Contribution ID: **226** Type: **Oral Presentation**

Beyond Carbon Neutral with Ultra-low Coke-rate Blast Furnace

Wednesday, October 8, 2025 10:20 AM (20 minutes)

The blast furnace (BF) is the most energy-efficient iron-making process but faces significant challenges in the carbon neutral (CN) movement. To address this, we've developed a groundbreaking concept of CN BF, called SimpLE (Smart iron-making process for Low Emissions).
In Step 1, SimpLE aims for a near-zero Coke Rate (CR) through smart charging, smart reduction, and smart combustion. The SimpLE BF combines a DRI process with an oxygen melter, featuring three-stage tuyeres and top gas recycling with an external-fuel reformer (existing hot stove). Three-stage tuyeres enable central flow operation and achieve almost 100% gas-reduction (Smart reduction) without coke gasification/degradation or sinter degradation. Burdens are mixed and charged in layers according to particle size (Smart charging). Smart charging and smart reduction lower the cohesive zone head loss by 6/7, reduce the heat load in the lower furnace by 2/3, and make the unburnt pulverized char (UPC) consumed in the lower furnace (Smart combustion). Accordingly, compared to conventional BFs, SimpLE will reduce carbon input by 40 to 50% and enable near-zero CO2 emissions (80% reductions) with CO2 recovery, while maintaining the equivalent net heat consumptions.
In Step 2, SimpLE will preprocess relatively available but impure renewable fuels, such as municipal wastes, to substitute metallurgical coal by means of distillation and chloride volatilization in the coke ovens that will acquire surplus production capacity by near-zero CR. This approach will enable near-zero fossil-derived carbon input far more energy-efficiently than any other iron-making process and will realize negative emissions of 30% or more with CO2 recovery compared to conventional BFs. Additionally, it will drastically improve the heat efficiency of municipal wastes including CO2 recovery, reducing the total net heat consumptions of iron-making and its society. Renewable fuels can be substituted by e-fuels with less priority, particularly because e-fuels or hydrogen require tremendous primary energy.

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Session Classification: Blast Furnace Decarbonization

Track Classification: CO2 mitigation in iron and steelmaking