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# steel research

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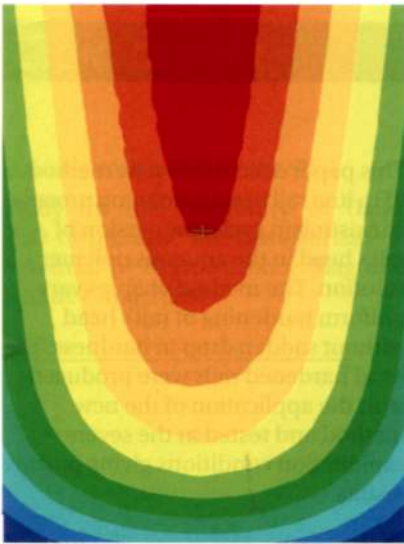
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## Cover Photo:

Both the analytical calculation and the numerical simulation methods were researched to predict the total solidification time of large steel ingots. More details can be found in the manuscript Ji et.al.

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## Contents

### Editorial:

T. Adams

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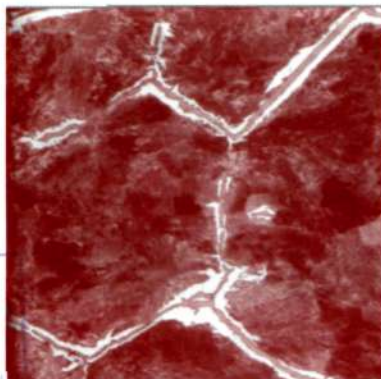
7

G. MingLong, C. HaiDong, L. Feng-Fang, Z. Xiang\*, and Z. Liang

Effect of Magnetic Field Intensity on Abnormal Microstructure in Fe-1.1%C Alloy

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8



The effects of magnetic field intensity (0, 1, 2, 4, 8, and 12 T) on abnormal microstructure in Fe-1.1%C alloy were investigated during the austenitic decomposition. The magnetic field increases the area fraction and width of the abnormal microstructure. The area fraction of the abnormal microstructure first increases, and then decreases. It reaches the maximum value when the magnetic field intensity increases to 4 T.



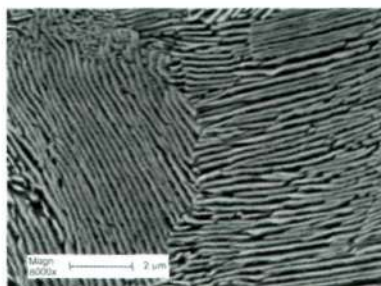
# Contents

R. Kuziak\* and T. Zygmunt

**A New Method of Rail Head Hardening of Standard-Gauge Rails for Improved Wear and Damage Resistance**

EDITOR'S CHOICE

13

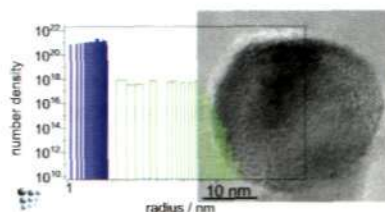


This paper describes a new method of in line rail head hardening process consisting in cyclic immersion of rail's head in the aqueous polymer solution. The method enables very uniform hardening of rail's head without sudden drop in hardness. The head hardened rails were produced with the application of the new method and tested in the severe exploitation conditions giving positive results.

S. Zamberger\*, T. Wojcik, J. Klarner, G. Klösch, H. Schifferl, and E. Kozeschnik

**Computational and Experimental Analysis of Carbo-Nitride Precipitation in Tempered Martensite**

20

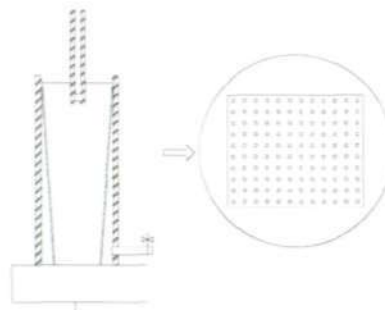


The analysis of carbo-nitride precipitation kinetics in tempered martensite of Nb-Ti-micro alloyed steel with a carbon content of 0.3 wt% is described. Based on the information obtained from transmission electron microscopy and scanning electron microscopy, a computational simulation procedure is developed within the software package MatCalc. No explicit fitting parameters are used in the computer simulation. The input data is entirely based on independent physical or microstructural parameters.

X. Jin, D. F. Chen\*, X. Xie, J. Shen, and M. Long

**Investigation on Water Model for Fluid Flow in Slab Continuous Casting Mold With Consideration of Solidified Process**

31

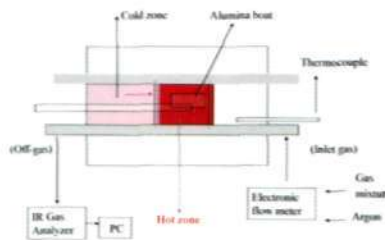


This study aims to propose suitable simulation methods, which enable to reduce the major differences between water model and real caster. With consideration of solidified process, the method is concerned with the change of flow space and flow mass at the casting direction in water model. The results indicate that it is necessary for water model to take the solidified process into account to acquire more accurate and reliable experiment results.

P. J. Y. Rubio, R. Khanna\*, N. S. Chaudhury, and V. Sahajwalla

**Simultaneous Decarburization and Oxidation Reactions Occurring in Silicon and Ferrosilicon Alloys at 1823 K**

40



Decarburization and silicon oxidation reactions occur extensively in the cupola process. This paper presents high temperature investigations on ferrosilicon alloys ranging from 24.7 to 98.5% Si when interacting with oxidizing gases. The present work evaluates the effect of the alloy composition, oxygen partial pressure and flow rate on interactions at 1823 K. Both reactions were found to occur simultaneously.

# Contents

D. Lindström and D. Sichen\*

**Study on the Possibility of Using ZnO to Increase the Desulfurization Potential of Blast Furnace Slag and Sulfide Capacities**

48



The present work was carried out to examine whether ZnO could help the remaining blast furnace (BF) slag to capture sulfur. For this purpose, slags prepared with relatively high ZnO content was equilibrated with either liquid silver or liquid copper under controlled oxygen potential. It was found that most of the ZnO escaped during the experiment, indicating thereby that ZnO could not increase the desulfurization potential of the BF slag. The experimental data were used to evaluate the sulfide capacities of the studied slags. In some of the slags equilibrated with silver, the MgO activities were evaluated.

S. N. Silva, F. Vernilli\*, S. M. Justus, C. M. d. S. Araújo, E. Longo, J. A. Varela, J. M. G. Lopes, and B. Vidal de Almeida

**Selection of Desulfurizing Agents and Optimization of Operational Variables in Hot Metal Desulfurization**

56



*Slag Skimming*



*Torpedo Ladle Tipping*



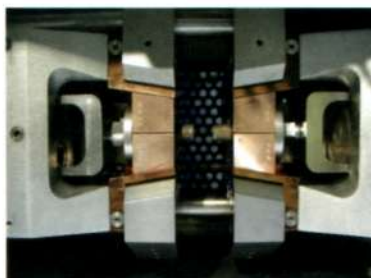
*Mouth Cleaning*

The operational variables of desulfurization process in torpedo car, as well as its causes and solutions were analyzed. Then laboratorial and industrial tests were done to select the proper desulfurizing agents. Were tested agents based of  $\text{CaC}_2$ ,  $\text{CaO}$ ,  $\text{CaCO}_3$ , and  $\text{Mg}$  to assess the cost per quantity of product desulfurized. The best result was not with the greater  $\text{CaC}_2$  content.

J. Haapakangas\*, J. Uusitalo, O. Mattila, T. Kokkonen, D. Porter, and T. Fabritius

**A Method for Evaluating Coke Hot Strength**

65



The use of a Gleeble device for measuring the hot strength of coke was evaluated. The hot strength of coke was decreased from 15.1 to 12.1 MPa when heated from 1000 to 1600°C. The strength of coke was homogenized at high temperatures. The deformation behavior of coke was brittle at 1000°C, but partially plastic at 1600°C. The decreased strength at high temperature could explain the decrease of coke size observed in quenched blast furnaces.

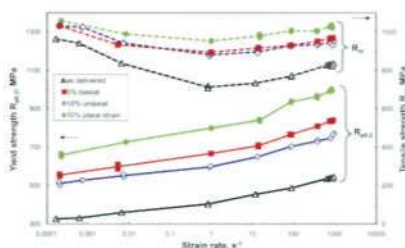


# Contents

P. Larour,\* P. Verleysen, K. Dahmen, and W. Bleck

## Strain Rate Sensitivity of Pre-Strained AISI 301LN2B Metastable Austenitic Stainless Steel

72

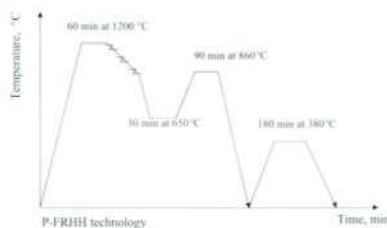


The dynamic behaviour of AISI 301LN2B metastable austenitic steel is investigated at 296 K, in the strain rate range  $0.005\text{--}1000\text{s}^{-1}$ , in the as delivered, as well as 10% uniaxial, biaxial and plane strain pre-strained conditions. The martensitic  $\gamma \rightarrow \alpha'$  transformation is highly strain rate and pre-straining sensitive. Pre-straining reduces the adiabatic tensile strength softening in the low strain rate range  $10^{-4}\text{--}10\text{s}^{-1}$ .

M.-C. Zhao, J.-L. Li, Y.-C. Zhao, X.-F. Huang, J.-Z. Li, and A. Atrens\*

## A Novel Heat Treatment for Excavator Dipper Teeth Manufactured from Low-Carbon Low-Alloy Steel

89

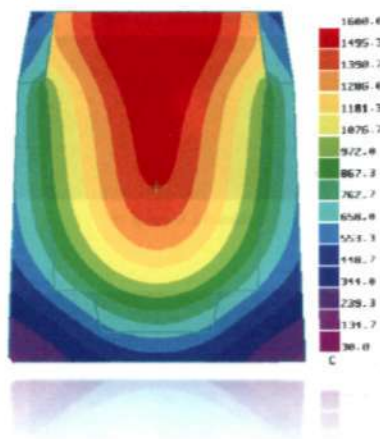


A novel partial forging-remnant-heat hardening technology is proposed for forged excavator teeth from low-carbon low alloy steel. The key metallurgical aspect is the intermediate transformation to pearlite, and the production of a fine tempered martensite microstructure. Dipper teeth produced using this novel technology had good mechanical properties, and a lower cost, congruent with the low carbon economy.

Z. Ji\*, S. Li, Y. Zhang, and G. Tang

## Calculation of the Total Solidification Time for the 230t Large Steel Ingot

94



This study provides a reference for the prediction on the total solidification time of large steel ingots. Both the analytical calculation and the numerical simulation methods were researched to predict the total solidification time. The results showed that both methods can predict the time effectively, however, for the analytical method, the ingot mold should be or like a cylinder.