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Important aspects to optimise hydrogen enrichment in direct reduction

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Hydrogen enriched direct reduction (DR) is a key decarbonisation technology. Natural gas driven DR is established in industry mostly outside Europe but there are no experiences with syngas of high H2 enrichment > 80%. H2-based reduction is endothermic and the influences on effective kinetics and DRI morphology are not known. Also, properties like local permeability and movement of pellets in the reactor are not known and issues like sticking cannot be excluded. These can significantly influence the temperature distribution and flow of solids and gas. No reliable prognosis is possible yet, in particular regarding local permeability, process stability and product quality of industrial size furnaces where there are higher mechanical loads on the particles and larger local process differences.

Many activities have been initiated for demonstration of H2-enriched DR but they will not close all of these knowledge gaps. This paper summarises the current state of work and results of the Horizon Europe project "MAXimise H2 enrichment in Direct Reduction shaft furnaces"(MaxH2DR) which provides missing data and knowledge of H2-enriched reduction processes and products and combines experimental results with models to a unique hybrid demonstrator.

A physical demonstrator shows the linked solid and gas flow in DR shaft furnaces and a world-first test rig determines pellet properties at industrial conditions. The results are combined with mathematical models including the key technology DEM-CFD to develop the MaxH2DR hybrid demonstrator which is able to investigate scale-up and to optimise DR furnace design and operation for H2-enriched reduction.

This solid foundation of process knowledge is exploited to investigate also the DR process integration into existing steel process chains. Simulation tools are combined into a toolkit that covers impacts on downstream processes and gas and energy cycles. Promising process chains will be achieved for different steps along the road to full decarbonisation.**strong text**

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