

Proceedings of

INFACON XIII

THE THIRTEENTH INTERNATIONAL FERROALLOYS CONGRESS

Efficient Technologies in Ferroalloy Industry

Volume I

June 9-12, 2013
Almaty, Kazakhstan

Proceedings of

INFACON XIII

THE THIRTEENTH INTERNATIONAL FERROALLOYS CONGRESS

Efficient Technologies in Ferroalloy Industry

Volume II

June 9-12, 2013
Almaty, Kazakhstan

Efficient technologies in ferroalloy industry: Proceedings of the Thirteenth International Ferroalloys Congress INFACON XIII. (June 9-12, 2013, Almaty, Kazakhstan). - Karaganda, Publisher: "P. Dipner", 2013. Two volumes. – 1090 p.

ISBN 9965-729-35-2 (V.1)

ISBN 9965-729-36-0 (V.2)

ISBN 9965-729-34-4

Copyright © 2013 Public Association INFACON XIII. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise without written permission of the copyright owner.

These Proceedings contain original articles provided by authors. Any errors, omissions and grammatical inaccuracies are the responsibility of the original author.

ISBN 9965-729-35-2 (V.1)

ISBN 9965-729-36-0 (V.2)

ISBN 9965-729-34-4

Printed in Kazakhstan

FOREWORD

This publication records the proceedings of the Thirteenth International Ferroalloys Congress, INFACON XIII, held in Almaty, Kazakhstan on June 9-12, 2013. The Proceedings contain papers presented at this important event.

The theme of INFACON XIII – “Efficient technologies in ferroalloy industry” reflects needs and challenges that all ferroalloy producers are now facing. Rapid growth of ferroalloy production in recent years, deterioration of mineral and energy resources, toughening of environmental policy are calling for rational approach to management and utilization of available natural reserves.

Over 150 abstracts were sent for review from all over the world. The Program Committee accepted preliminary 145 papers for the evaluation of competent referees.

The Proceedings of INFACON XIII contain 119 papers, of which 75 papers to be presented in twenty five sessions, by authors from 23 countries.

The major ferroalloys, namely ferrochromium and ferromanganese, are covered extensively in many interesting papers. Many papers deal with complex alloys – a relatively new but promising direction in ferroalloy industry.

These Proceedings will be available both in a printed and electronic form with search function.

All papers included in these Proceedings were pre-reviewed by at least two referees. About 40 referees were sourced internationally, and their valuable technical and editing inputs are gratefully acknowledged. We appreciate the time and effort that the authors and referees have devoted to making this publication a really valuable document.

To achieve a broader perspective for the organizing work, an international Extended Program Committee was nominated and we are grateful for the contributions of the members of the Committee.

We are grateful to Dr. Nicholas Barcza, a Chairman of International Committee of Ferroalloys for trusting our ability to organize this event and honoring INFACON XIII to Kazakhstan.

I would like to make special mention of valuable contribution of Dr. Asmo Vartiainen, secretary of preceding INFACON, who passed his priceless experience and organizational skills to Organizing Committee of INFACON XIII. His attitude and support are greatly appreciated.

I sincerely hope that this Congress will contribute to further development of ferroalloy production and I wish all participants of INFACON XIII Congress a successful work for our common good.

Manat Tolymbekov
Chairman: INFACON XIII Congress

WELCOME TO INFACON XIII IN ALMATY, KAZAKHSTAN ON BEHALF OF THE INTERNATIONAL COMMITTEE ON FERRO-ALLOYS (ICFA)

On behalf of the International Committee on Ferro-Alloys (ICFA) it gives me great pleasure to welcome all the contributors to and participants at INFACON XIII in Almaty. ICFA is delighted that INFACON is being hosted in Kazakhstan for the first time. It is very appropriate that INFACON XIII is taking place in this important region that has been a major growth area for the ferro-alloys industry. Furthermore, innovative technologies have and are being implemented in Kazakhstan that are featured in the INFACON XIII technical programme and post-congress tours.

I would in particular like to acknowledge the leading roles of the Chairman of the INFACON XIII Organising Committee, Professor Manat Tolymbekov and the Congress Secretary Dr Sergey Kim. The tremendous efforts of the INFACON XIII Committee and their supporting staff in particular Academic Secretary, Dr. Natalya Lu in the preparations leading up to INFACON XIII over the past three years deserves special recognition. The new record contribution of high quality and topical manuscripts bears witness to their efforts and to the choice of an appropriate theme at this time of rising energy prices, namely 'Efficient technologies in Ferroalloy industry'.

The INFACON XIII Programme Committee has spent considerable effort in reviewing the large number of abstracts and subsequently the many manuscripts that were submitted. These were then processed through the traditional refereeing process that is necessary to ensure the high technical standards set in the past by previous INFACON Congresses. It is also gratifying to see that INFACON XIII has built on the success of INFACON XII in encouraging contributions from Russian-speaking regions.

The ICFA awarded INFACON XIII to Kazakhstan based on the strong merits for hosting the INFACON Congress as presented at the International Committee meeting in Helsinki during INFACON XII. It is therefore pleasing to note the outstanding level of support as received in the greatest number of contributors of papers in the history of INFACON.

The invaluable role of the Abishev Chemical Metallurgical Institute in Karaganda and the National Center on Complex Processing of Minerals of the Republic of Kazakhstan in Almaty in the hosting on INFACON XIII is also duly acknowledged.

INFACON XIII has also continued the innovative concept of forming an Extended Programme Committee that was conceived during the build-up to INFACON XII to assist by providing guidance regarding the planning and implementation of the Congress. The support from the members of the Extended Programme Committee over the past few years is much appreciated. Special mention needs to be made of the tremendous assistance given by the Outotec (the organisers of INFACON XII) and in particular to Dr Asmo Vartianen who, based on his experience as Congress Secretary, provided invaluable guidance to the Organising Committee of INFACON XIII. ICFA offers its thanks and appreciation to the members of the Extended Programme Committee and especially to Dr Vartianen.

The ICFA committee plans to hold its next meeting during INFACON XIII and will announce the host for INFACON XIV during the Closing Ceremony for INFACON XIII.

We look forward to a truly interesting technical and a most enjoyable social programme in Almaty during INFACON XIII, as well as the support of all the ferro-alloys producers and maximum level participation from all the ferro-alloys producing regions.

Nic Barcza, Chairman ICFA nicb@mintek.co.za
Rodney Jones, Secretary General ICFA rtjones@global.co.za
Secretariat International Committee on Ferro-Alloys
Mintek, 200 Malibongwe Drive,
Private Bag X3015, Randburg, 2125 South Africa

INFACON XIII COMMITTEES

Organizing Committee

Prof. Manat Tolymbekov (Congress chairman), Abishev Chemical-Metallurgical Institute

Dr. Sergey Kim (Congress secretary), Abishev Chemical-Metallurgical Institute

Prof. Sailaubay Baisanov, Abishev Chemical-Metallurgical Institute

Prof. Svetlana Efremova, National Center

Dr. Natalya Lu, Abishev Chemical-Metallurgical Institute

Natalya Popova, Abishev Chemical-Metallurgical Institute

Sholpan Abdrakhmanova, Abishev Chemical-Metallurgical Institute

Program Committee

Acad. Abdurassul Zharmenov (chairman), National Center

Prof. Manat Tolymbekov (co-chairman), Abishev Chemical-Metallurgical Institute

Dr. Sergey Kim (secretary), Abishev Chemical- Metallurgical Institute

Dr. Nic Barcza, ICFA

Dr. Asmo Vartiainen, Outotec Oyj

Jorma Daavittila, Outotec Oyj

Dr. Alma Terlikbaeva, National Center

Prof. Sailaubay Baisanov, Abishev Chemical-Metallurgical Institute

Dr. Natalya Lu, Abishev Chemical-Metallurgical Institute

Prof. Vladimir Zhuchkov, Ural Institute of Metallurgy, Russian Academy of Sciences

Prof. Michael Gasik, Aalto University

Prof. Sergey Grischenko, Ukraine Ferroalloy Association

Elena Vlasyuk, Ukraine Ferroalloy Association

Dr. Erzhan Abdulabekov, Kazchrome JSC, Aktyubinsk Ferroalloy Plant

INFACON XIII REFEREES

Bodil Monsen

John Rankin

Erzhan Abdulabekov

Gudrun Saevarsdottir

Alexander Kim

Askar Chekimbaev

Timo Fabritius

Nelson Jannotti

Vitaliy Malyshev

Manat Tolymbekov

Eli Ringdalen

Alibek Baisanov

Antti Roine

Lauri Holappa

Pekka Santala

Astra Turdukozhaeva

Thomas Magnussen

R. Hurman Eric

Nic Barcza

Ilkka Kojo

Helge Krogerus

Sergey Kim

Johan Basson

Joo Hyun Park

Jurek Latusek

Andrie Garbers-Craig

Zhanibek Nurmukhanbetov

Vasiliy Kim

Onuralp Yucel

Khanat Kuzgibekova

Kevin Cookson

Laszlo Kadar

Franciscus Prins

Alexander Akberdin

Asmo Vartiainen

Roger Urquhart

Saylaubay Baisanov

Marko Kekkonen

Merete Tangstad

INFACON XIII SPONSORS

PLATINUM SPONSOR:

**SMS
SIEMAG**

SMS group

GOLD SPONSORS:



SILVER SPONSORS:



BRONZE SPONSOR:



Technical Tours to Aktobe Ferroalloy Plant and Aksu Ferroalloy Plant supported by

JSC TNC Kazchrome

**We have a part ... in making
the world go round.**

SMS  group



► **Competence from one source**

What connects the world originates with us. We plan, design and construct plants worldwide for producing and processing steel, aluminum and copper.

The result: Quality products that stand up to top strains ensure sustainable quality of life around the globe. And that brings us closer together.

SMS group

Eduard-Schloemann-Strasse 4
40237 Düsseldorf, Germany

Phone: +49 211 881-0
Fax: +49 211 881-4902

E-mail: communications@sms-group.com
Internet: www.sms-group.com

**SMS
SIEMAG**
SMS group

**SMS
MEER**
SMS group

MEETING your EXPECTATIONS

Print run 500 copies. Offset paper. Offset printing. Format: A4 (210x297 mm.)
Printed by P.Dipner
Karaganda, Kazakhstan.