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Enhancing Molten Steel Temperature Prediction Using a Hybrid Approach: Machine Learning and Finite Volume Method

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Molten steel temperature control is an important aspect of the steelmaking process, which influences product quality, energy efficiency, and the performance of continuous casting (CC). To include a safety margin, operators often set the endpoint temperature of steelmaking routes such as Basic Oxygen Furnace (BOF) or Electric Arc Furnace (EAF) higher than necessary. This ensures the appropriate molten steel temperature when it reaches the CC despite temperature losses during ladle transportation and waiting times. However, higher steel temperatures in the BOF or EAF not only increase energy consumption but also complicate phosphorus removal, highlighting the need to balance refining efficiency with proper casting temperatures.
In this study, an existing finite volume method was applied to simulate the temperature of molten steel throughout the complete cycle of production. This model offers valuable predictions, though it shows deviations in comparison to actual temperature measurements for steels, limiting the effectiveness of thermal management.
To overcome this challenge, a data-driven approach is proposed to predict the error between the simulated and measured molten steel temperatures. We aim to leverage a machine learning model to enhance the temperature prediction accuracy by correcting the physical model's prediction. Additionally, Optimization techniques are also applied to estimate the thermal model's parameters, further improving its performance. The optimized physical model is then combined with plant data to train the machine learning algorithm. This hybrid framework has the potential to enhance the efficiency of thermal management, reduce energy consumption, and improve the quality of produced steel.

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