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Using CFD to study freeze-lining formation: a collaborative research project between academia and industry

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The formation of freeze lining (FL), a protective layer of solidified slag, holds significant economic value in industrial processes by safeguarding furnace reactors and refractories from corrosive molten slag and providing a thermal barrier that minimizes energy consumption. To deepen our comprehension of FL formation, a collaborative research project has been undertaken, bringing together academic partners from the University of Leoben (Austria) and the University of Leuven (Belgium), alongside industrial partners RHI Magnesita and Aurubis-Beerse.
This collaboration has led to the development of a novel CFD model framework capable of simulating FL formation across a broad range of applications. The model has undergone rigorous testing in various settings, ranging from controlled laboratory experiments to industrial processes.
Laboratory experiments were conducted to investigate FL formation under controlled conditions, providing a valuable foundation for model development. The model's ability to accurately replicate these experimental results demonstrated its capability to predict FL dynamics under well-defined conditions. In industrial applications, the model was employed to simulate FL formation in an electric smelting furnace and a slag fuming furnace. The electric smelting furnace simulation highlighted the intricate interplay between heat transfer and fluid flow dynamics in shaping FL formation. For the slag fuming furnace simulation, model predictions were validated against industrial data, exhibiting a remarkable agreement regarding both FL thickness and heat fluxes across the furnace.
These comprehensive testing procedures have validated the robustness and applicability of the newly developed model framework. Moreover, the model has proven to be versatile and accurate across diverse industrial processes. These qualities make it a valuable tool for optimizing reactor design, enhancing energy efficiency, extending the lifespan of the reactor and refractory materials, and improving overall sustainability.

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