frontiers | Frontiers in Materials

TYPE Editorial
PUBLISHED 24 January 2023
DOI 10.3389/fmats.2023.1145618

OPEN ACCESS

EDITED AND REVIEWED BY
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SPECIALTY SECTION
This article was submitted to Structural Materials, a section of the journal Frontiers in Materials

RECEIVED 16 January 2023
ACCEPTED 18 January 2023
PUBLISHED 24 January 2023

CITATION
Shu Q, Li J and Yan B (2023), Editorial: Fluxes and steel quality.
Front. Mater. 10:1145618.
doi: 10.3389/fmats.2023.1145618

Editorial: Fluxes and steel quality

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KEYWORDS

fluxes, steel quality, slag, slag metal reaction, mold powder

Editorial on the Research Topic
Fluxes and steel quality

Control of steel quality is one of the most important topics for steelmakers. Fluxes plays critical roles in the production of high-quality steels and therefore has received increasing research interests in recent years. One of the aspects of steel quality is cleanliness of steel, which is reflected by the composition, size distribution, morphology of non-metallic inclusions in steels. The non-metallic inclusions can be controlled by optimizing operations from steel refining to continuous casting. The recent studies (You et al., 2021; Scheller and Shu, 2014) have revealed the impact of reaction between slag/flux and steel on the inclusion evolutions during steel refining. Among these, the optimization of ladle slag/flux is one of the crucial steps for achieving better steel cleanliness. The surface quality of steel cast products is another important issue since the surface defects will lead to the post-processing of steel and even downgrading or rejecting the products. The formation of surface defects, e.g., longitudinal cracks, is closely related to the performance of mold fluxes. It is well accepted that the longitudinal crack in steel mainly stems from the large shrinkage induced by peritectic reaction from δ-Fe to γ-Fe. Mild cooling provide by high crystallinity mold fluxes is the most efficient way to reduce the occurrence of longitudinal cracks (Hanao et al., 2012).

The aims of Research Topic: Fluxes and steel quality are to collect the state-of-the-art research work in fluxes/slag for improving steel quality. To this end, four articles including three original and one review work have been published in this Research Topic, covering the topics of the modelling thickness of mold fluxes film, melting of mold powder, reaction between slag and titanium steel and deoxidation of high-silicon austenitic stainless steel.

The first two articles are dealing with the behavior of mold powder in continuous casting of steel. Xu et al. established three-dimensional fluid flow, heat transfer and solidification model, interfacial heat transfer model and two-dimensional stress-strain model to calculate the thickness distributions of liquid slag, solid slag and air gap in the ultra-high speed billet continuous casting mold, and analyzed the effects of melting temperature of mold flux and mold taper. Kölbl assessed the melting rate determination methods with respect to their ability to determine melting rates under service-related conditions and developed criteria for this purpose. Fifteen methods have been classified into two groups and the second group allow for the melting determination of mold powders in service. The restrictions for heating rate are determined from the conditions for Fourier and Biot numbers of varying test setups.

The last two articles are mainly related to the reaction between slag and steel for achieving better steel cleanliness and yield of valued elements. Dou et al. developed a thermodynamic model of the slag-steel reaction of austenitic stainless steel containing 5.

0 wt% Si with CaF_2-CaO-Al_2O_3-MgO-SiO_2 slag based on the ion-molecular coexistence theory (IMCT) to investigate the deoxidation reaction and the oxygen control mechanism of the steel. The model was validated by the experimental data in laboratory. Optimized Al_2O_3 and basicity have been proposed to achieve low oxygen content in steel. Zhao et al. established a thermodynamic model for seven CaO-MgO-BaO-CaF_2-SiO_2-Al_2O_3-TiO_2 ladle slags based on the Ion and Molecule Coexistence theory (IMCT) and validated the model using experimental data at 1873K for reducing the reaction between Ti in steel and slag to obtain better yields. The influences of CaO/SiO_2, CaO/Al_2O_3, TiO_2, BaO on slag thermodynamics and reaction between Ti steel and slag were investigated.

The four articles published in this Research Topic give us the glimpse of recent development in fluxes and slags for steel quality. We hope that these articles will be interesting and useful to the researchers in both academic unit and steel plants. We believe the research interests for fluxes and slags in process metallurgy will be continued and hope these articles in the Research Topic will stimulate some interests in this area.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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