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Practical Sintering Guidance System: Integrating Data-Driven and Transient Models

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The digital transformation of the sintering process requires controlling the return ore ratio, which is the proportion of fine sintered ore particles smaller than 4 mm that cannot be used in the blast furnace, within a target range. When the return ore ratio is too high, the productivity of the sintering process decreases. On the contrary, when we aim for an excessively low return ore ratio, it leads to high production costs.

In the conventional manual operation, since the operators took control actions only after the return ore ratio increased, it remained high for approximately two hours until the effects of the control actions appeared, resulting in low productivity. In addition, the operators tended to increase the quicklime ratio to reduce the return ore ratio unnecessarily, and the production costs increased.

To address the problem and achieve the efficient and productive sintering process, we took a data-driven approach. We identified factors effective for predicting the future return ore ratio from big data (2,000 items) using the stepwise method, and these factors were fed into a machine learning model. This enables the accurate prediction of the two-hour-ahead return ore ratio for taking proactive control actions before the return ore ratio fluctuates.

Moreover, we developed a transient model that can predict the sintering bed temperature. Based on these two models, we constructed an operation guidance system that derives the optimal control actions to reduce production costs without increasing the return ore ratio. It also considers the operational constraints on the sintering bed temperature. The validation results in an actual plant demonstrated that the developed guidance system successfully decreased the quicklime ratio by 12% compared to the conventional manual operation, achieving the digital transformation of the sintering process.

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