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Advancing hydrogen plasma smelting reduction: Experimental insights from a pilot plant

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The hydrogen plasma smelting reduction process is a promising technology for sustainable steel production from iron ores, utilizing molecular, atomic and ionized hydrogen as reducing agents. The reactor is a gas-tight direct-current electric arc furnace with a hollow graphite cathode for material and gas feeding. To investigate scale-up parameters, a pilot plant with a capacity of 100 kg iron ore per trial has been built at the site of voestalpine Stahl Donawitz GmbH in Leoben, Austria, and is operated by K1-MET GmbH, Linz, Austria. This study examines the impact of selected parameters on the reduction process. Therefore, thermal insulation is applied to the vessel above the crucible to mitigate heat losses and enable higher bath temperatures. Furthermore, different crucible refractory materials are evaluated for their performance, especially their chemical interference with the slag. Additionally, pre-reduced material is processed and the differences in reduction kinetics are discussed. These combined results provide insights into the optimization of process conditions for hydrogen plasma smelting reduction at pilot scale.

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