Contribution ID: **397** Type: **Oral Presentation**

Physicochemical properties of electric steelmaking slags for the mitigation of CO2 emissions: Active use of HBI with various intrinsic carbon

Thursday 9 October 2025 11:00 (20 minutes)

It is well known that global CO2 emission from steel sector is 7-8%, which is approx. 1/3 of industrial energy use. Hence, many steel companies are trying to develop the electric arc furnace (EAF) and/or electric smelting furnace (ESF) steelmaking processes instead of blast furnace (BF) and basic oxygen furnace (BOF) integrated routes by employing high amounts of direct-reduced iron (DRI) and/or hot briquetted iron (HBI) to mitigate CO2 emissions. The DRI/HBI as substitutes for virgin scrap in EAF has been used because DRI/HBI does not have tramp elements. Unfortunately, however, commercially available DRI contains the relatively high levels of phosphorus and gangue oxides, which adversely affects not only the steel properties but also the operation efficiency. Alternatively, integrated steel mills have focused on the ESF process by keeping conventional BOF to produce high-end quality products. The H2-reduced DRI or HBI are charged in ESF in conjunction with fluxes and carbon sources, producing hot metal. The high-grade iron ores (Fe>68%) are economically used in EAF, whereas low-grade iron ores (Fe<65%) are targeted to be used in ESF. In the present paper, the challenging points regarding the high temperature physical chemistry of slags to achieve the improved and stable EAF or ESF technology on the way to green steel will be reviewed, and the recent experimental and modelling research will be discussed. For example, the initial melting phenomena of HBI and the slag formation behavior was observed using a high-frequency induction furnace. Main component of gangue oxides in HBI was SiO2, Al2O3, and CaO in conjunction with unreduced iron oxide. To increase the dephosphorization efficiency, the distribution ratio of phosphorus between metal and slag was simulated using FactSage thermochemical software and was compared to the measured results.

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Session Classification: Waste Utilization & Carbon Capture and Utilization

Track Classification: CO2 mitigation in iron and steelmaking