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Machine learning model for mould powder consumption in continuous steel casting

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Mould powders play a critical role in the continuous casting of steel by facilitating lubrication, regulating heat transfer, absorbing deoxidation products, preventing reoxidation, and providing thermal insulation at the meniscus. Accurately predicting mould powder consumption is essential for optimizing efficiency and cost-effectiveness in steel manufacturing. However, existing models lack consensus on the key influencing factors, beyond slag viscosity and casting speed, which govern casting powder consumption in continuous casting of steel.

This study aims to develop a machine learning model or equation to predict mould powder consumption and identify the most significant influencing factors. This initiative seeks to achieve enhanced process optimization in the steel manufacturing by capitalizing on data-driven insights. In addition, existing mould powder consumption models from the literature are tested using industrial data. The dataset was sourced from internal measurements at voestalpine Stahl Linz, with average values calculated for each slab, and was further enhanced with calculated parameters from the literature, such as surface-to-volume ratio. A rigorous preprocessing pipeline including data cleaning, outlier removal, and feature selection based on statistical relevance was applied to ensure model reliability. A Random Forest Regressor was trained and evaluated using cross-validation.

The model achieved strong predictive performance, with an average R^2 score of 0.88, indicating high accuracy. Feature importance analysis revealed that steel carbon content had the greatest impact on mould powder consumption, followed by casting speed, surface-to-volume ratio, steel titanium content, and slag viscosity. These findings highlight the critical role of steel composition and operational parameters in determining mould powder usage. The developed machine learning model provides a reliable tool for predicting mould powder consumption trends, enabling improved decision-making and process control. By merging industrial data with advanced analytics, this study contributes to improve the efficiency and cost-effectiveness of steel casting operations.

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