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GIESSHALLENTSTAUBUNG

Special Topic from the K1-MET-Competence Center
Guest Editors: Werner Kepplinger, Johannes Schenk



MET

metallurgical competence center

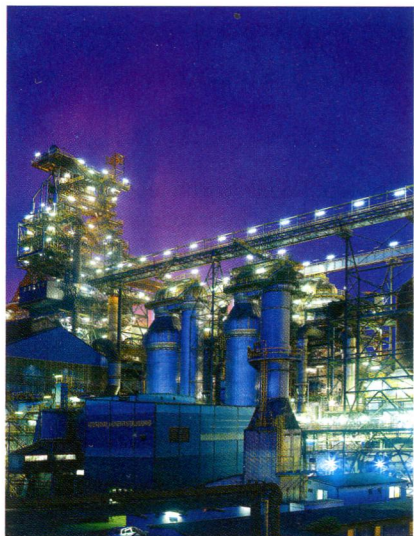
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Cover Photo:

Blastfurnace A of the voestalpine works in Linz, Austria, is an international benchmark for the hot metal production and an example for the successful implementation of metallurgical and environmental process innovations developed in the research programme of the Austrian K1-MET-Competence Center for Advanced Metallurgy and Environment.

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Special Topic: K1-MET-Competence Center for Advanced Metallurgy and Environment

Editorial

W. Kepplinger and J. Schenk

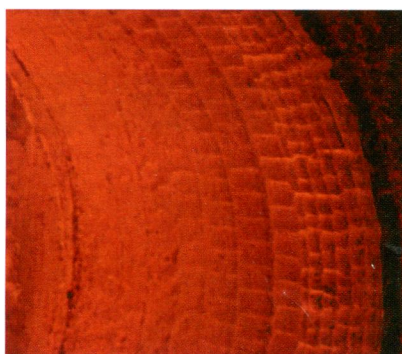
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Full Paper

D. Gruber* and H. Harmuth

**Thermomechanical Behavior of
Steel Ladle Linings and the Influence
of Insulations**

512



For common refractory materials thermomechanical loads in steel ladles lead to irreversible compressive strains. If these strains are exceeding a critical value and the lining shows further radial displacement joints in brick lined ladles will open. A Finite Element simulation was set up to quantify the impact factors with special emphasis on the insulation.

Contents-Special Topic

T. Steinparzer,* M. Haider, F. Zauner,
G. Enickl, M. Michele-Naussed and
A. C. Horn

Electric Arc Furnace Off-Gas Heat
Recovery and Experience with a Test-
ing Plant

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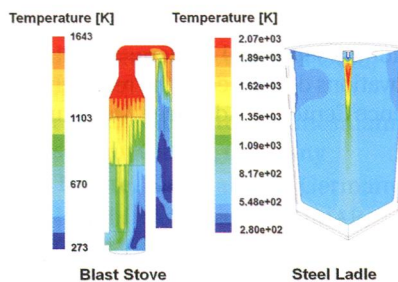


This paper deals with electric arc furnace off-gas heat recovery and first experiences with a testing plant. The testing plant based on molten salt as heat transfer fluid is installed inside the existing off-gas system of Stahlwerk Thüringen GmbH. Targets of the testing plant are to evaluate tube materials and to measure the influence of hot corrosion and dust settlement. First experimental and simulation results are presented.

J. Rieger,* M. Drózd-Ryś, C. Weiss and
H. Harmuth

Thermochemical Wear of Refractory
Linings Associated With Gas Firing in
Metallurgical Plants

527

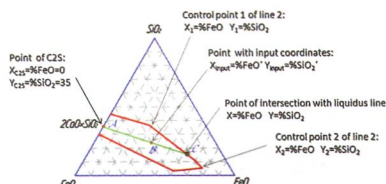


The influence of gas combustion atmosphere on the corrosion of the refractory lining during preheating of a steel ladle and the operation of a blast stove is investigated with the help of computational fluid dynamics CFD. Heat release and species composition are calculated. Corrosion mechanisms are partly determined carbon burnout kinetics and pollution formation NO_x, CO is calculated.

Y. Lytvyniuk,* J. Schenk, M. Hiebler,
and A. Sormann

Thermodynamic and Kinetic Model
of the Converter Steelmaking Pro-
cess. Part 1: The Description of the
BOF Model

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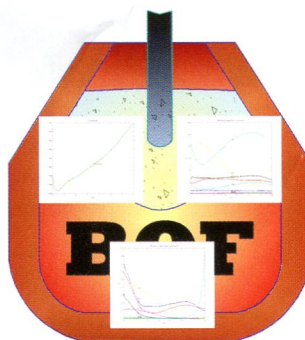


A new model for the simulation of the converter steelmaking process is developed after the detailed study of existing thermodynamic and kinetic models and approaches. This model consists of the reaction model and models for charge materials melting and dissolution. The approaches of the melting of scrap and dissolution of MgO- and CaO-based materials are explained in detail.

Y. Lytvyniuk,* J. Schenk, M. Hiebler
and A. Sormann

Thermodynamic and Kinetic Model
of the Converter Steelmaking Pro-
cess. Part 2: The Model Validation

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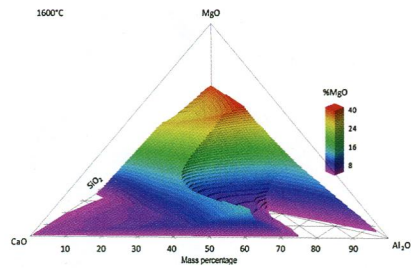
In order to validate the BOF process model, the heats in 170- and 330-ton converters are simulated. The behaviors of the metal and slag phase components, temperature and charge material melting, and dissolution are shown and analyzed. Using the simulation results, the oxidation–reduction behavior of phosphorus and manganese during the converter steelmaking process is explained.

Contents-Special Topic

J. Goriupp,* J. Schenk, G. Klösch, and M. Hiebler

Thermochemical Calculation of the Quaternary CaO–SiO₂–Al₂O₃–MgO System at 1600°C for Predicting the MgO-Saturation and MgO–MgO–Al₂O₃ Equilibrium of Secondary Metallurgical Slag

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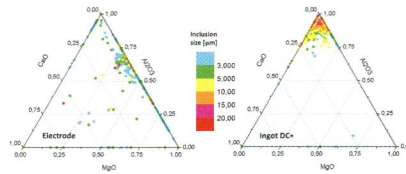


This work presents different quaternary CaO–SiO₂–Al₂O₃–MgO Systems which were calculated with thermochemical-calculations at various temperatures by using FactSage6.2. The calculated systems provide enhanced knowledge of secondary metallurgical ladle slag conditions at process temperatures. These systems can also be used for predicting the MgO-saturation and the MgO–MgO–Al₂O₃ equilibrium at various temperatures for commonly used ladle slag compositions.

A. Paar, R. Schneider,* P. Zeller, G. Reiter, S. Paul, and P. Würzinger

Effect of Electrical Parameters on Type and Content of Non-Metallic Inclusions after Electro-Slag-Remelting

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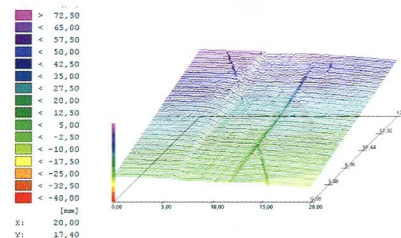
This paper describes the effect of different electrical parameters (DC–, DC+, 1Hz) during electro-slag-remelting on the type and content of non-metallic-inclusions in the material X38CrMoV5-1, determined by automated SEM-EDX-analysis. Anodic polarity (DC+) leads to an increase in oxygen content and in the size and amount of inclusions, especially of Al₂O₃-type. One hertz-AC-currents provided the best results with lowest contents in oxides, oxysulfides, and especially sulfides.

Contents

M. Naderi, A. H. Mohammadi,* G. Balaji and W. Bleck

Wear Behavior of Hardfacing Coatings Applied on Glass Processing Tools

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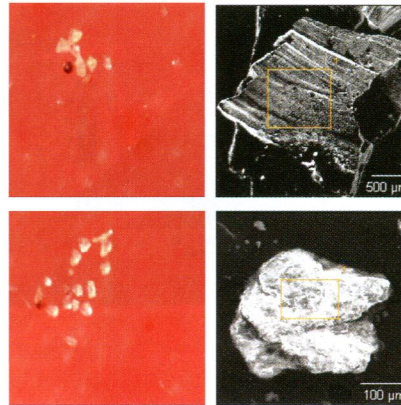
Wear behavior of coatings applied by various hardfacing techniques [TIG and plasma transferred arc (PTA) welding and chromizing] and electrodes (Stellite 12 & Tribaloy T-401) is evaluated. In order to simulate real field conditions on a lab scale, tests are performed with a specially designed system and actual process parameters. The best wear resistance is obtained in PTA welding hardfacing with Stellite 12 alloy.

Contents

Y. Gu, H. Wang,* R. Zhu, J. Wang, M. Lv and H. Wang

Study on Experiment and Mechanism of Bottom Blowing CO₂ During the LF Refining Process

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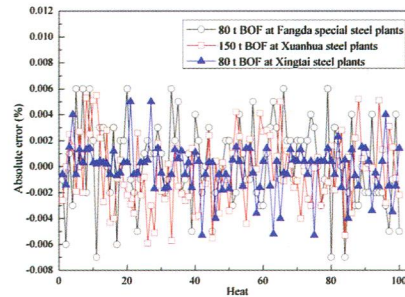


This paper describes the metallurgical behavior and mechanism of bottom blowing CO₂ in LF. The kinetics and thermodynamics of bottom blowing CO₂ are investigated. Some exploratory industrial experiments have been conducted. The research shows that chemical reaction or mass transfer of CO is the possible rate-determining step. It is possible to use CO₂ in LF.

Z. Wang, F. Xie, B. Wang, Q. Liu,* X. Lu, L. Hu and F. Cai

The Control and Prediction of End-Point Phosphorus Content during BOF Steelmaking Process

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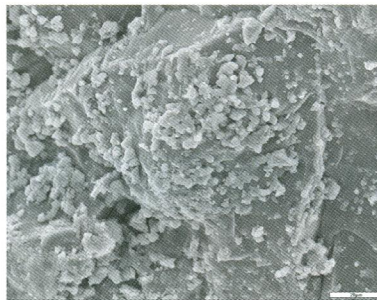


This paper presents the research on thermodynamic analysis of dephosphorization process and establishment of the multi-level recursive regression model for the prediction of end-point phosphorus content during BOF steelmaking process. The verification with the data taken from three steel plants indicates that the hit rate of the model is above 84 when predictive errors of the model are within ± 0.005 .

F. Engström,* M. Lidström Larsson, C. Samuelsson, Å. Sandström, R. Robinson, and B. Björkman

Leaching Behavior of Aged Steel Slags

607

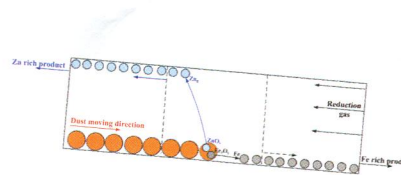


In this work, the leaching behavior of aged steel electric arc furnace slags has been investigated. Reactions taking place inside as well as on the surface of the steel slags were monitored during 24 months. Calcium carbonates crystals were formed on the surfaces of all slags within 12 months of ageing in a varying extent, see picture.

J.-T. Gao

Separation of Fe and Zn in EAF Dust by Counter-Current Gas-Solid Reduction in Moving Bed

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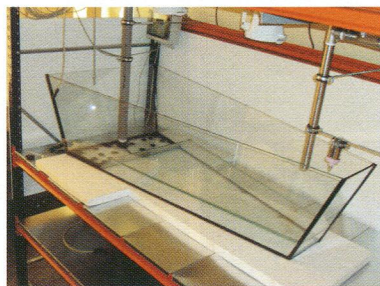
The reactor of moving bed for counter-current gas-solid reduction test is researched and developed. By the reformed blast furnace gas, EAF dust is highly transformed in form of $Fe_xO_y(s) \rightarrow MFe(s)$ and $ZnO(s) \rightarrow Zn(g)$ with the Fe and Zn separated continuously and quickly in a non-molten state with high reduction degree at 800–900°C.

Contents

A. Cwudziński

Numerical, Physical, and Industrial Experiments of Liquid Steel Mixture in One Strand Slab Tundish with Flow Control Devices

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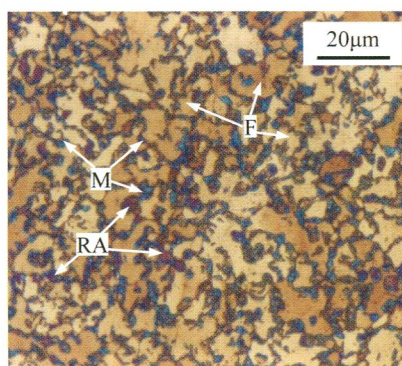


The paper presents investigation results related to a tundish furnished with a FCDs. To evaluate the influence of FCDs on the pattern of liquid steel flow, an industrial and a laboratory experiments (physical and numerical simulation) were carried out.

Z. C. Zhang,* Y. M. Li, X. W. Kong*, K. Manabe, and N. Wang

Effect of Intercritical Annealing Time on Microstructure and Axial Mechanical Properties of TRIP Seamless Steel Tube

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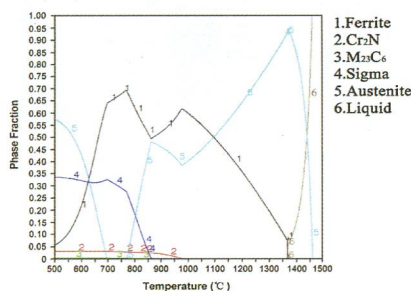


The current study focused on the effect of IA time on microstructure and mechanical properties of TRIP seamless steel tube at a predetermined other heat treatment conditions, to maximize the volume fraction and stability of retained austenite as well as to obtain a good combination of strength and ductility of TRIP seamless steel tube.

Z. Zhang, H. Zhang, L. He, D. Han, Y. Jiang and J. Li*

Microstructure Evolution in Aged UNS S82441 Duplex Stainless Steel

640

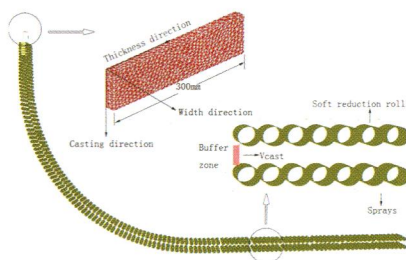


The precipitation and evolution of secondary phases in aged UNS S82441 Duplex Stainless Steel is investigated with morphological observation. The coexistence of nitrides, carbides, and sigma and chi phase is found during the initial aging stages. The relationships between aging time and microstructure evolution of this alloy are discussed in detail.

X. K. Zhao,* J. M. Zhang, S. W. Lei and Y. N. Wang

The Position Study of Heavy Reduction Process for Improving Centerline Segregation or Porosity With Extra-Thickness Slabs

645

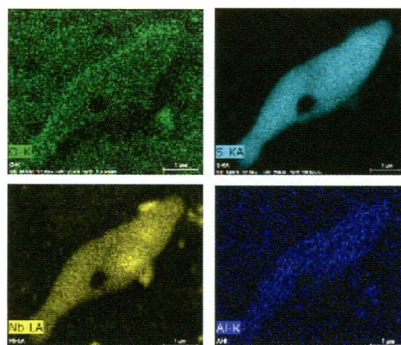


In this paper, a two-step strategy was preceded to study the heavy reduction process at the end of a continuous caster, using software THERCAST which was coupled macroscopic segregation with thermal-mechanical GNS method. The aim of this study is to fix the dividing position of improving centerline segregation or porosity. After analysis, a range of results are concluded.

Contents

Y. Bi,* A. Karasev and P. G. Jönsson
**Three-Dimensional Investigations of
Inclusions in Ferroalloys**

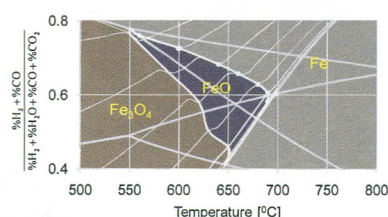
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As the requirements on material properties increase, the effect of impurities in ferroalloys on the steelmaking process is increasingly becoming more important. The characteristic of inclusions (morphology, number, size, and composition) in ferroalloys investigated in three-dimensional after electrolytic extraction is a good method for studying the evolution of inclusions during steelmaking.

M. Bernasowski
**Theoretical Study of the Hydrogen
Influence on Iron Oxides Reduction
at the Blast Furnace Process**

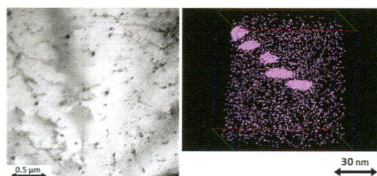
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Why the direct reduction ratio in blast furnace noticeably decreases with hydrogen introducing into the bosh gas? Basing on the thermochemical calculations, the article shows the wustite stability area at the blast furnace process condition and lists possible mechanisms of FeO reduction taking into account reducing ability of solid carbon and water-gas shift reaction.

M. Nöhler,* W. Mayer, S. Zamberger,
E. Kozeschnik and H. Leitner
**Precipitation Behavior of Strain-
Induced V Precipitates in Ferrite at
Different Temperatures in a 0.2 wt%
Carbon Steel**

EDITOR'S CHOICE 679



The aim of this work was to investigate the precipitate evolution of strain induced V particles in ferrite at 700 and 600°C by means of Transmission electron microscopy and atom probe tomography. The experimental results are compared with simulation data, which were calculated by MatCalc. During the precipitate evolution of the V carbonitrides the C/N ratio of them changes from N rich at the early stages to C rich after longer dwell times. At 700°C the precipitate evolution is faster than at 600°C.

C. Allertz, N. Kojola, W. Hui and
D. Sichen*
**A Study of Nitrogen Pickup from the
Slag during Waiting Time of Ladle
Treatment**

689



An investigation of the nitrogen pickup of liquid steel from ladle slag after vacuum degassing is made by laboratory experiments and industrial trials. The nitride capacities of the ladle slags are measured at 1873 K. The nitride capacities determine along with the results of industrial trials revealed that slag is not the main reason for the nitrogen pickup.

Contents

J. Liao,* X. Xue, C. Zhou*, F. Barlat and J. Gracio

A Semi-Analytic Model to Predict and Compensate Springback in the 3D Stretch Bending Process

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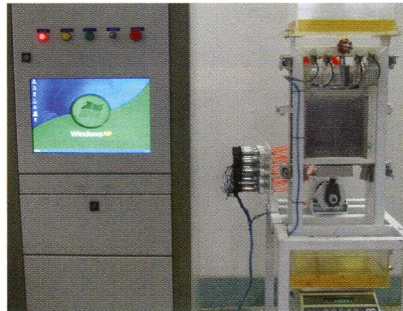


A semi-analytic springback prediction and compensation model based on inprocess measurement is proposed, in which measured strain and curvature data from the actual stamping process are incorporated in a semi-analytic model, and then springback is predicted based on the elastic unloading from the residual differential stress during sheet metal forming.

J. Yang, X. Meng* and M. Zhu

Experimental Study on Mold Flux Lubrication for Continuous Casting

710



In the present work, a new experimental apparatus for simulating mold oscillation of continuous casting was developed. The result reveals that the periodical shifting of pressure in the channel has a time lag in relation to the oscillating motion, and the flux thickness has a significant influence on the infiltration behavior compared with the mold oscillation.

M. Kazemi, B. Glaser, and D. Sichen*

Study on Direct Reduction of Hematite Pellets Using a New TG Setup

718



A new TG setup has been developed to study reactions involving weight changes (even solid–solid reactions). The advantage of this method over the conventional TGA is that it avoids the gradual change of gas composition in the initial stages. The setup has been used to study reduction of hematite pellets. Reduction rates obtained have been found considerably higher than the conventional TG.