

AIM _ EAF International Meeting
Bergamo, 30 Novembre 2023

SPEAKER
Ing. Fabiano Ferrari

Decarbonizing Steel industry

Participation to EU funded Project (*):

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



(*9) 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



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Summary

1. Project overview
2. Partners' activities
3. Nippon Gases participation: Fuel Supply Regulation System
4. Current project status
5. Introduction to Nippon Gases
6. Nippon Gases solutions for a Carbon Neutral World



Project Overview

Problem tackled by DevH2forEAF

Analyze issues related to **storage, transportation, and injection** of H₂ into the EAF and provide some indication about the **influence of the hydrogen combustion** in substitution of fossil fuels in **EAF process metallurgy**

Main objectives



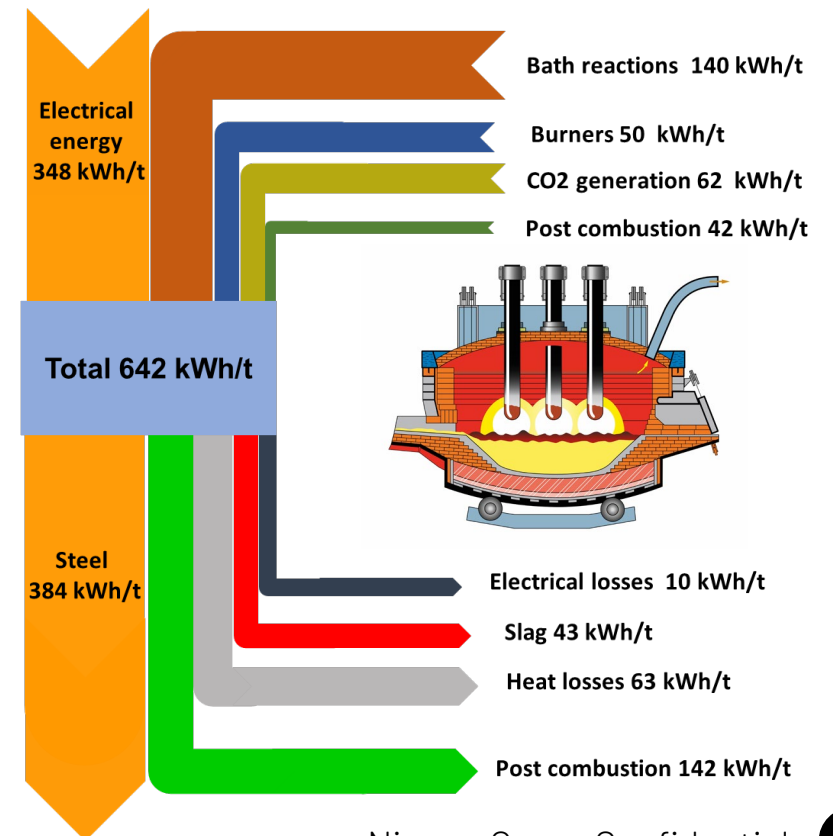
Design and realization of burners, able to work with NG/H₂ mixture, up to 100% hydrogen. The burners are designed and manufactured to work in severe environment, thus ensuring mechanical and thermal resistance in respect of EAF operative conditions.



Risk analysis for the definition of the correct actions and countermeasures **when hydrogen is used in EAF process**: safety issues related to **storage, transport and injection** identified and risks minimized.



Analysis the **performance of hydrogen burner** in replacement of NG through experimental trials at two industrial sites.



Partners' Activity

The Gas Professionals

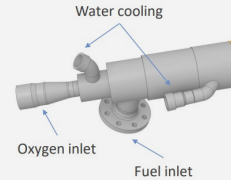


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DESIGN and CONSTRUCTION



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



Design and realization of Fuel Supply Regulation System NG/H2 mixture, up to 100% H2



DEMO TRIAL



Prototype burner on 600kW pilot EAF. Trials to investigate off-gas composition H2 pickup of the melt



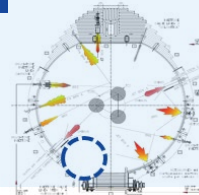
Pilot trials on combustion chamber. Investigation on heat transfer, T profile in the burner, Off gas chemical composition



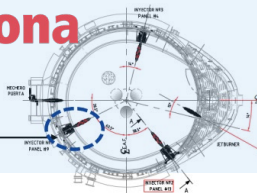
TEST AT INDUSTRIAL SITE



Experimental campaign on 147 t (liquid) EAF



Experimental campaign on 162 t (liquid) EAF



Feasibility Study - Identification of relevant scenario and other suitable applications



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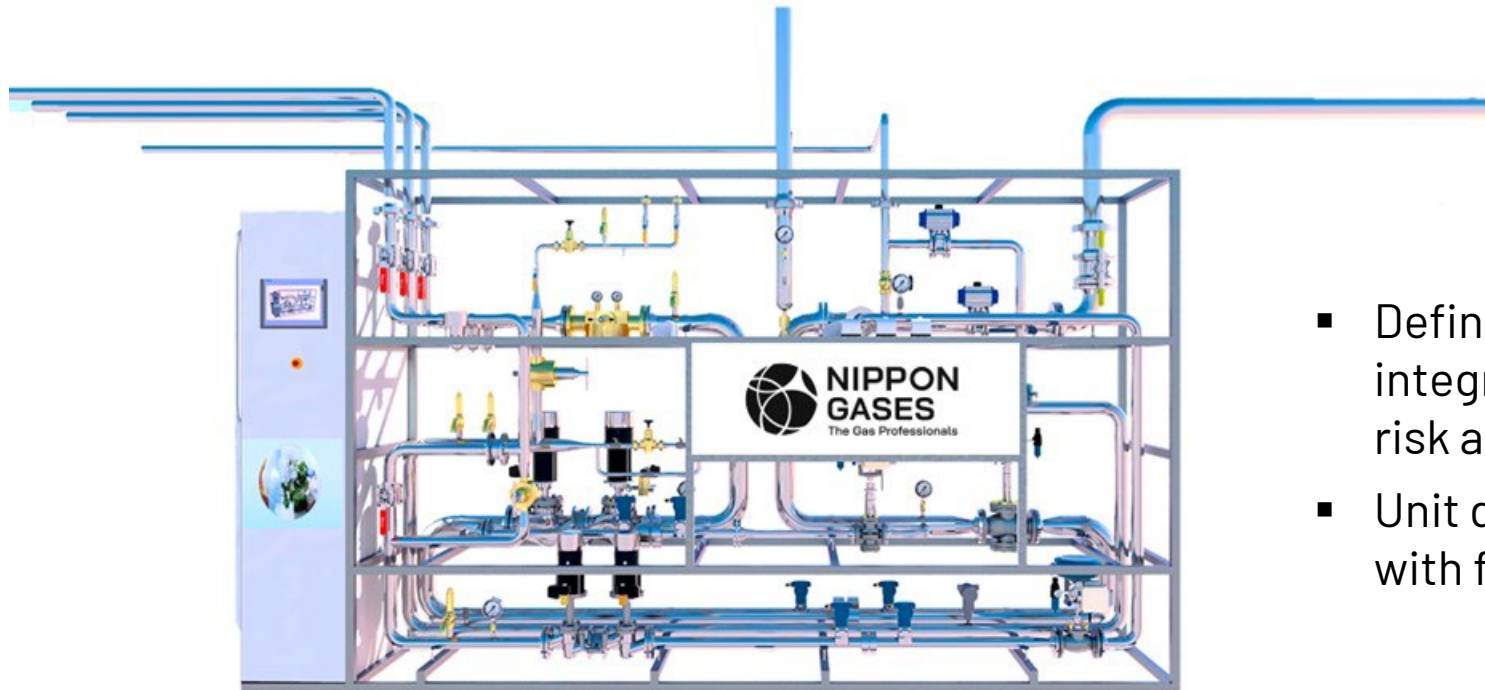


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Fuel Supply Regulation System

Critical design aspects

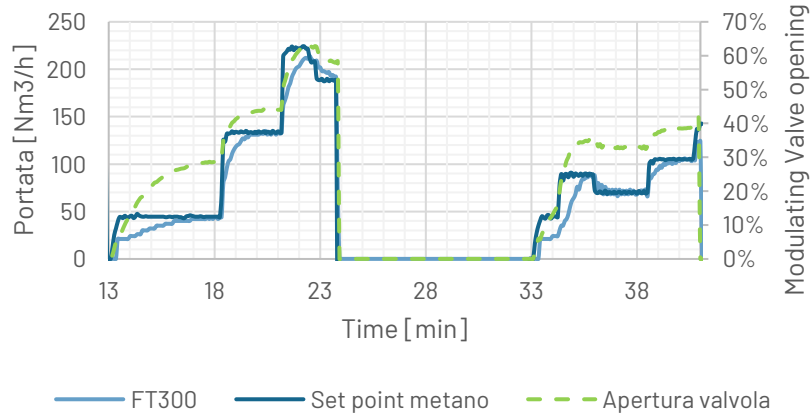


- Definition and Design of proper safety integrity level based on semi-quantitative risk analysis (SIL Vs. PL).
- Unit design based on multiple variables with focus on accuracy & sensitivity.

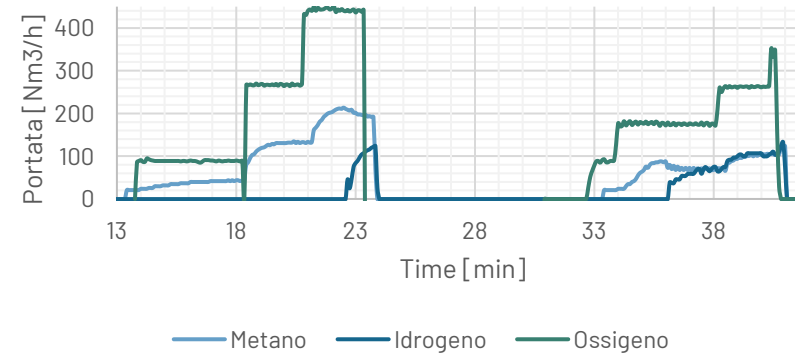


FSRS (Fuel Supply Regulation System) Control philosophy

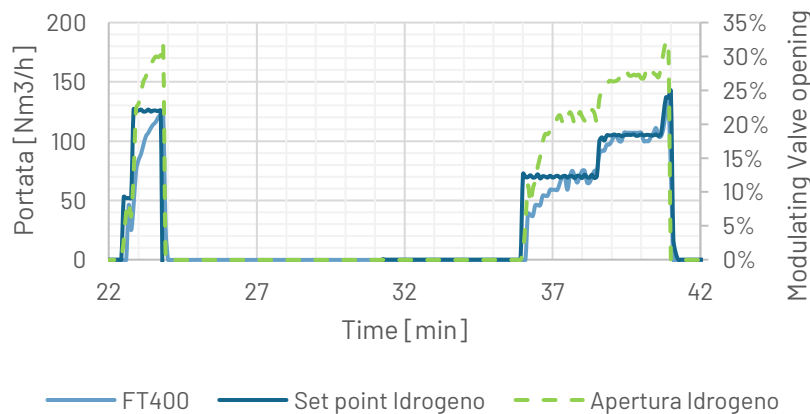
Natural gas regulation test



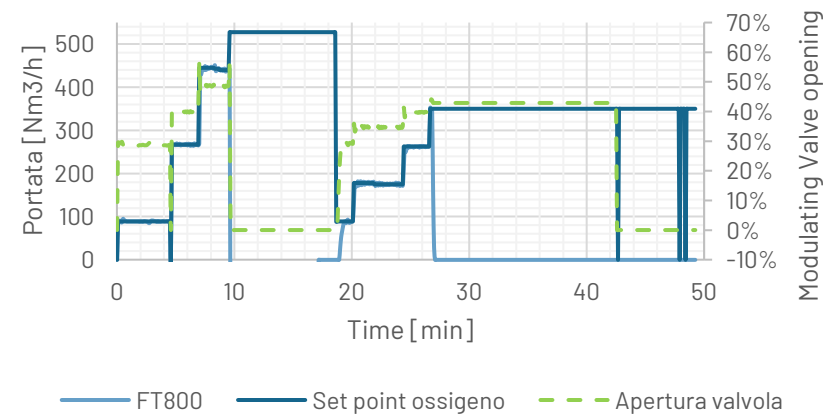
Oxygen, Hydrogen, Natural gas regulation test



Hydrogen regulation test



Oxygen regulation test



FSRS

Control philosophy

Hydrogen and H₂/CH₄ Mixtures handling

Functional safety logic (SIL and Performance Level)

Layers of protection analysis (LOPA) methodology risk analysis

Sensitivity of measuring systems and adjustment accuracy

Stress analysis of long distribution pipes and seismic compliance

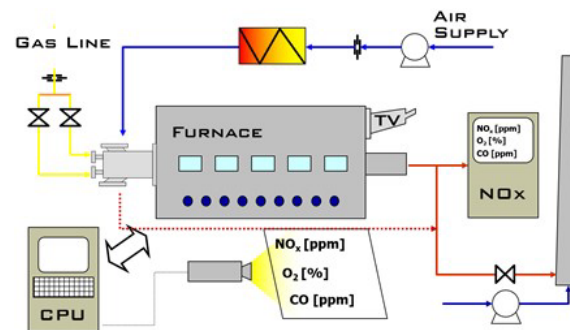
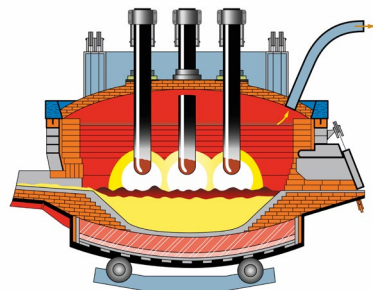
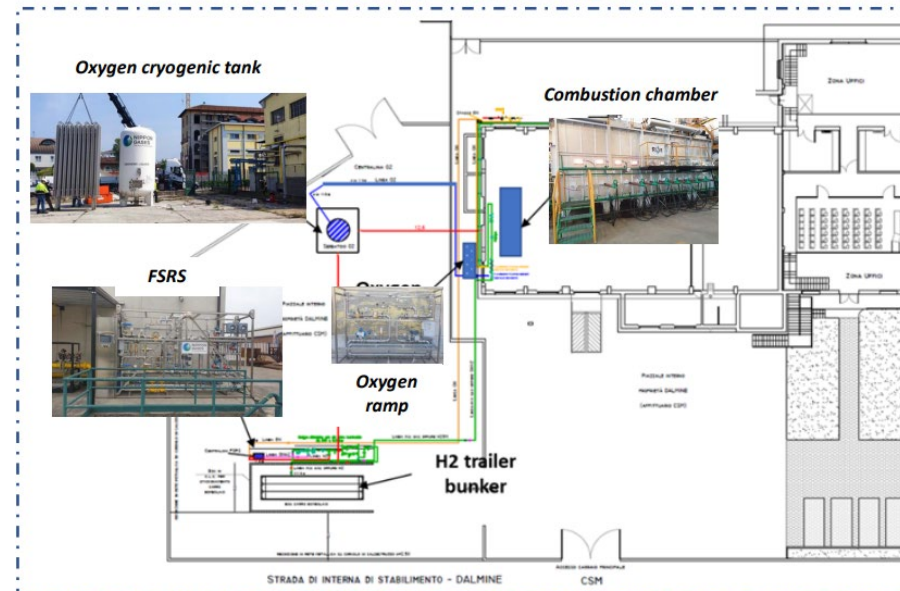
3-D modelling and structural analysis of control skids



Current Project's Status

- Ready for 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 NO_x).
- Prototype burner on 600kW pilot EAF in RWTH premises with pure NG (reference) as well as mixtures of H_2-CH_4 up to 100% H_2 operation. The trials will be used to investigate the off-gas composition hydrogen pickup of the melt.
- First experimental campaign at FeNo to be started by 2024 and CELSA will follow

RINA- CSM Dalmine layout



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 & NO_x

Control System of furnace

Flow rate, Pressure and temperature monitoring and recording

Continuous Video Monitoring



Aknowledgment

This work was carried out with support from the European Union's Research Fund for Coal and Steel (RFCS) research program under the ongoing project:

Developing and enabling H₂ burner utilization to produce liquid steel in EAF – DevH₂forEAF – GA number 101112264.



Nippon Gases Italia member of Nippon Gases Europe



NIPPON SANSO HOLDINGS

Nippon Gases is part of the Nippon Sanso Holdings Corporation -the parent company to the Taiyo Nippon Sanso industrial gas business in Japan, the US Matheson Tri-Gas Group, the European Nippon Gases, the Asia/Oceania Regional Group and Thermos Business Group- which has over 100 years of experience and boasts a major presence in Japan, Southeast Asia, Australia, the United States and Canada.

Established in
30th Oct **1910**

Head office
in Tokyo **Japan**

With more than
employees **19K**

Operations in
countries **30** | Operating over
Air Separation Units **130**



Sales FYE 2023: **460 Mi€**

Employees: approx. **670**

- 1 Headquarters
- 21 Sales offices
- 2 Pipelines
- 2 Specialty gas production plant
- 6 Air Separation Unit (1 under construction)
- 4 CO₂ production plants
- 3 HyCO plants
- 14 Filling centres*
- 6 Storehouses

*Filling center operated with third parties are excluded.



Meet **The Gas Professionals** now in Europe


 Over **3,000** employees

 Over **150,000** customers

 **14** Pipelines


 **5** Specialty Gases Laboratories

 **28** Air Separation Units

 **6** Hydrogen Plants

 **39** Small On-Site

 **14** CO₂ Plants

 Over **600** trucks

 Over **2.7 M** cylinders

 **38** Filling Stations

 **11** Dry Ice Plants

 **9** CO₂ Terminals

 **3** CO₂ Ships



Carbon neutral world

Carbon neutral world is the new initiative of Nippon Sanso Holdings (NSHD), oriented towards helping our customers reduce their carbon footprint.

What are we doing to achieve this change?

As part of our strategy to contribute to this change we are refocusing our gas-based solutions on five key pillars.



Greening
Combustion

Hydrogen
Solutions

CO₂
Capture

Circular
Economy

Digitalisation

Visit carbonneutralworld.com to know more!



We enable
a carbon neutral
world

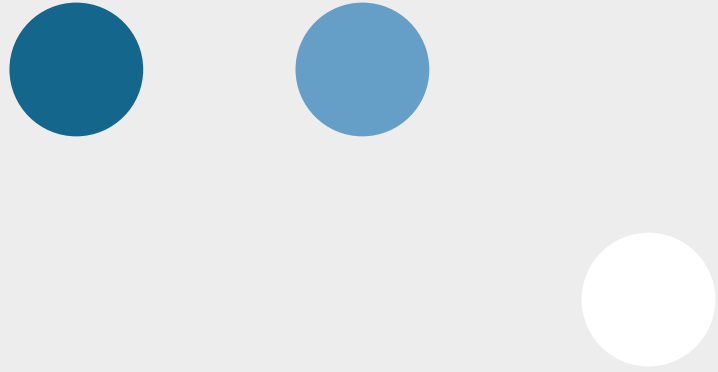
A NIPPON SANSO HOLDINGS INITIATIVE



NIPPON SANSO HOLDINGS

TAIYO NIPPON SANSO | MATHESON | NIPPON GASES





Thank you for the attention

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Join our journey:

Carboneutralworld.com



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