MaxH2DR newsletter

August 2026

ISSUE n°VIII

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Maximise H2 Enrichment in Direct Reduction Shaft furnaces

The project falls under the funding programme of Horizon Europe – Clean Steel Partnership.

The call topic is related to Carbon Direct Avoidance in steel: electricity and hydrogen-based metallurgy.

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This project has received funding from the European Union under grant agreement n°101058429

PROJECT KEY FACTS

Max H2 DR

Maximise H2 Enrichment in Direct Reduction Shaft Furnaces

GRANT AGREEMENT ID : 101058429

Hydrogen-based direct reduction as ground-breaking technology for climate neutral steelmaking

DURATION 4 YEARS
Start: 01 June 2022
End: 31 May 2026

BUDGET
Total cost : 4 476 585 €

FUNDED UNDER
Horizon Europe Clean Steel Partnership

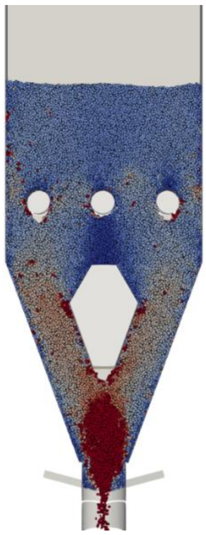
COORDINATOR
SSSA - Suola Superiore di Studi Universitari e di Perfezionamento Sant' Anna (IT)

CONSORTIUM
10 Partners from 7 EU countries

TARGET MAXH2DR
Raise the maturity of the relevant toolkits from TRL 5 to TRL 8

Experiments meet digital twins: validating pellet flow in the demonstration shaft furnace

In hydrogen-based direct reduction, iron ore pellets slowly descend through a shaft furnace while hot hydrogen gas flows upward to convert them into iron. Getting this solid flow right is critical: if pellets move unevenly, the gas cannot reach every pellet equally, and the whole process becomes less efficient. A previous issue of this newsletter introduced the computer simulations that BFI and Ruhr-University Bochum (RUB) use to study this flow. Deliverable D2.3 takes the next step: bringing physical experiments and two independent digital models together into what the project calls a "hybrid demonstration" – and checking, rigorously, whether they agree.



DEM simulation of pellets flowing out of the shaft

At BFI's demonstration-scale shaft furnace, cameras film how DR-pellets, clay pellets and wooden spheres descend through a transparent front window, while software tracks their velocity frame by frame. Earlier measurements were noisy – surface reflections, dust and scratches on the window made the pellets hard to distinguish. This year the team completely revised the video-analysis procedure: enhancing contrast, filtering out implausible readings, and correcting for camera-angle distortion. The result: measured descent velocities now match independent reference sensors to within 0.1 mm/s – a major improvement on the earlier data, and a solid basis for calibrating the digital models.

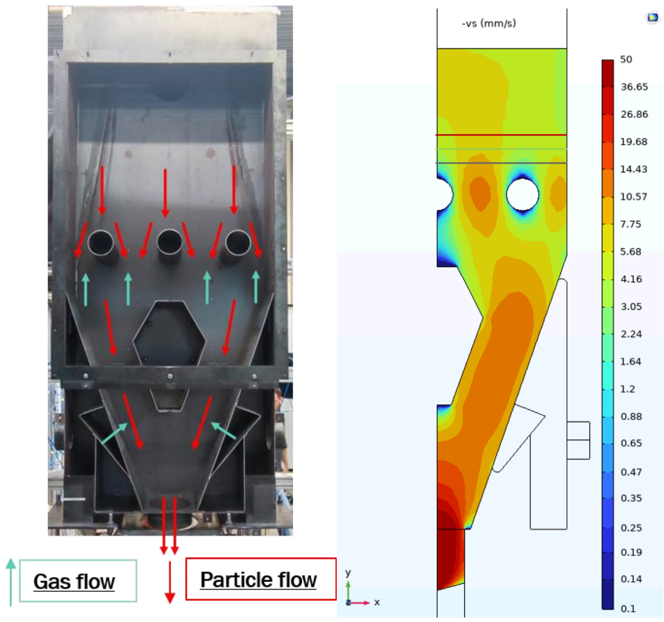
Using the improved dataset, RUB validated its detailed, particle-by-particle DEM model – simulating around 176,000 individual pellets falling through the furnace. The simulation reproduces the real flow pattern well: velocities rise from the furnace walls towards the center with clear stagnant zones above the Midrex furnaces internal installations (the “Christmas tree” and bolts/horizontal feeders shown below).

For clay pellets, simulated and measured velocity trends already agree closely; for the wall conditions and the coarser DR-pellets, the model currently predicts somewhat higher speeds than measured – a gap the team is closing through further parameter tuning.

In parallel, BFI develops a much faster alternative: a FEM-based rheology model that treats the descending pellet bed like a slow-moving virtual fluid rather than tracking every particle. It costs a fraction of the computing time of the DEM approach, making it practical for running many what-if scenarios for process optimisation. Validated against the same experiments, it reproduces the descent profiles well for wood spheres and clay pellets; for DR-pellets, deviations remain near the furnace walls, and the team is adjusting the model’s wall-friction settings to close the gap.

3 materials tested	**176,000 particles**	**±0.1 mm/s**
DR-pellets, clay pellets & wood spheres	simulated in the DEM model	accuracy of the revised velocity measurements

With both models now validated under these cold, gas-free conditions, the next set of simulations adds gas flow: RUB is already running coupled DEM-CFD simulations with 1,200 m³/h of air moving through the furnace, capturing how the rising gas and descending pellets interact. This hybrid demonstration – experiment, detailed particle model and fast rheology model, all agreeing on the essentials – gives the MaxH2DR consortium a validated foundation for the final step: scaling these models up to real, hot industrial conditions and optimising the direct reduction process for clean, hydrogen-based steelmaking.



The furnace’s internal installations – bolts, the diamond-shaped “hexagon” and outlet plates – are exactly what shapes the uneven flow patterns both models are learning to reproduce.

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