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CFD-Driven Analysis of EAF Dynamics: Insights into Thermal and Flow Optimization

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The Electric Arc Furnace (EAF) has become a cornerstone of modern steel production, accounting for over 43% of Europe's output. Despite its widespread adoptionseveral aspects of the furnace are operated and optimized empirically due to the extreme conditions within the furnace. Numerical modelling provides a valuable approach to bridge this gap by simulating arc behaviour and its interactions, enabling industrial advancements and greener technologies.
We present a comprehensive numerical model that is able to simulate industrial scale furnace. The model couples the high-speed arc jet with magnetohydrodynamic (MHD) flow of the liquid slag and molten metal and the interaction including arc impingement. The model effectively captures key interactions within the furnace, including those between the plasma, liquid pool, and refractories. Thermal and flow patterns predicted by the simulation align closely with experimental measurements, demonstrating its accuracy. It successfully simulates the arc jet flow, magnetohydrodynamic flows, and thermal flow interactions inside the furnace. Additionally, the model examines the impact of external magnetic fields on furnace performance and their implications for energy transfer. The insights gained contribute to improved furnace design, enhanced energy utilization, and optimized EAF operations.

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