING – CENTRO SVILUPPO MATERIALI (**RINA – CSM**)
- CENTRE DE RECHERCHES METALLURGIQUES (**CRM**)
- ARCELORMITTAL GLOBAL R&D SPAIN (**AM**)
- PAUL WURTH (**PW**)
- ACCIAIERIE D'ITALIA (**AdI**)

Project objectives

- To adapt an existing pilot plant on industrial site to **produce hot H2-rich syngas** by dry-reforming of coke oven gas and/or natural gas with hot CO2 from oxy-combustion of **coke breeze** or **alternative solid circular Carbon sources**.
- To evaluate the performance of the **reforming process** and provide sufficient and reliable **data** to extrapolate the operating results to the industrial scale through **pilot tests**.
- To evaluate the **industrial applicability** of the reforming process, evaluating alternative applications of the syngas with detailed **CO2 emission**, **LCA** and **economic evaluation**.

Main activities

- **Laboratory analysis** on feedstock material and reforming process.
- **Modeling** and **fine tuning** of the reforming reactor and burners.
- **Engineering**, **adaptation** and **commissioning** of the pilot plant for coke breeze combustion.
- **Pilot tests campaigns** and analysis of the results.
- **Evaluation of industrial application potential** of the reforming process in integrated steel plants.
- **Calculations of CO2 emissions**, **LCA** and **economic calculations**.



BIOmass for COkemaking Decarbonization

RFCS-02-2022-PDP

Project n. 101112264

01/07/2023-31/12/2026

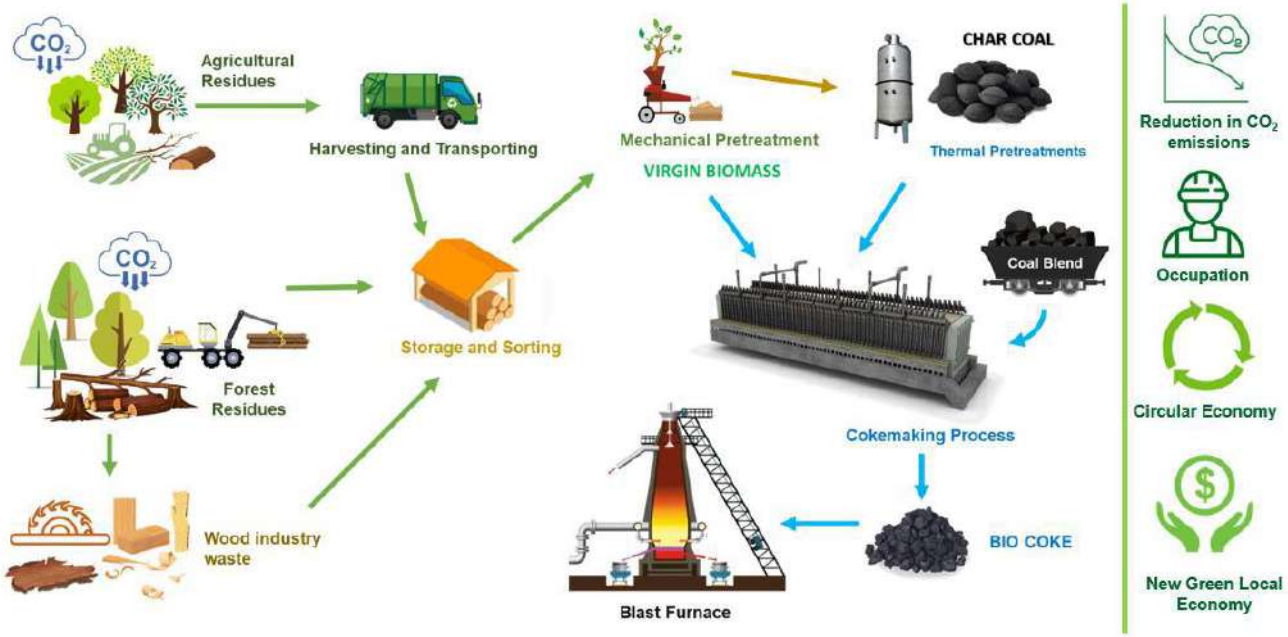
The research leading to these results has received funding from the European Union's Research Fund for Coal and Steel research program under grant agreement number: 101112264

Partners

- Acciaierie d'Italia (**AdI**)
- Thyssenkrupp Steel Europe AG **(tkSE)**
- Paul Wurth Italia (**PIT**)
- Rina consulting – Centro Sviluppo Materiali (**RINA – CSM**)

Project objective

The general objective of the **BIOCODE** project is the **partial substitution** at industrial level of **fossil coal with charcoal** in the coke production up to 10%, **to reduce CO2 emissions** in hot metal process and to increase the sustainability of cokemaking process.



Main activities

- **Material characterization and selection** - Biomass and the treatment for biochar production will be individuated.
- **Laboratory and pilot scale tests** - Carbonization laboratory and pilot scale tests of the biochar/coal blends selected
- **Industrial scale trials** - The most promising blends tested will be tested in an industrial coke oven cell. The produced bio-coke will be characterized, and the results compared with the current industrial standard.
- **Digital tool** - Advanced digital tools will be developed, adapted, customized and installed, to enable required on-line data acquisition, monitoring and control during the execution of the various pilot and industrial tests, as well as deferred analysis.
- **Process scalability and industrialization** - All of the necessary requirements for the industrial scale-up will be fully evaluated.
- **LCA** and economic evaluation will be performed.

Developing and enabling H2 burner utilization to produce liquid steel in EAF

RFCS-02-2020-RPJ

GA number: 101034081

01/07/2021-31/12/2024

The research leading to these results has received funding from the European Union's Research Fund for Coal and Steel research program under grant agreement number: 101112264

General information

Name	Developing and enabling H2 burner utilization to produce liquid steel in EAF
Acronym	DevH2EAF
GA Number	101034081
Start Date	01-07-21
End Date	31-12-24
Duration	42 months
Coordinator	Rina-CSM
Partners	RWTH-IOB, FENO, SMS, NipponGases, Beltrame, CELSA

Scope of the project: Realization and testing of innovative H2 burners to be adopted in EAF.

Main tasks:

- Designing of innovative burners
- Preliminary risk analysis for Hydrogen use in EAF
- Tracking the performance of hydrogen burner in replacement of methane or other carbonaceous fuels through laboratory trials and industrials trials
- Studying of actual performance of H2 burners with the definition of future improvements

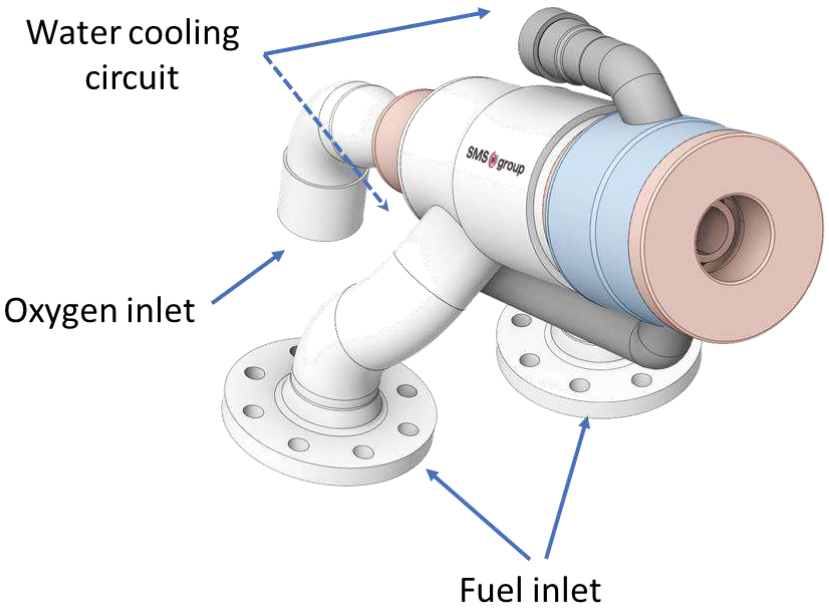
Project activities

1) Design and realization of EAF burners, able to work with NG/H2 mixture, up to 100% hydrogen (SMS)
2) Design and realization of H2 pipeline from the tube trailer to EAF in safety conditions (NG Ind.)
3) Experimental trials at lab and pilot scale (RWTH and CSM) an at two industrial sites (FeNo and CELSA).

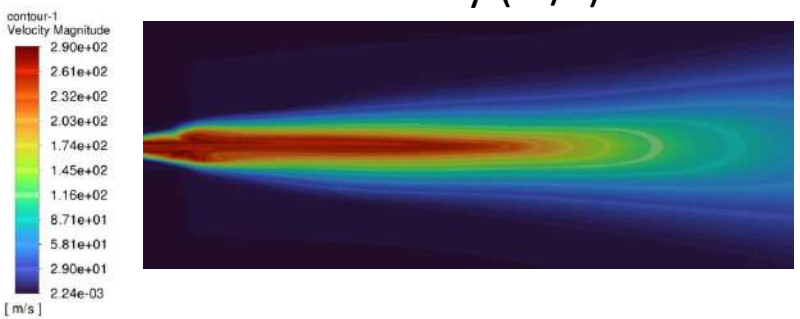
Design and realization of EAF burners, able to work with NG/H2 mixture, up to 100% hydrogen (SMS)

The CFD analysis results of burner at 3 MW with 100% hydrogen show:

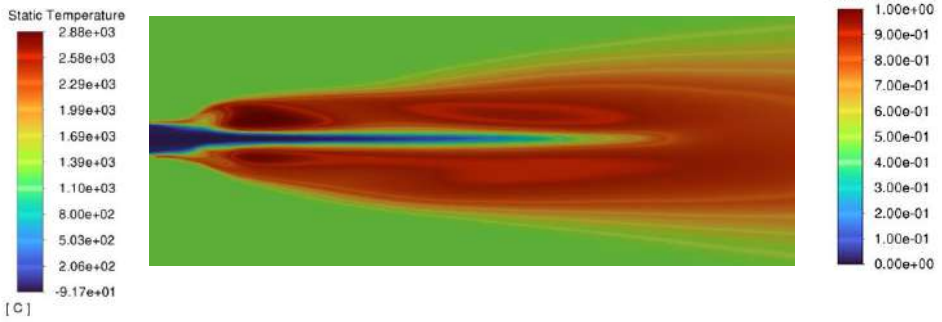
1) The combustion of hydrogen is complete in less of 2 meters.
2) The central oxygen jet remains stable, improving the stability of the flame, being the oxygen the stream that guides the remaining fuel flow rate.
3) The fast ignition favors the mixing of oxidant and oxidizer.
4) The high speed of the central oxygen permits to produce an elongated flame with a progressively combustion through the entire length of the jet reducing the heat load on the burner head.



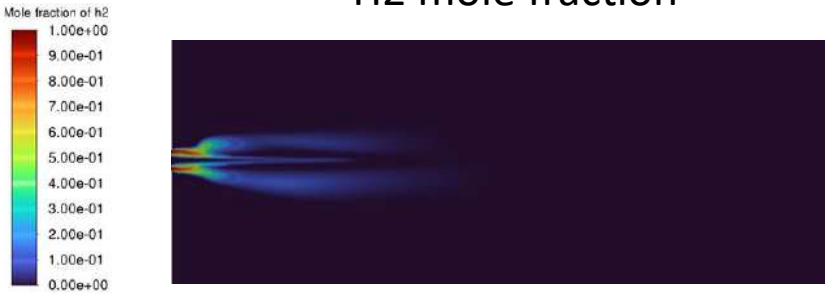
Velocity (m/s)



Temperature (°C)



H2 mole fraction

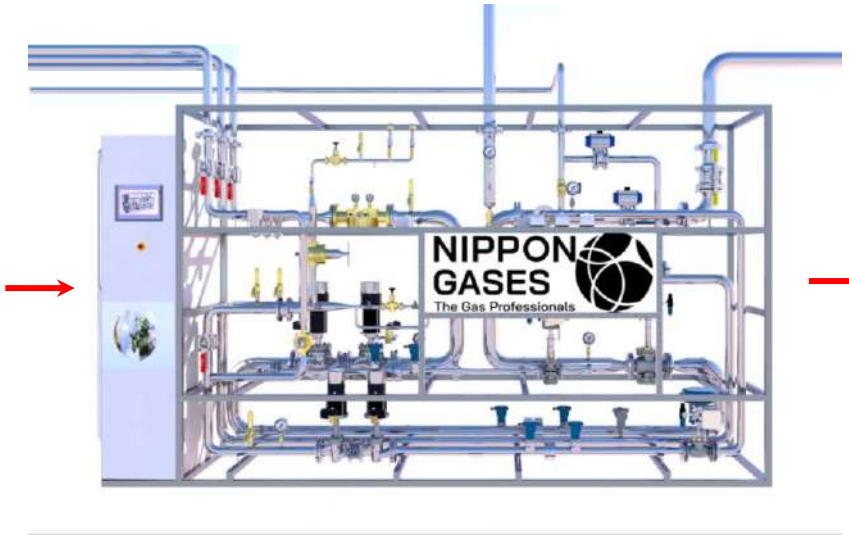


Design and realization of the fuels supply system and pipelines design (Nippon Gases Industrial)

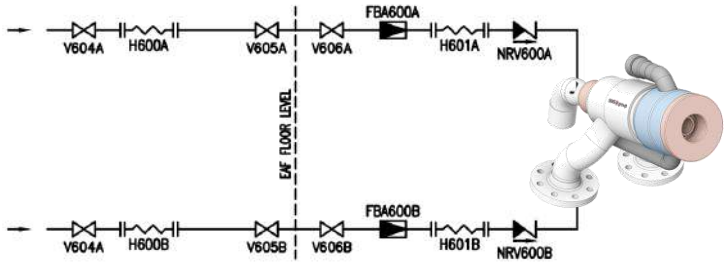
1) Hydrogen high flowrate tube trailer with decompression system.
2) Hydrogen pipeline design.
3) Fuel Supply Regulation System (FSRS) to mix various percentage of H2 and NG.
4) Flash-back arrestors system to protect the equipment from damage or explosion.
5) SIL3 design for stoichiometric ratio control.

Hydrogen high flowrate tube trailer

Hydrogen decompression system



FSRS



Flash-back arrestors system (P&ID)

EAF Burner

Experimental trials at lab and pilot scale (RWTH and CSM) an at two industrial sites (FeNo and CELSA).

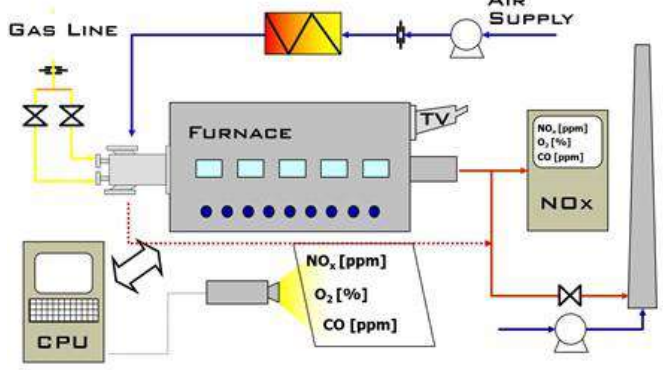
1) Pilot trials on **RINA-CSM** combustion chamber to investigate the heat transfer, temperature profile into the burner, chemical composition of off gas (O_2, CO_2, H_2O, CO and NOx).
2) Prototype burner on 600kW pilot EAF in **RWTH** premises with pure NG (reference) as well as mixtures of H2-NG up to 100% H2 operation. The trials will be used to investigate the off-gas composition hydrogen pickup of the melt.
3) The experimental campaigns at **FeNo** and **CELSA**

RWTH 600kW pilot electric arc furnace plant

- *Transformer rated power: 850 kVA*
- *Secondary voltage: 250 850 V in 10 steps*
- *Arc current: max. 2 kA*
- *Active power: max. 600 kW*

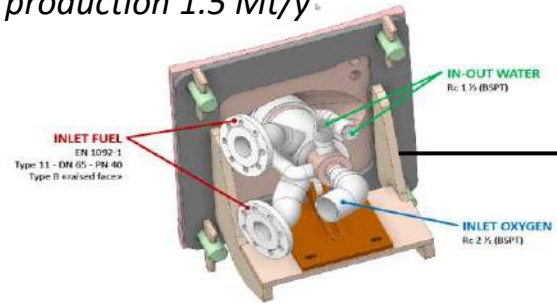
RINA-CSM combustion Chamber

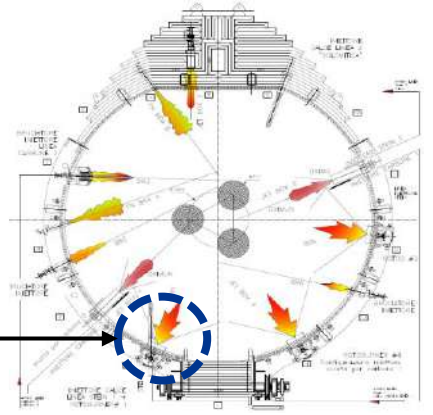
Maximum Fuel flow rate: 300 Nm3/h of NG, 2000 Nm3/h for syngas compositions
Pollutants Monitoring and Recording: O2, CO, CO2 & NOx
Control System of furnace
Flow rate, Pressure and temperature monitoring and recording
Continuous Video Monitoring



Burner position in Ferriere Nord EAF

Capacity : 148t
Dimensions 7100 mm diameter
Installed Power 130 (+10%) MVA
Tap to tap time 46'
Yearly production 1.5 Mt/y





Downstream processes

Thermal treatment and reheating have high natural gas demand (about 50 Nm3/t)

Decarbonization of downstream processes requires electrification of furnaces or NG substituion (or combination of both)

Three projects just started to reduce Ng utilization in reheating furnaces

Downstream processes

HyTecHeat

To apply hybrid/H2 heating technologies and to evaluate the effects of the quality of the steel products, on the refractories and also on the combustion systems

Three Demo cases testing innovative multifuel burner and testing the limit of current systems at TRL 7 will facilitate the hydrogen transition of the steel sector

RINA tenova nunki TATA SWERIM SSAB Linde ArcelorMittal snam DE NORA Tenaris

ModHEAtech

The project ModHEAtech proposes to decarbonize the ROLLING MILL PLANT, keeping high quality standard without negative impact on productivity and economic needs

Process is aimed at realization of small scale pilot plant

RINA ORI MARTIN FERALPI GROUP Tekniker sidenor

ModIplant

The primary scope of this project is the introduction of hybrid heating technology, based on electrification and gas-burning properly combined.
The partial electrification of the furnaces is realized by the installation of an induction system and an innovative alternative system.
The relevant aspect of this project is the full-scale applications on industrial processes.

RINA FERALPI GROUP MARCEGAGLIA universität freiburg Łukasiewicz Instytut Metalurgii Żelaza