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Cover Photo:

This cover shows transient solid flow and temperature field in reduction shaft of COREX, obtained from an advanced combined approach of discrete element method and computational fluid dynamics. This development is a critical step for the establishment of a comprehensive thermo-chemical mathematical model of COREX. More details can be found in the manuscript by Q. F. Hou and co-workers on page 626.

Editorial

Aibing Yu and Yansong Shen

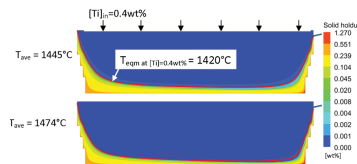
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Full Paper

K. M. Komiyama, B.-Y. Guo,* H. Zughbi, P. Zulli, and A.-B. Yu

Numerical Analysis of Titanium Compounds in Blast Furnace Hearth During Titania Addition

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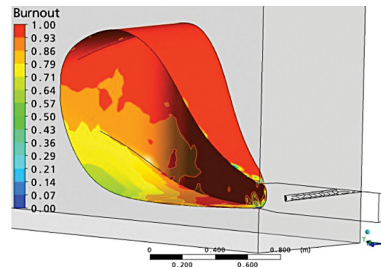
The addition of titania into the Blast Furnace may promote Ti-rich scaffolds along the damaged hearth lining. A Computational Fluid Dynamics model is used to investigate the solid particles formation behavior in the hearth during titania addition. Results show the profile of the particle rich layer along the hearth bottom matches well with the equilibrium temperature isotherm of the incoming hot metal solution.

Contents

Y. Shen* and A. Yu

Characterization of Coal Burnout in the Raceway of an Ironmaking Blast Furnace

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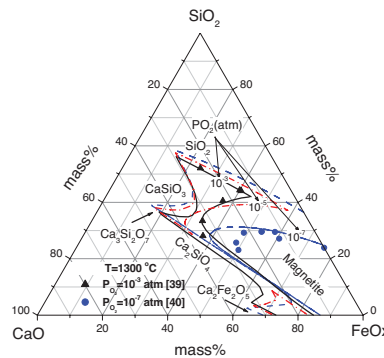


This paper confirms that rather than coal burnout at the end of coal plume in the raceway that was widely used in the past, coal burnout calculated over the whole raceway surface is a more reliable indicator representing coal combustion efficiency in the raceway, and cannot be replaced by the former. It should be employed in the future when examining the combustibility of specific coals under blast furnace conditions.

C. Chen

Application of MPE Model to Iron Ore Sintering, Ironmaking and Steel-making Processes

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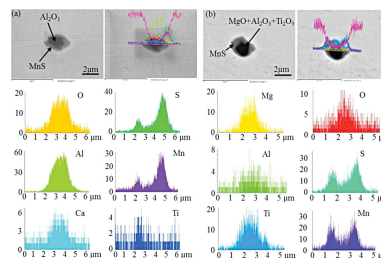


A short review of the available models and databases in the Multi-Phase Equilibrium (MPE) package developed by CSIRO are outlined in this paper. Some examples on the validation of the model and databases against published experimental data on slag liquidus, sulphur capacity, phosphorus partitioning and viscosity etc. are shown. Finally, a few examples on application of MPE to iron ore sintering, ironmaking and steelmaking are also presented.

J. Yang,* L. Xu, K. Zhu, R. Wang, L. Zhou, and W. Wang

Improvement of HAZ Toughness of Steel Plate for High Heat Input Welding by Inclusion Control with Mg Deoxidation

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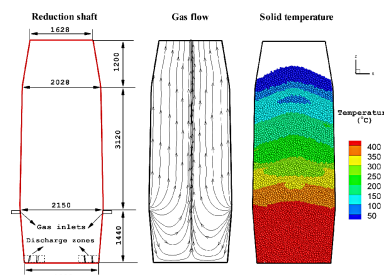


The effect of Mg content on the evolution behavior of inclusions in the steel plates with Mg deoxidation is investigated based on the experimental studies and thermodynamic calculations. The HAZ toughness of steel plates after welding with heat input of 400 kJ/cm is greatly improved by inclusion control with Mg deoxidation.

Q. Hou,* J. Li, and A. Yu

CFD-DEM Study of Heat Transfer in the Reduction Shaft of Corex

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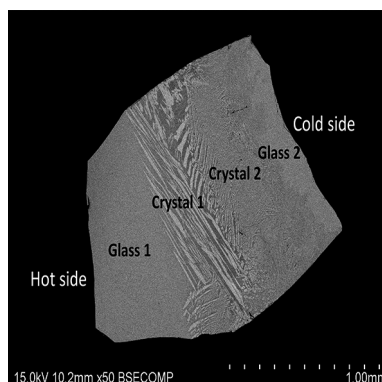
Corex is a promising iron making process beside blast furnace. Using a combined approach of computational fluid dynamics and discrete element method transient heat transfer of gas-solid flow in reduction shaft of Corex is investigated. The effects of discharge rate and burden profiles are discussed. Useful information for the scaling of a discrete particle model is provided.

Contents

J. Yang, Y. Cui, L. Wang, Y. Sasaki,
J. Zhang,* O. Ostrovski, and
Y. Kashiwaya

In-Situ Study of Crystallization Behavior of a Mold Flux Using Single and Double Hot Thermocouple Technique

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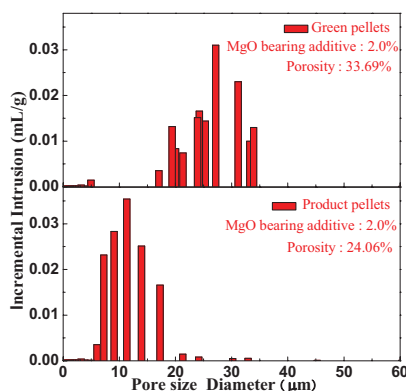


Crystallization behavior of a mold flux for low carbon steel casting is investigated using SHTT and DHTT. CCT and TTT diagrams indicate that the critical cooling rate is $7\text{ }^{\circ}\text{C}\text{s}^{-1}$ and the shortest incubation time is 15 s at $1000\text{ }^{\circ}\text{C}$. DHTT experiment suggests that the mold flux will establish a three-layer structure – glassy layer, crystalline layer and liquid layer in continuous casting operation.

F. Shen, Q. Gao,* G. Wei, X. Jiang, and
Y. Shen*

Densification Process of MgO Bearing Pellets

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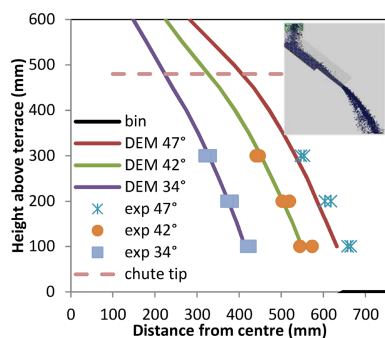


The densification process of MgO bearing pellets are investigated. MgO addition has a negative effect on the densification process of pellets. With the addition of MgO bearing additive from 0 to 2.0 %, the pore size and porosity of product pellets increases gradually, and the densification ratio of pellets decreases from 46.3 to 28.6%.

S. Liu, Z. Zhou,* K. Dong, A. Yu,
D. Pinson, and J. Tsalapatis

Numerical Investigation of Burden Distribution in a Blast Furnace

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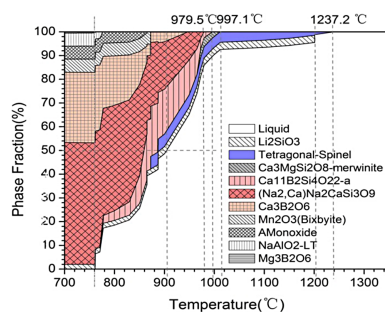


Blast furnace burden distribution phenomena are captured by DEM approach, including justification of surface properties of spheres, burden trajectories from the chute tip, and formation of burden layers in the throat region. Proper values for rolling and sliding friction are recommended. Sensitivity tests are conducted to reveal the significance of particle surface properties on burden layer formation.

Y. Cui, L. Wang, J. Yang, J. Zhang,*
Y. Sasaki, and O. Ostrovski

Phase Equilibria of Fluoride-Free Boracic Mould Flux for Steel Continuous Casting

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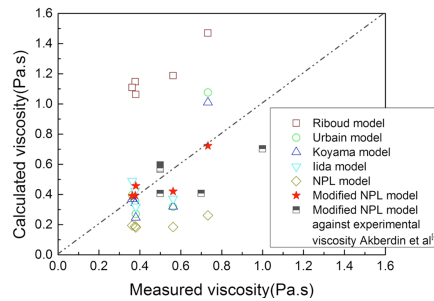
This paper analyzes phase composition of fluoride-free mould fluxes containing B_2O_3 , TiO_2 , Na_2O , and MgO using the thermochemical software FACTSage. The phase equilibria of these boracic mould fluxes calculated are in reasonable agreement with the experimental phase characterization results and therefore can provide the guidance for boracic flux composition selection.

Contents

L. Wang, Y. Cui, J. Yang, C. Zhang, D. Cai, J. Zhang,* Y. Sasaki, and O. Ostrovski

Melting Properties and Viscosity of $\text{SiO}_2\text{-CaO-Al}_2\text{O}_3\text{-B}_2\text{O}_3$ System

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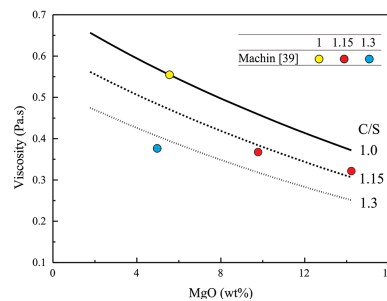


In this paper, the melting properties and viscosity of $\text{SiO}_2\text{-CaO-Al}_2\text{O}_3\text{-B}_2\text{O}_3$ fluxes were measured with a mass ratio of CaO/SiO_2 from 0.83 to 1.5 and B_2O_3 concentration from 5 to 9 wt%; flux viscosity was described using modified NPL model. The results of this investigation will provide basis for further development of fluorinefree boracic mould fluxes.

C. Han, M. Chen, W. Zhang, Z. Zhao, T. Evans, A. V. Nguyen, and B. Zhao*

Viscosity Model for Iron Blast Furnace Slags in $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ System

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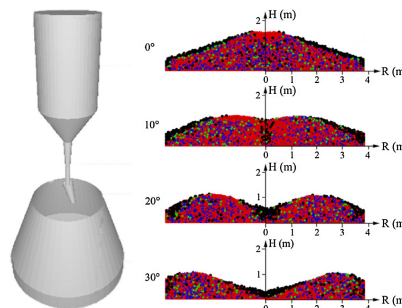


An improved viscosity model has been developed for blast furnace slag in $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ system. A large number of viscosity data has been collected and critically evaluated for the model optimization. This new model has a reduced number of equations and parameters compared to the original Urbain model. The predictions of this model show lowest deviation in existing viscosity models for blast furnace slags.

M. Kou,* S. Wu, G. Wang, B. Zhao, and Q. Cai

Numerical Simulation of Burden and Gas Distributions Inside COREX Shaft Furnace

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A 3D model of COREX-3000 shaft furnace with charging system is developed based on DEM to investigate the effects of distributor angles on the burden and gas distributions. The results suggest that the distributor angle should be no larger than 10° to control the central gas flow and be larger than 25° to prevent the peripheral gas from over developing.