

Essential Readings in **Light Metals**

VOLUME 1

Alumina and Bauxite

Edited by

Don Donaldson and Benny E. Raahauge

TMS

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PREFACE

Since 1962, alumina production has grown from about 9–10 million to 87–88 million tpa smelter grade alumina, with China accounting for about 33–34 million tpa in 2011. Chemical or special alumina of varying specifications account for additional 8–9 million tpy alumina production. The energy consumption in modern alumina refineries using the Bayer process to produce alumina hydrate followed by the calcination process producing smelter grade alumina has decreased from about 13–14 GJ per ton in 1970 to 8–9 GJ per ton alumina in 2011.

In 1962 the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) organized a symposium on alumina and aluminum and published *Extractive Metallurgy of Aluminum, Volume 1, Alumina* and *Volume 2, Aluminum* in 1963. Subsequently, each year from 1971 to the present, TMS has published the *Light Metals* proceedings, which includes the Alumina and Bauxite section. We thank all of you for your contribution and support during all those years. We are confident the new generation of scientists, engineers, and technologists will make the alumina industry even better than it is today.

This volume includes the best technical papers published in the *Light Metals* volumes from 1963 to 2011 selected by the editorial team comprising Don Donaldson, Tim Laros, Chuck Misra, Linus Perander, Benny E. Raahauge, and Fred Williams.

On behalf of the editorial team and The Minerals, Metals, & Materials Society, it is our privilege to dedicate this volume of *Light Metals* articles on alumina and bauxite to all those authors and their co-workers, universities, and companies whose collective work represents an enormous investment in intellectual resources by concluding the research and development work, and subsequently preparing the technical papers for presentation of the results for the benefits of the alumina industry.

The selection process was challenging, owing to the great number of quality papers to review. First, subjects were selected to cover the alumina industry as shown in the Table of Contents. All alumina and bauxite proceedings, covering more than 40 years of symposia, were scanned to assign every paper to a subject; this alone is a valuable feature of the book. The work was then allocated so that at least two members of the editorial team were involved in the selection of each final paper. The subject lead editor and his assistants read and screened papers and finally selected 15% of the best papers from 1963 to 2011. A brief introduction to each subject has been prepared by the subject lead editor, and at the end of each section is a listing of recommended *Light Metals* alumina and bauxite articles for further reading.

The paper selection process was guided by the following criteria:

- Papers we remember as important in a fundamental context and had an influence on our work
- Papers we believe have had an impact on the industry
- Papers that describe a breakthrough or shift in applied technology
- Important review papers that bring together the current (at the time) thinking on key topics and that have stood the test of time
- Papers that received the Light Metals Award (Best Paper)
- Papers that are not overly commercial

It has been an honor for the editorial team to do the assigned work and our ambition is that the articles included here combined with the list of recommended readings in each section pave the way for you to use this book as a valuable tool and source of information in making your future work more effective and rewarding.

Finally, we hereby extend our thanks to Matt Baker for organizing and steering us through this challenging project and Stephen J. Lindsay for his constructive review of this preface and the section introductions.

Don Donaldson

Benny E. Raahauge

Lead Editors

LEAD EDITORS



Don Donaldson

Don Donaldson received his B.S. degree in Chemical Engineering from the University of Texas in 1947. He has worked in the sugar refining, seawater magnesia, and alumina industries. In the employ of Kaiser Aluminum & Chemical Corporation he worked 34 years in all facets of the production of alumina from bauxite and, subsequently, he was an Independent Alumina Consultant for 25 years.

Don has written several publications and holds patents in alumina technology.



Benny E. Raahauge

Benny E. Raahauge graduated as M.Sc. Chemical Engineering from the Danish Technical University in 1972. His current position is General Manager – Pyro and Alumina Technology at FLSmidth, Minerals Processing Division, Denmark. Prior to joining FLSmidth in 1974, he worked as Plant Engineer for the Danish Sugar Factories.

Benny has more than 36 years' experience with calcination of alumina hydrate to alumina, and joint Alcan – FLSmidth development of the solid liquid calcination technology for liquor purification and destruction of salt cake.

Benny is the holder of several patents and has submitted several technical papers on calcination to TMS since 1980. He has acted as TMS Session Chair on Alumina and Bauxite sessions on several occasions, and he was Program Organizer for the TMS 2012 Alumina and Bauxite Session.

EDITORIAL TEAM

Associate Editor

Fred S. Williams



Fred S. Williams graduated from the University of Kansas with a B.S. Ch.E. in 1958 and M.S. Ch.E. in 1960. Upon graduation he joined Alcoa Research in East St. Louis, Illinois, USA, and continued to work for Alcoa in alumina and chemical research and production assignments in the United States and Suriname for 42 years. Among other assignments, Fred was Manager of Alumina and Chemical Research at the Alcoa Technical Center from 1977 to 1986.

Since retiring in 2002, Fred has continued as a consultant to the alumina and bauxite industry.

Fred is the holder of several patents and has written a number of published technical papers. He has been Alumina Subject Chairman three times and numerous times Session Chairman at TMS annual meetings.

Other Team Members

Tim Laros



Tim Laros is currently Manager of Strategic Initiatives, Group Research and Product Review, FLSmidth, Salt Lake City, Utah, USA. He has a B.S. degree in Civil Engineering from Iowa State University and an M.S. degree in Mineral Processing from The Pennsylvania State University. From 1979 to 1984, Tim held various positions in operations for the Anaconda Minerals Co. He joined the FLSmidth legacy company, Eimco Process Equipment, in 1984 where he has held various positions in Marketing and in Research and Development in the area of solid liquid separation. He has more than 20 years' experience in the alumina refining process primarily in red mud washer circuits and red mud disposal. He has published numerous papers and has many U.S. and international patents in solid liquid separation. In 1995 Tim received the Alcoa Environmental Excellence Award for his work in Improved Bauxite Residue Management, Western Australian Operations.



Chanakya (Chuck) Misra

Chuck Misra received his Ph.D. in Chemical Engineering from the University of Queensland, Australia. He has worked in the alumina industry for more than 50 years and presently works as an independent consultant.

Chuck has authored many publications including three books. He holds more than 35 patents.



Linus Perander

Linus received a Doctor of Philosophy (Chemistry) degree from the University of Auckland (Auckland, New Zealand) and a Master of Science (Chemistry) degree from Abo Akademi University (Turku, Finland). He is currently working in the Light Metals and Fluidized Bed business unit at Outotec GmbH in Germany as a Product Engineer. He has over 6 years of industrial experience and more than 8 years of academic experience mainly from the fields of alumina and aluminum production and research.

Linus's industrial experience ranges from quality control and industrial research to process engineering and procurement, and comes from several different processes and plants. He has participated in several technical audits at alumina refineries and aluminum smelters, aimed at improving production rates and product quality. Prior to taking up the role as Product Engineer with Outotec, Linus worked as a Senior Research Engineer, and later as a Project Manager, at the Light Metals Research Centre (University of Auckland, New Zealand) where he was responsible for executing and delivering a number of externally funded research projects for clients in the global alumina and aluminum industries.

Linus's academic experience also relates mainly to the alumina and aluminum production processes. Much of his work has been focused on how the calcination process influences the alumina properties and quality and furthermore what consequences this has when the material is used as a feedstock and scrubbing medium in the aluminum smelter. He has authored/presented about 20 publications in international peer reviewed journals and industry relevant conference proceedings (including 3 TMS contributions).