Contents

PREFACE xxi

**Advanced Installation Techniques and Equipment**

DEVELOPMENT OF AUTOMATIC REPAIR TECHNOLOGY BY CONTINUOUS AND QUICK MIXING TECHNOLOGY
   Junichi Tsukuda, Hiroyuki Itoh, Youichi Furuta, Kazunori Seki, Seiji Hanagiri, Takayuki Uchida,
   Satoru Itoh, Seiji Asoh, and Sakae Nakai

DEVELOPMENT OF CONTINUOUS QUICK MIXING & REPAIRING TECHNOLOGY
   Satoru Itoh, Seiji Hanagiri, Takayuki Uchida, Hironori Takeuchi, Hisashi Nakamura, Seiji Asoh,
   Hiroyuki Itoh, Youichi Furuta, Kazunori Seki, Junichi Tsukuda, and Sakae Nakai

THE NEXT GENERATION OF MONOLITHIC INSTALLATION TECHNOLOGY: CONTINUOUS MIXING OF LOW CEMENT CASTABLES FOR WET SHOTCRETING APPLICATIONS
   Josh Pelletier, Charles Alt, Chris Parr, Jim Farrell, and Tripp Farrell

TAPHOLES REPAIR ON CSN'S BLAST FURNACE 3: CORE & CAST AND CORE & PLUG*

GUNNING ROBOTS FOR THE HOT REPAIR
   Christian Wolf

**Advanced Testing of Refractories**

CHARACTERIZATION METHODS OF ZIRCONIA AND THE IMPACT OF STABILIZING AGENTS ON ITS FUNCTIONALITY
   C. Bauer, B. Rollinger, G. Krumpel, O. Hoad, J. Pascual, and N. Rogers

CHARACTERIZATION OF THE MECHANICAL BEHAVIOR OF MAGNESIA SPINEL REFRACTORIES USING IMAGE CORRELATION
   Y. Belrhiti, A. Germaneau, P. Doumalin, J.C. Dupré, O. Pop, M. Huger, and T. Chotard

TEMPERATURE DEPENDENT THERMO-MECHANICAL BEHAVIOR OF NOVEL ALUMINA BASED REFRACTORIES
   A. Böhm, E. Skiera, C.G. Aneziris, S. Dudczig, and J. Malzbender

*NOTE: A bold title indicates that the paper was peer-reviewed.*
THERMO-MECHANICAL CHARACTERISATION OF MAGNESIA-CARBON REFRACTORIES BY MEANS OF WEDGE SPLITTING TEST UNDER CONTROLLED ATMOSPHERE AT HIGH-TEMPERATURE
E. Brachen, C. Dannert, and P. Quirmbach

MATERIAL SPECIFIC PROPERTIES FOR THE EVALUATION OF THE THERMAL STRESS RESISTANCE OF REFRACTORY PRODUCTS—COMPENDIUM AND NEW INVESTIGATION METHODS
E. Brachen and C. Dannert

MEASUREMENT OF THE VOLUME EXPANSION OF SiC REFRACTORIES INDUCED BY MOLTEN SALT CORROSION
E. de Bilbao, P. Prigent, C. Mehdi-Souzani, M.L. Bouchetou, N. Schmitt, J. Poirier, and E. Blond

BASIC UNDERSTANDING OF PHYSICAL PROPERTIES OF CARBON BONDED REFRACTORY COMPOSITES
D. Dupuy, M. Huger, T. Chotard, S. Zhu, D. DeBastiani, P. Guillo, C. Durnazeau, and C. Peyratout

THERMAL SHOCK ON THE LOWER SLIDE GATE PLATE WHEN CLOSING: TEST DEVELOPMENT AND POST MORTEM INVESTIGATIONS
Renaud Grasset-Bourdel, Javier Pascual, and Christian Manhart

CORROSION OF CORUNDUM-MULLITE REFRACTORIES IN GASEOUS HCl/H2O ATMOSPHERE AT ELEVATED TEMPERATURE
M.M. Jafari, M. Ghanbari, F. Golestanifard, and R. Naghizadeh

DEVELOPMENT OF A NEW SPALLING TEST METHOD FOR BOTTOM BLOWING TUYERES FOR BOFS
M. Kakihara, H. Yoshioka, M. Hashimoto, and K. Inoue

REFRACTORY INDUSTRY SUFFERS FINANCIAL DAMAGES THROUGH IMPRECISE TEST PROCEDURES FOR THE DETERMINATION OF THE CORESISTANCE OF REFRACTORY MATERIALS—TIME TO REVIEW ISO 12676 AND ASTM C 288
Olaf Krause, Christian Dannert, and Lisa Redecker

CURRENT SITUATION AND DEVELOPMENT OF CHINESE STANDARDS ON REFRACTORY PRODUCTS
Peng Xigao, Li Hongxia, and Wang Xiaoli

THE INFLUENCE OF IN-SITE FORMATION SPINEL ON THE FRACTURE ENERGY OF ALUMINA-MAGNESIA REFRACTORY CASTABLES
Hongbin Qin, Hongxia Li, Jiandong Wang, Guoqi Liu, and Wengang Yang

HIGH TEMPERATURE CHARACTERISTICS OF REFRACTORY ZIRCONIA CRUCIBLES USED FOR VACUUM INDUCTION MELTING
A. Quadling, L. Vandeperre, W.E. Lee, and P. Myers

CHARACTERIZATION OF MAGNESIA AND MAGNESIA-CHROMITE BRICKS BY THE USE OF DIFFERENT DESTRUCTIVE AND NON DESTRUCTIVE TESTING METHODS
A. Ressler, C. Manhart, and R. Neuboeck

INFLUENCE OF PROCESS CONDITIONS ON THE CRYSTALLIZATION OF CALCIUM SILICATES IN THE STIRRING AUTOCLAVE AND THEIR IMPACT ON THERMAL STABILITY
Benjamin Schickle, Thorsten Tonnesen, Rainer Telle, Ann Opsommer, and Oras Abdul-Kader

MICROSTRUCTURAL PROCESSES IN THE WAKE REGION OF THE CRACK IN CASTABLES CONTAINING EUTECTIC AGGREGATES
Jonas Schnieder, Nicolas Traon, Thorsten Tonnesen, and Rainer Telle

IMPLEMENTATION OF A STANDARD TEST METHOD FOR ABRASION RESISTANCE OF REFRACTORY MATERIALS FOR TESTING AT ELEVATED TEMPERATURES
Ralf Simmat, Christian Dannert, Olaf Krause, and Peter Quirmbach
INFLUENCE OF THE CABOURES CONTENT ON THE STRENGTH OF CARBON BONDED ALUMINA OBTAINED BY MEANS OF SMALL PUNCH TEST
S. Soltysiak, M. Abendroth, and M. Kuna

INFLUENCE OF THE PORE SHAPE ON THE INTERNAL FRICTION OF REFRACTORY CASTABLES
Nicolas Traon, Thorsten Tonnesesen, Rainer Telle, Barbara Myszka, and Rafael Silva

CONTRIBUTION OF DIFFERENT BINDER SYSTEMS TO YOUNG’S MODULUS OF ELASTICITY OF CARBON-BONDED ALUMINA AT ELEVATED TEMPERATURES
J. Werner and C.G. Aneziris

INVESTIGATION ON RELIABILITY OF REFRACTORIES VIA WEIBULL AND NORMAL DISTRIBUTION
Wenjie Yuan, Qingyou Zhu, Chengji Deng, and Hongxi Zhu

DRY-OUT SIMULATION OF CASTABLES CONTAINING CALCIUM ALUMINATE CEMENT UNDER HYDROTHERMAL CONDITIONS
J.M. Auveay, C. Zetterström, C. Wöhrmeyer, H. Fryda, C. Parr, and C. Eychenne- Baron

Cement and Lime Refractories

DRY AND WET GUNNING—TECHNICO-ECONOMIC REFRACTORY CONCRETE CONCEPTS FOR HIGHLY LOADED CEMENT PLANTS
Kai Beimdiek and Hans-Jürgen Klischat

DEVELOPMENT OF AN ELECTROFUSED MgO-CaZrO₃ REFRACTORY WITH ADDITION OF HERCYNITE FOR THE CEMENT INDUSTRY
G. Alan Castillo, Fabiola Davila, T. K. Das Roy, B. Krishnan, Ana-Maria Guzmán, and S. Shaji

HYBRID SPINELS TECHNOLOGY FOR BASIC BRICKS IN CHEMICALLY HIGHLY LOADED CEMENT ROTARY KILNS
G. Gelbmann, R. Krischanitz, and S. Joerg

THE EFFECT OF TiO₂ ON PROPERTIES AND MICROSTRUCTURE OF CHROME-FREE BASIC BRICK
S. Ghanbarnezhad, M. Bavand-Vandchali, A. Nemati, and R. Naghizadeh

THE PERFORMANCE OF HIGH QUALITY MAGNESIA RAW MATERIALS IN CEMENT APPLICATIONS
F. Goorman, J. Visser, M. Ruer, C.G. Aneziris, and J. Ulbricht

HIGHER THERMOCHEMICAL RESISTANCE BY INSTALLATION OF MAGNESIA FORSTERITE BRICKS
Hans-Jürgen Klischat and Holger Wirsing

THE PROCESS OF NEW PHASES FORMATION IN THE Al₂SiO₅-ZrSiO₄ REFRACTORY MATERIAL DURING INDUSTRIAL TEST IN CEMENT KILN PREHEATER
Dominika Madej, Jacek Szczerba, and Krzysztof Dul

DEVELOPMENT OF MAGNESIA-SPINEL BRICK FOR TRANSITION ZONE IN CEMENT ROTARY KILNS UNDER THE VASTLY INCREASING USE OF WASTE
Makoto Ohno, Hitoshi Toda, Kozo Tokunaga, Yoshiki Tsuchiya, and Yoshio Mizuno

A NEW TYPE OF BASIC CASTABLE FOR THE CEMENT INDUSTRY
V. Wagner and P. Malkmus

MAGNESIA-SPINEL REFRACTORIES FOR ROTARY KILN BURNING 60% ALTERNATIVE FUEL
Michał Sułkowski, Lucyna Obszynska, and Czesław Golawski

INFLUENCE OF ANDALUSITE ADDITION AND PARTICLE SIZE ON PROPERTIES OF Bauxite-SILICON CARBIDE BRICK
Jinxing Ding, Guotian Ye, Yaoheng Li, Lin Yuan, and Anping Fu
Developments in Basic Refractories

STUDIES ON THE EFFECT OF NANO-CARBON IN MgO-C: A NEW GENERATION REFRACTORIES 227
M. Bag, R. Sarkar, A. S. Bal, R. P. Rana, S. Adak, and A. K. Chattopadhyay

REACTANT SIZE EFFECTS ON MgAl2O4 FORMATION EXPANSION 233
Flavia C. Duncan and Richard C. Bradt

MAGNESIA-CARBON BRICKS MADE IN EUROPE: CHALLENGES AND SOLUTIONS 239
G. Buchebner, A. Kronthaler, and W. Hammerer

MICROSTRUCTURAL AND PHYSICO-CHEMICAL EVOLUTION OF Al2O3 AND Fe2O3 245
NANOPARTICLES DOPED MAGNESIA (MgO) SINTERED AT 1600 °C
C. Gómez Rodríguez, T. K. Das Roy, S. Shaji, G.A. Castillo Rodríguez, and L. García Quiñónez

EFFECTS OF Mg ADDITION ON PROPERTIES, PHASE COMPOSITION AND MICROSTRUCTURE OF Al2O3-C MATERIAL 251
Xinhong Liu, Zhiwang Niu, Enxia Xu, Xiaoyan Zhu, Long Feng

EFFECT OF MAGNESIA DISSOLUTION IN NON-STOICHIOMETRIC CHROMIUM-FREE COMPLEX SPINEL 257
Rahul Lodha, Carmen Oprea, Tom Troczynski, and George Oprea

SPINEL INVERSION AND LATTICE PARAMETERS IN CHROMIUM-FREE SPINEL SOLID SOLUTIONS 263
Rahul Lodha, George Oprea, and Tom Troczynski

DEVELOPMENT OF PLANAR AND CYLINDRICAL REFRACTORIES WITH GRADED MICROSTRUCTURE 267
Uwe Scheithauer, Tim Slawik, Kristin Haderk, Tassilo Moritz, and Alexander Michaelis

DEVELOPMENT OF MAGNESIA REFRACTORIES WITH HIGHER SLAKING RESISTANCE 273
Koichi Shimizu, Yoshitaka Sadatomi, Tsubasa Nakamichi, and Jyouki Yoshitomi

THERMAL CYCLING RESISTANT MgO BASED MONOLITHIC LININGS 279
C. Dromain, P. Malkmus, and J. Soudier

ALUMINATES INFLUENCE ON EVOLUTION OF THE THERMOMECHANICAL PROPERTIES OF REFRACTORY MATERIALS FROM THE CaO-MgO-Al2O3-ZrO2 SYSTEM 285

DEVELOPMENT OF MgO-C NANO-TECH REFRACTORIES OF 0 % GRAPHITE CONTENT (NANO-TECH REFRACTORIES-12) 291
Shinichi Tamura, Tsunemi Ochiai, Shigeyuki Takanaga, Osamu Matsuura, Hiroki Yasumitsu, and Masami Hirashima

MICROSTRUCTURE AND PROPERTIES OF POROUS ZrO2 CERAMICS PREPARED BY FOAMING COMBINED WITH GELCASTING METHODS 297
Wang Gang, Han Jianshen, Yuan Bo, and Li Hongxia

METASTABILITY IN THE MgAl2O4-Al2O3 SYSTEM 303
Kelley R. Wilkerson, Jeffrey D. Smith, and James G. Hemrick

THE EFFECT OF RARE EARTH OXIDES ON THE STRUCTURE AND PROPERTIES OF MgO-CaO CERAMICS 309
Y. W. Yu and Y. X. Zhao

INFLUENCE OF SOLID SOLUTION FORMATION ON THE SOLID STATE SINTERING OF MgCr2O4 313
Hamidreza Zargar, George Oprea, and Tom Troczynski
Energy Savings Through Refractory Design

EVALUATION OF THERMAL CONDUCTIVITY OF REFRACTORY MONOLITHICS BY VARIOUS METHODS AND THE ISSUES THIS RAISES
Zena Carden, Andrew J. Brewster, Dr. David Bell, and Ian Whyman

EFFECT OF PARTICLE SIZE ON PROPERTIES OF NOVEL THERMAL INSULATION MATERIALS SYNTHESIZED BY MOLTEN SALT METHOD
Chengji Deng, Jun Ding, Xiaojun Zhang, Wenjie Yuan, and Hongxi Zhu

ROTARY KILNS—LINING DESIGN AND ENERGY SAVINGS
Niels I. Jacobsen and Leo F. Juhl

DEVELOPMENT OF A NEW CALCIUM SILICATE BOARD WITH SUPER INSULATING PROPERTIES
Volker Krasselt, Jürgen Rank, Ann Opsommer, and Xiao Wu

IMPROVEMENT OF THERMAL EFFICIENCY IN STEEL LADLES
Yong M. Lee, Sanjay Kumar, Jim Bradley, Lionel Rebouillat, and Norman Roy

ACHIEVEMENT OF THE REDUCING EROSION FOR THE INVESTIGATION OF TROUGH BOTTOM ANGLE IN THE SEMIPoolING TYPE MAIN TROUGH
Hiroshi Fujiwara, Toshio Komatsu, Masaki Kajiwara, and Hideyuki Tasaki

ENERGY SAVING OF SLAB REHEATING FURNACES BY IMPROVEMENTS OF REFRACTORIES
Masaharu Sato, Takeuchi Tomohide, Kohno Kohji, and Shimpo Akihiro

NOVEL GENERATION OF KILN FURNITURE
U. Scheithauer, C. Freytag, K. Haderk, T. Moritz, M. Zins, and A. Michaelis

ENERGY SAVING IN WALKING BEAM FURNACES AT ARCELORMITTAL (BREMEN, GERMANY)
BY A NEW CONCEPT FOR SKID PIPE INSULATION
Jens Heinlein, Heiko Steffke, Michael Springer, Frank Hügel, Andreas Buhr, and Rainer Kockegey-Lorenz

ENERGY SAVINGS AND IMPROVEMENT OF PRODUCTIVITY IN CONTINUOUS REHEATING FURNACES
Patrick Tassot, Jörg Fernau, and Hugues Lemaistre

 NANOPOROUS REFRACTORY INSULATING: SOLUTION OR ILLUSION?
Diogo O. Vivaldini, Vânia R. Salvini, Amadeu A.C. Mourão, and Victor C. Pandolfelli

MATERIAL DESIGN FOR NEW INSULATING LINING CONCEPTS
Dale Zacherl, Dagmar Schmidtmeier, Rainer Kockegey-Lorenz, Andreas Buhr, Marion Schnabel, and Jerry Dutton

Global Education in Refractories

ENHANCING TECHNOLOGY TRANSFER CAPABILITIES—A GERMAN PERSPECTIVE
Anja Geigenmueller and Stefanie Lohmann

VISUALIZING THE INVISIBLE: HOW TO ATTRACT STUDENTS TO REFRACTORY ENGINEERING
Anja Geigenmueller

PROMOTING NATURAL SCIENCE AND ENGINEERING AT FREIBERG UNIVERSITY—SOME OUTSTANDING TOOLS AND RESULTS
Kathrin Haeussler

KOBLENZ UNIVERSITY OF APPLIED SCIENCE, DEPARTMENT OF MATERIALS ENGINEERING, GLASS AND CERAMICS PLAYING A KEY ROLE IN THE SCIENCE AND EDUCATION NETWORK FOR THE REFRACTORY INDUSTRY
Olaf Krause and Peter Quirlmbach
INTEGRATING EDUCATION CONCEPTS—THE KOBLENZ REGION OFFERS A ONE-OF-A-KIND INFRASTRUCTURE TO IDENTIFY AND QUALIFY SPECIALISTS IN ORDER TO ENSURE RELIABLE AND CONTINIOUS PROVISION OF BEST-SKILLED EMPLOYEES TO THE REFRACTORY INDUSTRY
Peter Quirmbach and Olaf Krause

GRADUATE PROGRAMS IN REFRACTORY ENGINEERING: WHAT IS DULY NEEDED?
Michel Rigaud

Iron and Steel Making Refractories—Blast Furnace Troughs

DEVELOPMENT AND APPLICATION OF TAPHOLE MUD FOR 5800 M³ LARGE SCALE BLAST FURNACE
Ping-Kun Chen and Nan-Hsien Lin

HIGH PERFORMING Al₂O₃–SiC–C MONOLITHIC REFRACTORIES RELEASING NO HYDROGEN FOR BF CASTHOUSE APPLICATIONS
Nicolas Duvauchelle and Jérôme Soudier

INVENTION REACTION BONDED ALUMINA BRICKS FOR BF CERAMIC CUP
Yun-Cheol Hong, Soon-II Yoon, and Sang-Ahm Lee

INNOVATIVE GRAPHITIC CASTABLE UTILIZED AS BOTH A REPAIR AND REPLACEMENT MATERIAL FOR CARBONACEOUS REFRACTORY
Yuechu Ma, Dominic J. Loiacono, and Floris Van Laar

CHALLENGES TO IMPROVING THE ENVIRONMENTAL AND HEALTH SAFETY CHARACTERISTICS OF TAP HOLE CLAY
James W. Stendera, Ryan A. Hershey, and Glenn G. Biever

HOT STRENGTH IN RELATION WITH BINDING SYSTEM OF SiC AND Al₂O₃ BASED CASTABLES INCORPORATED WITH SILICON POWDERS AFTER NITRIDATION
Renhong Yu, Huifang Wang, and Ningsheng Zhou

Iron and Steel Making Refractories—BOF

PROPERTIES AND PERFORMANCE OF GUNNING AND PATCHING MATERIAL OF CONVERTER AT TATA STEEL
Goutam Ghosh, Amit Banerjee, Brijender Singh, Subir Biswas, and Atanu Ranjan Pal

IMPROVEMENT OF DURABILITY AND TAPPING TIME OF TAP HOLE SLEEVE BY COMPOSITION AND SHAPE CONTROL
Kye-sung Kim, In-kyoun Bae, Ji-eon Lee, and Kang-yong Lee

POST MORTEM ANALYSIS OF BOF TUYERES
S. K. Kubal, C. Pleydell-Pearce, J. R. Powson, and W. E. Lee

IMPROVEMENT OF BOF BOTTOM STIRRING AT RUUKKI, RAAHE STEEL WORKS
Heikki Pärkkä, Tuomas Meriläinen, Jukka Vatanen, Petri Tuominen, and Jaakko Kärjä

IMPROVEMENT OF THE REFRACTORY LINING CONCEPT AND OF THE INSTALLATION METHOD OF A BOF AT VOESTALPINE LINZ
Helge Jansen, Luiz Schade, Dr. Thomas Schemmel, and Reinhard Exenberger

Iron and Steel Making Refractories—Coke Ovens

PHYSICAL PROPERTIES OF USED BRICKS OF COKE OVENS
S. Hosohara, H. Matsunaga, and Y. Fushima
INFLUENCE OF THERMAL EXPANSION BEHAVIOR ON THE ADHESIVE STRENGTH OF SILICA MORTAR
Atsuya Kasai

EVALUATION OF COKE OVEN REGENERATOR CHECKERS AFTER 40 YEARS IN SERVICE
Silvia Camelli, M. J. Rimoldi, A. Vázquez, and Dario Beltrán

DEVELOPMENT OF ZERO EXPANSION SILICA BRICKS FOR HOT REPAIR OF COKE OVEN
S. P. Das, S. Si, B. Prasad, J. K. Sahu, B. K. Panda, J. N. Twari, and N. Sahoo

Iron and Steel Making Refractories—Continuous Casting

EFFECTS OF VISCOSITY AND SURFACE TENSION OF FREE FLUORINE FLUXES ON THE WEAR MECHANISMS OF Al2O3-C NOZZLE
E. Benavidez, M. V. Peirani, M. Ávalos, and E. Brandalez

DEVELOPMENT OF ALUMINOUS NOZZLES REINFORCED WITH SIALON
Clenice Moreira Galinari and Paula Regina Dutra

PROPERTIES OF SELF-GLAZING Al2O3-C-REFRACTORIES INFLUENCED BY THE GRAPHITE CONTENT AND NANOSCALED ADDITIVES
Susann Ludwig, Vasileios Roungos, and Christos G. Aneziris

Iron and Steel Making Refractories—General

DEVELOPMENT OF NEW BASIC WORKING LINING FOR TERNIUM SIDERAR TUNDISHES
Silvia Camelli, Maria Lujan Dignani, and Marcelo Labadie

APPLICATION OF MULTI-HOLES STOPPER FOR MOLD LEVEL STABILITY
Sangbae Choi, Ikbae Lee, Domun Choi, Kwangchul Choi, Sangahn Lee, and Sik Sunwoo

NEW DEVELOPMENTS ON REFRACTORY HOLLOWWARE MATERIALS FOR INGOT CASTING
Roberto de Paula Rettore, Erwan Guéguen, and Gilbert Zieba

CHALLENGES OF BLAST FURNACE CASTHOUSE: FAILURE ANALYSIS OF MAIN RUNNER REFRATORY CASTABLE

NOVEL DRY MIX TECHNOLOGY FOR TUNDISH REFRATORY LINING

DEVELOPMENT OF ACTIVE AND REACTIVE CARBON-BONDED FILTERS FOR STEEL MELT FILTRATION
M. Emmel and C. G. Aneziris

IMPROVING MAINTENANCE AT DIRECT-REDUCTION PLANTS USING INFRARED THERMOGRAPHY
Y. J. Girón, E. J. Estrada, and D. Gutiérrez-Campos

APPLICATION AND DEVELOPMENT OF HBS IN CHINA
Fuchao Li, Jianhao Li, Hongqin Dong, and Gengchen Sun

EFFECTS OF CORDIERITE ADDITION ON THE PROPERTIES OF MULLITE-ANDALUSITE-CORDIERITE BRICKS
Fuchao Li, Jianhao Li, Hongqin Song, Gengchen Sun, Guolu Zhou, and Shijian Gao

TAPE CASTING OF COARSE-GRAINED OXIDE POWDERS FOR THE MANUFACTURE OF ADVANCED REFRACTORY MULTILAYER COMPOSITES
D. Jakobsen, I. Götschel, and A. Roosen
DIFFERENT FABRICATION ROUTES FOR CARBON-BONDED $\text{Al}_2\text{O}_3$-C AND THEIR INFLUENCE ON THE PHYSICAL AND MECHANICAL PROPERTIES  
Yvonne Klemm, Horst Biermann, and Christos Aneziris  

DEVELOPMENT OF A MONOLITHIC REFRactory USING SPENT REFRactories  
Ryo Otake, Hitoshi Sawada, Koji Nakanishi, and Ko Kobayashi  

EFFECTS OF B$_4$C ADDITION ON THERMO-MECHANICAL PROPERTIES OF AI-Si INCORPORATED LOW CARBON $\text{Al}_2\text{O}_3$-C SLIDE PLATE MATERIALS  
Xinhong Liu, Yanna Wang, and Xiangchong Zhong  

OPTIMUM QUANTITY OF GAS BLOWN INTO THE BORE OF TUNDISH UPPER NOZZLE  
A. Mizobe, J. Kurisu, K. Furukawa, T. Tsuduki, M. Yamamoto, T. Oouchi, and K. Oki  

IMPROVEMENT OF THE DURABILITY ON SG PLATE FOR STEEL LADLE  
Zenta Ohmaru, Keiichiro Akamine, Katsumi Morikawa, and Jyouki Yoshitomi  

DEVELOPMENT OF A METHOD TO MEASURE TORPEDO LADLE BRICK THICKNESS USING A COMMERCIAL 3D LASER SCANNER  
Ryo Otake, Norio Sakaguchi, Koji Nakanishi, Ko Kobayashi, and Toshiya Ozato  

HOW DO STEELMAKERS PICK REFRRACTORIES? A SUPPLIER'S PERSPECTIVE  
Ian D. Prendergast  

STEEL CLEANLINESS & SEQUENCE LENGTH IMPROVEMENT THROUGH TUNDISH CONFIGURATION & BLACK REFRactories QUALITY OPTIMIZATION AND BY INTRODUCING THE CONCEPT OF MANAGEMENT  
Asis Sarkar  

BENCHMARKING OF CAS-OB REFRactory BELLS  
S. Muthukumar and A. Kremer  

REFRACTORY RESPONSE FOR PIG IRON REFINING WITH KR-PROCESS  
Patrick Tassot, Jacky Wang, and Hugues Lemaistre  

CHEMICAL WEAR OF $\text{Al}_2\text{O}_3$-$\text{MgO}$-C BRICKS BY AIR AND BASIC SLAGS  
Leonardo Musante, Pablo G. Galliano, Elena Brandaleze, Vanesa Muñoz, and Analia G. Tomba Martinez  

ANDALUSITE APPLIED IN EAF ROOF CASTABLES  
Xiao-Yong Xiong, Zong-Sun Mu, Zhi-Jian Li, and Feng Hu  

CALCIUM HEXALUMINATE DISTRIBUTION AND PROPERTIES OF CALCIUM ALUMINATE CEMENT BONDED CASTABLES WITH MAGNESIUM CHLORIDE ADDITION  
Qingfeng Wang, Guotian Ye, Yajuan Wang, Chuanyn Zhang, Yunfei Zhang, and Aiping Hua  

IMPROVEMENT OF REFRACTORY CASTABLES FOR KR DESULPHURIZATION IMPELLER  
Shang-ru Yeh, Henry Chen, and Wei-tin Lin  

STUDY ON LADLE PURGING PLUG WITH GRADIENT COMPOSITE STRUCTURE AND MATERIAL  
Zhang Hui, Yu Tongshu, Yang Wengang, and Chen Lu  

STRENGTHENING MECHANISM OF GRAPHENE OXIDE NANOSHEETS FOR $\text{Al}_2\text{O}_3$-C REFRactories  
Qinghu Wang, Yawei Li, Ming Luo, Shaobai Sang, Tianbin Zhu, and Lei Zhao  

Iron and Steel Making Refractories—Ladles  

TROUBLESHOOTING IN STEEL LADLES WITH REFRACTORY SOLUTIONS  
S. Bharati, S. Bose, B. Singh, and A. R. Pal
EFFECT OF MICROPOROUS AGGREGATE ON LIGHTWEIGHT ALUMINA-MAGNESIA CASTABLE FOR LADLE  

DEVELOPMENT OF ALTERNATIVE SOLUTIONS FOR IRON LADLE REFRACTORY LINING  

INSULATION BOARD INVESTIGATION AND TRIALS IN 300 TONNE STEEL LADLES AT ARCELORMITTAL DOFASCO  
Vanessa Mazzetti-Succi  

STEEL LADLE LINING: A PROVEN TECHNIQUE TO ACHIEVE 3.0% PRODUCTIVITY IN TRANSPORTED VOLUME WHILE REDUCING REFRACTORY COST USING A SMART LINING  
L.C. Simão, Paulo Osório R.C. Brant, and Robson A. Dettogne  

ALUMINA-MAGNESIA-CARBON BRICKS FOR STEEL LADLE  
Marcin Kiewski, Obęzyńska Lucyna, and Sulkowski Michał  

Iron and Steel Making Refractories—Magnesia-Carbon  

IMPROVEMENT AND MAINTENANCE OF MgO-C BOTTOM-BLOWING TUYERE IN BOF CONVERTER FOR PROLONGING SERVICE LIFE  
Li Lin, Peng Xiaoyan, Gao Fei, and Ding Hewei  

INFLUENCE OF Zn ADDITION ON PROPERTIES OF METAL COMPOSITE LOW CARBON MgO-C REFRACTORIES  
Chengliang Ma, Zhen Ren, Hua Ma, and Dongdong Meng  

EFFECTS OF NANO BORON CARBIDE AS ADDITIVE FOR MgO-C FOR BOF  
Carlos Pagliosa, Nestor Freire, Gabriel Cholodovskis, and Victor Carlos Pandolfelli  

DEVELOPMENT OF Al2O3-MgAl2O4-C REFRACTORIES FOR STEEL LADLE: EFFECT OF MgO AND Al2O3 REACTIVITY  
H. S. Tripathi and A. Ghosh  

PROPERTIES OF MgO BASED REFRACTORIES WITH SYNTHETIC MgO-SiC-C POWDER  
Yaowu Wei, Huawei Xu, Xinyan Li, Nan Li, Bing Wu, Luoxia Wang, and Lieying Ma  

THE COMPREHENSIVE STUDIES OF MAGNESIA CARBON BRICK’S ANISOTROPY  
Houliang Zhu, Hideo Asakura, Yasuo Mizota, Akira Yamaguchi, Zhongyang He, and Baikuan Liu  

Iron and Steel Making Refractories—RH Snorkels  

DEVELOPMENT OF DEGASSER SNORKEL REFRACTORIES AND THE EFFECT OF THE PROCESS PARAMETERS ON WEAR RATE  
Y. Bi, I. A. Smith, and K. Andreev  

THEORETICAL AND PRACTICAL TEMPERATURE GRADIENT OF THE REFRACTORY LINING OF THE RH SNORKEL  
Z. Czapka, J. Szczerba, and W. Zelik  

DEVELOPMENT OF HIGH-DURABILITY HOT REPAIR SPRAY AND NEW INSTALLATION METHOD FOR THE RH SNORKEL  
Je-Ha Lee, Byung-Su, Kim, and Chang-Jung Um