

# *Handbook of* Chlor-Alkali Technology

*Volume I: Fundamentals*



Thomas F. O'Brien, Tilak V. Bommaraju,  
and Fumio Hine

# Handbook Of Chlor Alkali Technology

**Supramaniam Srinivasan**



## **Handbook Of Chlor Alkali Technology:**

**Handbook of Chlor-Alkali Technology** Thomas F. O'Brien, Tilak V. Bommaraju, Fumio Hine, 2007-12-31 Foreword It is surprising that we had to wait so long for a new book that gives a comprehensive treatment of chlor alkali manufacturing technology Technologists are largely still making do with the classical book edited by Sconce but that is more than thirty years old At the time of its publication metal anodes were just beginning to appear and ion exchange membrane technology was confined to laboratories The various encyclopedias of industrial technology have more up to date information but they are necessarily limited in their scope Schmittinger recently provided an excellent shorter treatment of the broad field of chlorine technology and applications After discussing electrolysis and the principal types of cell this too gives rather brief coverage to brine and product processing It then follows on with descriptions of the major derivatives and direct uses of chlorine and a discussion of environmental issues The last feature named above has relieved the authors of this work of the obligation to cover applications in any detail Instead they provide a concentrated treatment of all aspects of technology and handling directly related to the products of electrolysis It covers the field from a history of the industry through the fundamentals of thermodynamics and electrochemistry to the treatment and disposal of the waste products of manufacture Membrane cells are considered the state of the art but the book does not ignore mercury and diaphragm cells They are considered both from a historical perspective and as examples of current technology that is still evolving and improving Dear to the heart of a director of Euro Chlor the book also pays special attention to safe handling of the products the obligations of Responsible Care and process safety management Other major topics include corrosion membranes electrolyzer design brine preparation and treatment and the design and operation of processing facilities Perhaps uniquely the book also includes a chapter on plant commissioning The coverage of membranes is both fundamental and applied The underlying transport processes and practical experience with existing types of membrane both are covered The same is true of electrolyzer design The book explores the basic electrode processes and the fundamentals of current distribution in electrolyzers as well as the characteristics of the leading cell designs The authors have chosen to treat the critical subject of brine treatment in two separate chapters The chapter on brine production and treatment first covers the sources of salt and the techniques used to prepare brine It then explains the mechanisms by which brine impurities affect cell performance and outlines the processes by which they can be removed or controlled While pointing out the lack of fundamental science in much of the process it describes the various unit operations phenomenologically and discusses methods for sizing equipment and choosing materials of construction The chapter on processing and handling of products is similarly comprehensive Again it is good to see that the authors have included a lengthy discussion of safe methods and facilities for the handling of the products particularly liquid chlorine While the discussion of the various processing steps includes the topic of process control there is also a separate chapter on instrumentation which is more hardware oriented Other chapters deal with utility systems cell

room design and arrangement with an emphasis on direct current supply alternative processes for the production of either chlorine or caustic without the other the production of hypochlorite industrial hygiene and speculations on future developments in technology There is an Appendix with selected physical property data The authors individually have extensive experience in chlor alkali technology but with diverse backgrounds and fields of specialization This allows them to achieve both the breadth and the depth which are offered here The work is divided into five volumes successively treating fundamentals brine preparation and treatment production technology support systems such as utilities and instrumentation and ancillary topics Anyone with interest in the large field of chlor alkali manufacture and distribution and indeed in industrial electrochemistry in general will find something useful here The work is recommended to students chlor alkali technologists electrochemists engineers and producers shippers packagers distributors and consumers of chlorine caustic soda and caustic potash This book is thoroughly up to date and should become the standard reference in its field

Barrie S Gilliatt Executive Director Euro Chlor      **Handbook of Chlor-Alkali Technology** Thomas F. O'Brien, Tilak V. Bommaraju, Fumio Hine, 2005

Made from common salt and water chlorine and its co product caustic soda are two of the most basic building blocks used for a wide range of products valued by society The Handbook of Chlor Alkali Technology provides comprehensive and concise treatments of all aspects of technology and handling directly related to the products of electrolysis A long awaited comprehensive treatment it covers the field from a history of the industry through the fundamentals of thermodynamics and electrochemistry to the treatment and disposal of the waste products of manufacture While membrane cells are considered state of the art the handbook does not ignore mercury and diaphragm cells They are considered both from a historical perspective and as examples of current technology that yet evolves Special attention is paid to safe handling of the products the obligations of Responsible Care and process safety management Other major topics include corrosion membranes electrolyzer design brine preparation and treatment and the design and operation of processing facilities The coverage of membranes is both fundamental and applied The underlying transport processes and practical experience with existing types of membrane both are covered as is electrolyzer design The book explores the basic electrode processes and the fundamentals of current distribution in electrolyzers as well as the characteristics of the leading cell designs while the appendix offers selected physical property data The authors each with extensive experience in chlor alkali technology but with diverse backgrounds and fields of specialization achieve both breadth and depth Anyone with interest in the large field of chlor alkali manufacture and distribution and indeed in industrial electrochemistry in general will find something useful here The Handbook offers not only broad coverage but also in depth treatment of each topic It will be an asset to managers process engineers and operating personnel working in the chlor alkali industry This book provides valuable information to engineers and scientists involved in development of chlor alkali technology and in the design of new plant or upgrading of existing plants It will be especially valuable to universities as it begins with fundamentals and

progresses methodically through each step involved in chlor alkali production including environmental issues from the Foreword by Barrie S Gilliatt Executive Director Euro Chlor Anyone with interest in the large field of chlor alkali manufacture and distribution and indeed in industrial electrochemistry in general will find something useful here The work is recommended to students chlor alkali technologists electrochemists engineers and producers shippers packagers distributors and consumers of chlorine caustic soda and caustic potash This book is thoroughly up to date and should become the standard reference in its field

**Handbook of chlor-alkali technology** Thomas F. O'Brien, Tilak V. Bommaraju, Fumio Hine, 2005 Annotation Foreword It is surprising that we had to wait so long for a new book that gives a comprehensive treatment of chlor alkali manufacturing technology Technologists are largely still making do with the classical book edited by Sconce but that is more than thirty years old At the time of its publication metal anodes were just beginning to appear and ion exchange membrane technology was confined to laboratories The various encyclopedias of industrial technology have more up to date information but they are necessarily limited in their scope Schmittinger recently provided an excellent shorter treatment of the broad field of chlorine technology and applications After discussing electrolysis and the principal types of cell this too gives rather brief coverage to brine and product processing It then follows on with descriptions of the major derivatives and direct uses of chlorine and a discussion of environmental issues The last feature named above has relieved the authors of this work of the obligation to cover applications in any detail Instead they provide a concentrated treatment of all aspects of technology and handling directly related to the products of electrolysis It covers the field from a history of the industry through the fundamentals of thermodynamics and electrochemistry to the treatment and disposal of the waste products of manufacture Membrane cells are considered the state of the art but the book does not ignore mercury and diaphragm

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Membrane cells are considered the state of the art but the book does not ignore mercury and diaphragm cells. *Modern Chlor-Alkali Technology* John Moorhouse, 2008-04-15 The book addresses the latest technical developments in the chlorine industry with emphasis on operational improvements. The effects of economic, political, environmental and safety issues surrounding the industry are covered. Modern Chlor-alkali Technology S. Sealey, 1998 An exciting overview of the latest technologies in use within the chlorine industry is given in *Modern Chlor Alkali Technology*. Volume 7 International academic and industrial expertise is reported with chapters ranging from the latest developments in membrane technology, diaphragm cell improvements, operating experiences and high current density operation of membrane cells to the removal of brine. Emphasis is also given to the vital issues of public awareness, environmental aspects and the need for good neighbour relations with discussions on how to tackle public relations and the public perceptions of the industry. This volume containing the most up to date information available on developments in chlorine technology will be an essential read for researchers and postgraduates in industry and academe or indeed for anyone who has contact with chlorine.

**Handbook of Industrial Chemistry and Biotechnology** James A. Kent, Tilak V. Bommaraju, Scott D. Barnicki, 2017-08-01 This widely respected and frequently consulted reference work provides a wealth of information and guidance on industrial chemistry and biotechnology. Industries covered span the spectrum from salt and soda ash to advanced dyes chemistry, the nuclear industry, the rapidly evolving biotechnology industry and most recently electrochemical energy storage devices and fuel cell science and technology. Other topics of surpassing interest to the world at large are covered in chapters on fertilizers and food production, pesticide manufacture and use and the principles of sustainable chemical practice referred to as green chemistry. Finally, considerable space and attention in the Handbook are devoted to the subjects of safety and emergency preparedness. It is worth noting that virtually all of the chapters are written by individuals who are embedded in the industries whereof they write so knowledgeably.

**Fuel Cells** Supramaniam Srinivasan, 2006-12-31 This concise sourcebook of the electrochemical engineering and economic principles involved in the development and commercialization of fuel cells offers a thorough review of applications and techno-economic assessment of fuel cell technologies plus in-depth discussion of conventional and novel approaches for generating energy. Parts I and II explain basic and applied electrochemistry relevant to an understanding of fuel cells. Part III covers engineering and technology aspects. The book is useful for undergraduate and graduate students and scientists interested in fuel cells. Unlike any other current book on fuel cells, each chapter includes problems based on the discussions in the text.

Modern Chlor-alkali Technology Kevin Wall, 1986

**Modern Chlor-Alkali Technology** T.C. Wellington, 2012-12-06 The papers in this volume were presented at the 1991 London International Chlorine Symposium held at the Intercontinental Hotel from 5th-7th June. This was the sixth symposium in a series organized by the Electrochemical Technology Group of the SCI and held in London at intervals of three years. A continued high level of interest in the proceedings was demonstrated by offers of 40 papers and of these 26 were selected for

inclusion in the programme The conference intention was to reflect the developments in chlorine technology hardware and software and to address the economic political environmental and safety issues which are increasingly impacting on the chlorine industry as the millennium approaches In the event the five sessions were broadly based on the following topic areas Chlorine and the Environment Membranes 1 Membranes 2 Chlorine Safety Electrodes Electrode Reactions Not unexpectedly the importance of membrane technology to the industry was reflected by the inclusion of 9 papers However the traditional diaphragm mercury and chlorate cell technologies were also represented The academic base of the organizing body was underlined by the selection of papers from the Universities of Milan and Calgary and by the opening and closing remarks of the Chairman of the SCI Electrochemical Technology Group Frank Goodridge Professor Emeritus of Newcastle University The opportunity was taken to present the SCI Castner Medal to Dr H Miyake of Asahi Glass Co Ltd for his work on the design and development of Flemion electrodes Renewable Energy in the Process Industry Eric van Steen, Nicholas S.

Featherstone, Linda H. Callanan, 2026-04-27 Thorough discussion on renewable energies and their implementation into the process industry emphasizing efficiency and demand of industrial processes Renewable Energy in the Process Industry provides an overview of the challenges associated with the generation and storage of renewable energy moving from a broad perspective to a zoomed in look at a variety of different industries The introductory chapter sets the current energy scene and its use in different countries An outline is given for the electricity mix how power generation is controlled and why it may lead to on demand power reduction This outline is followed by a discussion of the technical aspects on generating renewable energy as well as energy storage with respect to efficiencies and important factors in the decision making process Renewable Energy in the Process Industry includes information on Requirements for renewable energy in the process industry such as stronger grid connections extension of the grid together with its stability and better communication between operators Possible intermittency interruptions in the heat supply that can arise when renewable energy is used Electrification of the process industry to reduce emissions Implementation of renewable energies in a variety of different industries ranging from steel and cement manufacturing to pharmaceuticals and wastewater treatment with flowsheets and operating conditions Renewable Energy in the Process Industry is a timely forward thinking resource for process chemical and pharmaceutical engineers bioengineers and engineers involved in power technology *Electrochemical Power Sources: Fundamentals, Systems, and Applications* Tom Smolinka, Jürgen Garche, 2021-10-25 Electrochemical Power Sources Fundamentals Systems and Applications Hydrogen Production by Water Electrolysis offers a comprehensive overview about different hydrogen production technologies including their technical features development stage recent advances and technical and economic issues of system integration Allied processes such as regenerative fuel cells and sea water electrolysis are also covered For many years hydrogen production by water electrolysis was of minor importance but research and development in the field has increased significantly in recent years and a comprehensive overview is missing This book bridges this gap and provides

a general reference to the topic Hydrogen production by water electrolysis is the main technology to integrate high shares of electricity from renewable energy sources and balance out the supply and demand match in the energy system Different electrochemical approaches exist to produce hydrogen from RES Renewable Energy Sources Covers the fundamentals of hydrogen production by water electrolysis Reviews all relevant technologies comprehensively Outlines important technical and economic issues of system integration Includes commercial examples and demonstrates electrolyzer projects

**Electrochemical Engineering** Thomas F. Fuller, John N. Harb, 2018-02-16 A Comprehensive Reference for Electrochemical Engineering Theory and Application From chemical and electronics manufacturing to hybrid vehicles energy storage and beyond electrochemical engineering touches many industries any many lives every day As energy conservation becomes of central importance so too does the science that helps us reduce consumption reduce waste and lessen our impact on the planet Electrochemical Engineering provides a reference for scientists and engineers working with electrochemical processes and a rigorous thorough text for graduate students and upper division undergraduates Merging theoretical concepts with widespread application this book is designed to provide critical knowledge in a real world context Beginning with the fundamental principles underpinning the field the discussion moves into industrial and manufacturing processes that blend central ideas to provide an advanced understanding while explaining observable results Fully worked illustrations simplify complex processes and end of chapter questions help reinforce essential knowledge With in depth coverage of both the practical and theoretical this book is both a thorough introduction to and a useful reference for the field Rigorous in depth yet grounded in relevance Electrochemical Engineering Introduces basic principles from the standpoint of practical application Explores the kinetics of electrochemical reactions with discussion on thermodynamics reaction fundamentals and transport Covers battery and fuel cell characteristics mechanisms and system design Delves into the design and mechanics of hybrid and electric vehicles including regenerative braking start stop hybrids and fuel cell systems Examines electrodeposition redox flow batteries electrolysis regenerative fuel cells semiconductors and other applications of electrochemical engineering principles Overlapping chemical engineering chemistry material science mechanical engineering and electrical engineering electrochemical engineering covers a diverse array of phenomena explained by some of the important scientific discoveries of our time Electrochemical Engineering provides the critical understanding required to work effectively with these processes as they become increasingly central to global sustainability Electrochemical Polymer Electrolyte Membranes Jianhua Fang, Jinli Qiao, David P. Wilkinson, Jiujun Zhang, 2015-04-17 Electrochemical Polymer Electrolyte Membranes covers PEMs from fundamentals to applications describing their structure properties characterization synthesis and use in electrochemical energy storage and solar energy conversion technologies Featuring chapters authored by leading experts from academia and industry this authoritative text Disc Chlorine Peter Schmittinger, 2008-11-21 Chlorine is one of the most important inorganic basic chemicals It is not only an essential reaction



component for the synthesis of numerous organic and inorganic chemicals and plastics it is also of great importance for the production of pharmaceuticals disinfectants bleaches and insecticides Everything you need to know about chlorine is described in this book It provides a practical and up to date account of the scientific and technological basics for the production of chlorine and describes various applications and prospects for future developments Current issues such as environmental protection occupational health and safety aspects storage and transportation economic aspects quality specifications and analysis are treated in a competent and well balanced manner Chemists chemical engineers and chemical process engineers in various industrial sectors engineering companies universities and government authorities will certainly profit from this comprehensive review      **Handbook of Chemicals Production Processes** Robert Allen Meyers,1986

Modern Chlor-Alkali Technology N.M. Prout,J.S. Moorhouse,2011-10-12 The papers in this book were submitted for the 1988 London International Chlorine Symposium This was the fifth symposium organised by the Electro chemical Technology Group of the Society of Chemical Industry and proved as popular as ever attracting a record number of 294 delegates from 31 countries Twenty seven papers were presented during the two and a half day event covering the latest developments in chlor alkali technology The field of membranes and membrane cells was well represented by some 15 papers reflecting the importance of membrane technology to the future of the industry This is particularly relevant in view of increasing environmental pressures and rising costs However papers relating to the more traditional mercury and diaphragm cell technologies were also presented together with a paper concerned with sodium chlorate manufacture In addition there were presentations covering the commercial and safety aspects of the chlor alkali industry The Electrochemical Technology Group of the Society of Chemical Industry offer thanks to the many people and organisations whose help ensured the success of this symposium In particular we would like to thank 1 The contributors of the papers 2 The session chairmen Dr R G Smerko The Chlorine Institute Inc Mr B Lott The Associated Octel Company Limited Mr T F O'Brien United Engineers and Constructors Dr B S Gilliatt ICI Chemicals and Polymers Limited Mr D Bell Hays Chemicals Limited 3 The Chlorine Institute for assistance with printing costs and for active participation      The Handbook of Chlorination George Clifford White,1986      *Modern Chlor-alkali Technology* C. Jackson,1983      **Modern Chlor Alkali Technology** International Chlorine Symposium (4, 1985, London),1986

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