STEEL 24 MASTER

XXVI Edizione

RINA

1ª Settimana
RINA
Dalmine (BG)
6 - 10 Maggio 2024

2ª Settimana
Acciaieria Arvedi, c/o ARVEDI CAMPUS
Cremona
10 - 14 Giugno 2024

Flexible Bench-Scale Plant for Dry Reforming of Steelmaking Gases

Ana Oblanca, Research Engineer
ana.oblancagutierrez@arcelormittal.com

ArcelorMittal

Steelmaster
è una iniziativa sostenuta da

ESTEP · Federacciai · industriAll · Arvedi · European Commission

INDEX

- ArcelorMittal Global R&D
- ArcelorMittal Gaslab facilities
- ArcelorMittal contribution to ProSynteg

ArcelorMittal Global R&D

ArcelorMittal

- One of the world's leading steel and mining company, with around 158,000 employees in more than 60 countries.
- Leader in all major global steel markets, including Automotive, Construction, Household appliances and Packaging, with leading R&D and technology.
- Primary steelmaking facilities in **16** countries expose the company to all major markets, from emerging to mature

ArcelorMittal Global R&D

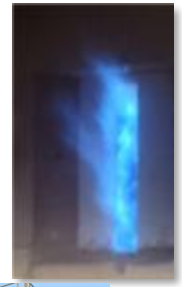
- 1600 Researchers in 14 geographical sites
- R&D portfolio: Process, automotive, packaging, metal processing, construction and infrastructures, mining, digital…
- More than 79 new inventions protected
- > 41 new products and solutions launched
- 12000 patents and patent applications

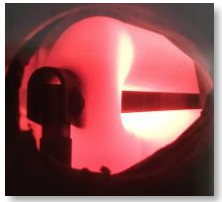
ArcelorMittal Global R&D - Gaslab Facilities

- Gaslab facilities → a reference R&D infrastructure for ArcelorMittal
- Direct access to real process gases supply directly from AM plant gas network (Blast Furnace Gas, Coke Oven Gas, Natural Gas…).
- Accurate assessments of actual technology performance by directly interfacing the equipment with real process gases and measuring actual process yields under relevant industrial conditions.

ArcelorMittal Global R&D - Gaslab Facilities

- **Real process gases supply, directly from plant gas network**
  - Steelmaking gases: Blast Furnace Gas, Coke Oven Gas, Natural Gas
  - Nitrogen, oxygen and steam
  - Hydrogen
- **Remote monitoring and control. 24/7 Operation**
- **Compression units**
  - Up to 1000 Nm^3 and up to 8 barg
- **Gas Analysis**
  - Mas spectrometer, gas chromatograph
  - Flue gas analysis, portable and fixed
  - Gas sampling
- **Furnaces**
  - Reheating furnaces: 1,2 MW, 250 kW
  - Radiant tubes: 360 kW
  - Mixing station for all gases.
  - Dynamic Control
- **CCUS**
  - Equipment installation and commissioning
  - Fast testing of different technologies (plug & play)
  - Mixing possibilities and gas pre-treatments
- **Control Systems**
  - SCADA with PCS7
  - Data loggers and cloud connectivity





ArcelorMittal contribution to ProSynteg

WP2

- **T2.5**: Small-scale reforming experiments with COG and CO_2

WP3

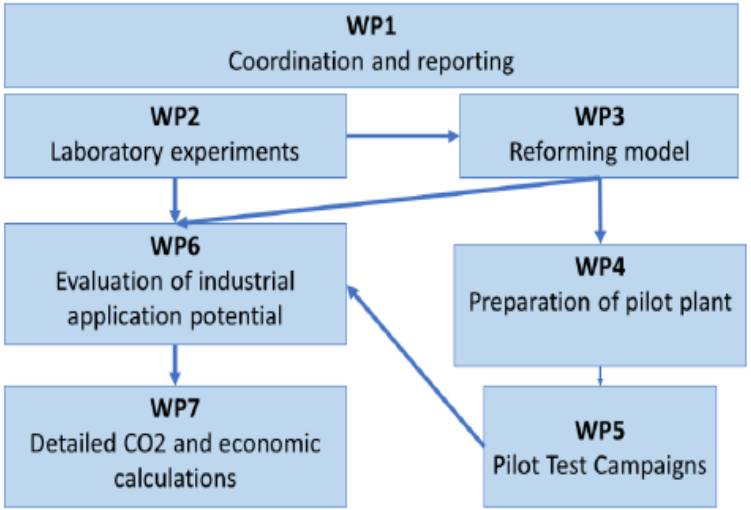
- T3.3: Calibration and fine-tuning of the model parameters based on lab experimental and pilot results

WP6

- T6.1: Flexibility of the process regarding raw materials
- T6.3: Detailed calculation of the value in-use of the syngas at the BF and comparison with direct injection of COG in tuyeres
- T6.4: Safety issues at the BF linked to the new process, to gas injection and to the increase H_2 content of the BF top gas
- T6.5: Alternative options for using the hot syngas in reheating furnaces or other combustion applications

WP7

- T7.1: CO_2 calculations and LCA on the main industrial options, including the injection of hot syngas in BF shaft
- T7.2: Economic calculations



WP2: Small-scale Reformer Trials

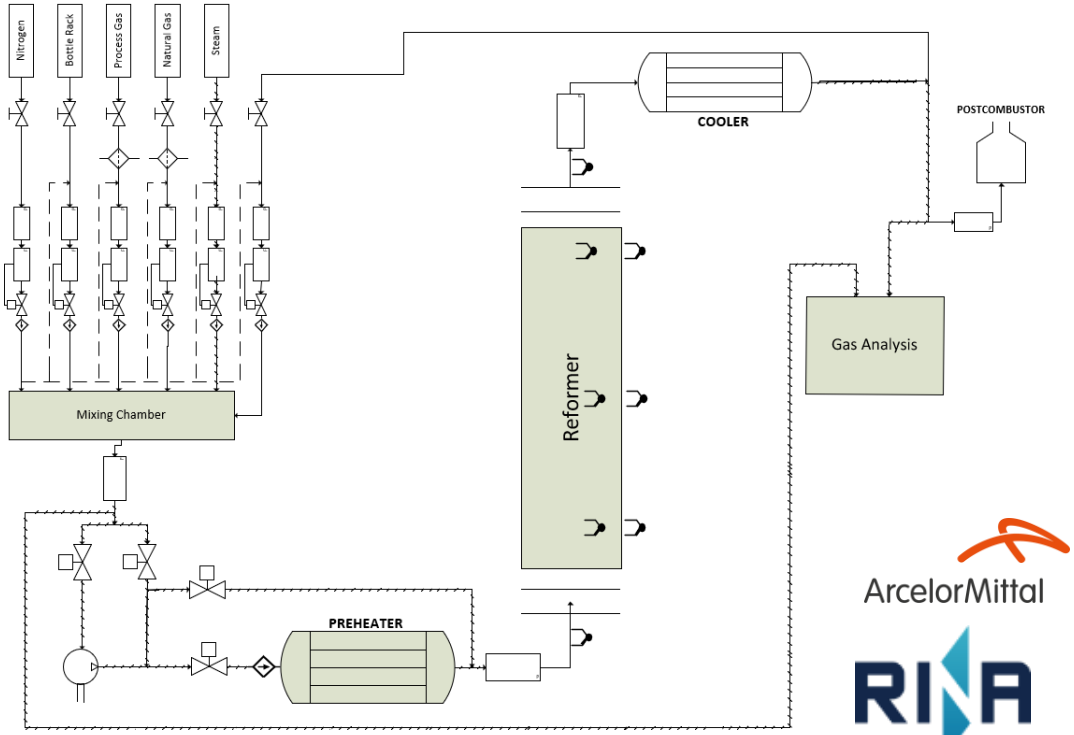
Reforming trials performed in ArcelorMittal Global R&D

- Fixed bed reactor
- Temperatures up to 1000ºC
- Flowrates capacities up to 6 Nm^3/h
- Connected to gas network (BFG) & bottle rack
- Product gas analysis

WP2: Small-scale Reformer Trials

Modifications of the reformer:

- Fixed bed reactor
- Temperatures up to 1200ºC
- Flowrates capacities up to 20 Nm^3/h
- Compression unit installed: 6 bar max
- Gas mixing station: connected to gas network (BFG, NG, COG, steam, N_2) & bottle rack (3 lines at a time)
- Inlet & outlet gas analysis



WP2: Small-scale Reformer Trials

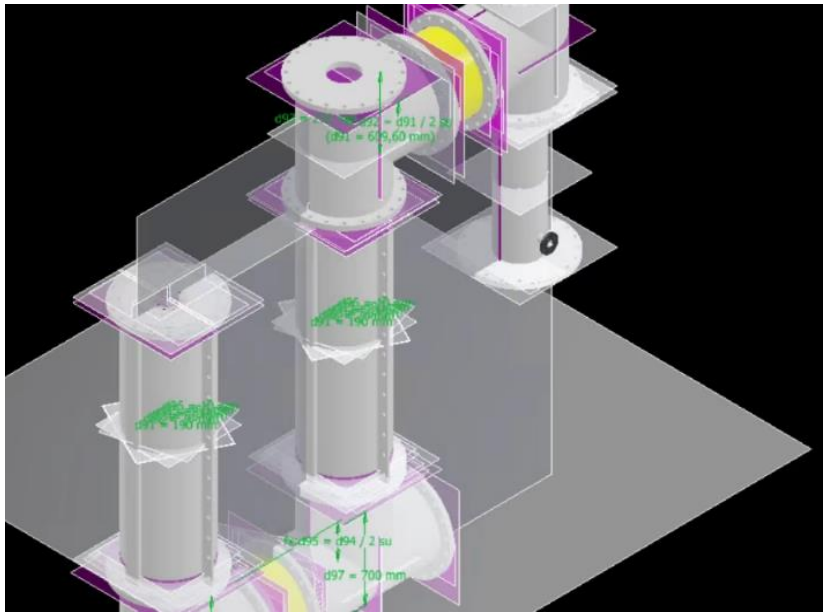
Modifications of the reformer: Mixing Station Rack and Compression System

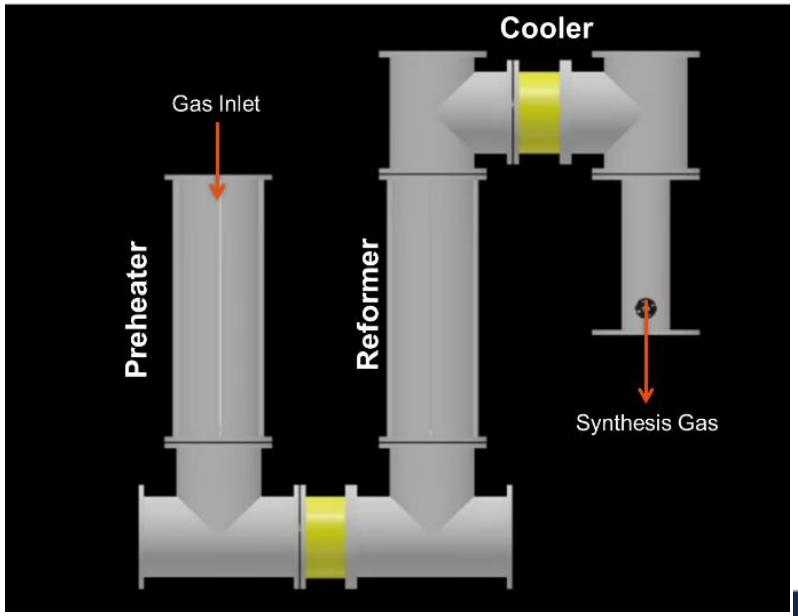
Mixing Station Unit

Compression System

WP2: Small-scale Reformer Trials

Modifications of the reformer: Preheater + Reformer + Cooler System





WP2: Small-scale Reformer Trials

Operational Parameters to test:

Temperature	Flowrates
• DMR performed at high T (700 -1000ºC) + catalyst • "Thermal" DR concept: no catalysts → higher required T (max1200ºC will be tested)	• Gas inlet flowrates could be beneficial for the performance of the reaction → linked to residence time of the gas inside the reactor. • Higher residence times → higher performance
Pressure	**Steam Addition**
Higher P could enhance the production of synthesis gas (max 6 bar)	• Adding small amounts of steam to the reaction will avoid soot formation → negative effect • Small amounts of steam additions will be varied during the trials to check this effect.

WP2: Small-scale Reformer Trials

Operational Parameters to test:

Feedstock gas mixtures

- Dry reforming reaction requires a CO_2 & CH_4 source.
- Potential mixtures to test:

CO_2 Sources	CH_4 Sources
• Oxycombustion off gases (coke breeze, biogenic or alternative carbon sources…) • Blast Furnace Gas • Simulated tail gas from CO_2 capture plant	• Natural Gas • Coke Oven Gas • Pure CH_4 • Other CH_4 sources

Contaminants/impurities

- Steelmaking process gases has some HC and S compounds
- Studied the effect of those impurities on the overall yield.
- BFG has high amount of N_2 (~50%) → to assess whether this compound solely affects the energy balance or if the conversion ratio will also be influenced.

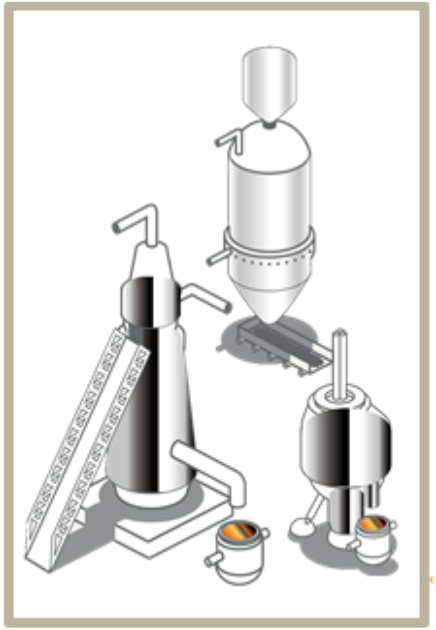
WP6: Evaluation of industrial application potential

Potential applications of the H_2-rich syngas produced:

- Blast Furnace Injection (both Tuyeres and Shaft)
- Combustion
- Reheating Furnaces

ArcelorMittal has developed several models to assess the suitability of a certain gas composition for its reuse in Blast Furnace layout.

Also, ArcelorMittal has performed different studies for application of different types of gases in the Reheating Furnaces and Combustion burners.



STEEL 24 MASTER

XXVI Edizione

RINA

ArcelorMittal

Thank you for your attention

Steelmaster
è una iniziativa sostenuta da

ESTEP · Federacciai · industriAll · Arvedi · European Commission