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Hy4Smelt –Industrial Demonstration Project to Proof Potential Net-Zero Ironmaking by Combining Breakthrough HYFOR® and Smelter Technologies

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Achieving net zero ironmaking demands a fundamental shift away from conventional blast furnace routes, which remain among the largest industrial sources of CO_2 emissions due to their dependence on fossil fuels and limited integration of hydrogen. The Hy4Smelt industrial demonstration project addresses this challenge by combining hydrogen based fine ore reduction using the HYFOR® process with an electrically powered Smelter, enabling the production of potential net-zero hot metal avoiding carbon intensive up-stream processes.

Hy4Smelt builds on extensive development of both HYFOR® fluidized bed reduction and Smelter technology. The process eliminates the need for agglomeration and can treat (ultra)fine iron ores of all available qualities and mineralogies. This flexibility is increasingly critical as global ore grades decline and options for beneficiation and agglomeration become more constrained. The integrated Smelter efficiently processes lower grade direct reduced iron (DRI) with higher gangue levels, ensuring stable melting performance across a broad feedstock range.

An industrial demonstration plant is currently being implemented by a consortium comprising Primetals Technologies, voestalpine, and Rio Tinto. Located at voestalpine's Linz site, the facility integrates HYFOR® fluidized bed technology producing up to 2.6 tons per hour of DRI with a Smelter designed for up to 2.4 t/h of green hot metal output. Fully powered by renewable electricity and supported by on site green hydrogen production via a PEM electrolyser, the plant aims to deliver hot metal and slag comparable in quality to blast furnace products while eliminating carbon intensive process steps. Continuous, near industrial scale operation will allow comprehensive validation of process performance, operability, and product quality.

This contribution presents the technological concept and current project status. Key topics include preheating strategies for (ultra)fine ores, reduction behavior within the HYFOR® reactors, and DRI fines handling, including HBI briquetting and alternative feeding methods into the Smelter. Focus areas at the Smelter include melting of fine and briquetted carbon-free DRI/HBI, management of varying metallization degrees, final iron oxide reduction in the slag phase, and hot metal carburization through secondary carbon sources. Additional attention is given to the utilization of the Smelter slag as a secondary cementitious material, highlighting the project's emphasis on circularity and resource efficiency.

The Hy4Smelt project is positioned to significantly reduce CO_2 emissions while establishing a new technological benchmark for sustainable ironmaking. Beyond its environmental impact, the demonstration plant will serve as an advanced digital showcase, a replicable blueprint for future climate neutral steel production facilities worldwide.

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