Contribution ID: **28** Type: **Oral Presentation**

Successful Full-Scale Implementation of Decarbonization Through Energy Efficiency and Use of Hydrogen

Wednesday 13 May 2026 11:20 (20 minutes)

Over the past years Linde has been supporting decarbonization at its steel industry customers by developing and implementing new technologies focused on energy-efficiency and use of hydrogen. The paper discusses these successful activities, taken place in close and direct cooperation with steelmaking companies, and show examples of the excellent results obtained.

Energy-efficient use of flameless oxyfuel in ladle preheating and reheat furnaces bring about substantial fuel savings from 10% up to 60%: in tundishes even higher. Results from recent such installations are presented here. This is paving the way for effective use of hydrogen as a fuel, which frequently is substantially more expense than an existing fossil fuel.

An important part of the development has been to ensure that the transition to use hydrogen does not lead to any negative consequences, including, e.g., increased NOx emissions and impact on the steel heated and the refractory lining. The key has been to further improve use of flameless oxyfuel combustion, securing no trade-off between reduction of CO2 and NOx emissions, but lowering both, and maintaining steel quality and yield. This technology, the challenges overcome, and the excellent results achieved are discussed along with the development hydrogen-oxygen combustion.

The most prominent example of this work is found at Ovako in Sweden. Following the 2020 successful world's first full-scale test with heating steel before rolling using 100% hydrogen, since early 2024 this has been turned into permanent operation. 48 soaking pit furnaces, heating hundreds of thousands of tonnes of steel annually, are operating with 100% flameless oxyfuel using 100% hydrogen. Compared to previous operation using fossil fuel, no major changes in operation practice have taken place. No negative impact on the steel heated and the refractory lining have been experienced. The hydrogen is supplied by an onsite alkaline electrolyzer powered entirely by fossil-free power. To date more than 500,000 tonnes of alloyed steel have reheated in this operation.

Following this success, Linde together with Ovako and other steelmakers are now implementing same pathway also in continuous reheat furnaces and finding solutions for viable supply of hydrogen; the main obstacle is not the use of hydrogen as a fuel but supply of hydrogen at a low cost and a low carbon footprint.

In addition to use of hydrogen as a fuel steel reheating, successful tests have taken place for use in electric arc furnace burners and injectors, and in ladle and tundish preheating.

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Session Classification: Energy Efficiency and Consumption Reduction

Track Classification: EMECR: EMECR 7. Energy savings and energy efficiency optimization