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Membrane Technology

A Practical Guide to Membrane Technology and Applications in Food and Bioprocessing

Z. F. Cui
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Edited by

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Preface

Separation and purification are key to many manufacturing processes in the food, bioprocessing and pharmaceutical industries. Furthermore, these processes are becoming increasingly important for the growth of industries such as bioenergy, biotechnology and nanotechnology. The multiple steps involved in separation/purification processing often require substantial up-front capital and significant operating costs. Thus the efficiency and productivity of separation technology can be critical to both the profitability and sustainability of an enterprise.

Recent developments in membrane technology, especially the development of novel membrane processes, are the most growing areas of process technology. There are several excellent books published in the general areas of membrane science and membrane technology, but there is minimal focus on the applications of membrane technology in food and pharma areas, even though they have grown steadily during the last two decades. For example, one of the major applications in the food industry is the use of reverse osmosis membranes to extend the evaporation capacity and reduce the overall energy costs, thus lowering the carbon footprint for the overall process.

The idea for this book, which focuses on the practical applications of membranes in food and bioprocessing, came out of a North American Membrane Society (NAMS) meeting in Chicago, Illinois, USA, in 2006, when both editors held a workshop on "Fundamentals and Applications of Membrane Technology in Food/Bio-processing". With our combined experience in food technology and bioprocessing, we felt that a book dedicated to the practical aspects and challenges of utilizing membranes effectively in an industrial setting would be an extremely useful tool for any one in membrane processing and practice. The idea gained even more momentum when Elsevier conducted a market study and subsequently expressed its interest in publishing a book on the topic.

In many ways editing this book has been a privilege and a unique experience. Thanks firstly to our excellent contributors without whose support, this book would not have materialized. It is most fitting that this technological work is published from contributors around the globe and is founded on the spirit of free enquiry coupled with hard work and imagination. It has indeed been a great pleasure to be in touch with all contributors during the last 3 to 4 years. Thanks also for their patience and understanding.

We would be utterly remiss if we did not acknowledge those people who have provided us with the inspiration, motivation and never-ending encouragement throughout the course of this work.

Dr Murali would like to acknowledge Mr Ronald Christenson, former Chief Technology Officer, Cargill Inc; his wife Ponnamma; his children Shubha and Shilesh, their spouses Chuck Harris and Nupur Parikh and his two lovely grandchildren Reya and Azad; all his teachers and mentors during his entire career; and his parents who would have been both excited and extremely proud to see this book published.

Dr Cui wishes to thank his wife, Dr Jing Yu, for her unreserved support over decades, his mother for her love, and his children, Jenny and Michael, for "keeping him happy". He would like to thank those who inspired and encouraged him to embark on a career in the "membrane world". Such a list would be long, and here just name a few: Tony Fane, John Howell, Norman Li and Bill Eykamp.

In setting our goal of bringing this book to fruition, we kept in mind these words from Robert Frost in The Road Not Taken:

"Two roads diverged in a wood and I-
I took the one less travelled by,
And that has made all the difference"

ZFC and HSM

About the Editors

Zhanfeng Cui is the Donald Pollock Professor of Chemical Engineering, University of Oxford since the Chair was established in 2000. He is the founding Director of the Oxford Centre for Tissue Engineering and Bioprocessing (OCTEB).

He was educated in China and got his BSc from Inner Mongolia University of Technology (1982) and MSc (1984) and PhD (1987) from Dalian University of Technology. After a postdoctoral experience in Strathclyde University in Scotland, he joined Edinburgh University as a Lecturer in Chemical Engineering (1991). He then held academic appointments at Oxford Engineering Science Department as University Lecturer (1994–1998) and Reader (1999–2000). He was a Visiting Professor of Georgia Institute of Technology, USA (1999), the Brown Intertec Visiting Professor to University of Minnesota, USA (2004), and a Chang-Jiang Visiting Professor to Dalian University of Technology, China (2005). He is a Chartered Engineer, a Chartered Scientist, and a Fellow of the Institution of Chemical Engineers. In 2009 he was award a Doctor of Science (DSc) by Oxford University to recognise his research achievement in membrane science and technology. Apart from membrane research, he also works on tissue engineering and stem cell technologies, and bioprocessing. He published widely and is also the academic founder of Zyoxel Limited, an Oxford University spin-off in 2009.

H.S. Muralidhara Ph.D is a Chemical Engineer. He retired from Cargill Inc. in Minneapolis, USA in Oct 2009 as a Vice President, Manager Process Technology, Corporate Plant Operation after 20 years of service. Prior to that he was a Research Leader at Battelle Memorial Institute in Columbus, Ohio, USA for 10 years. He is currently an industrial consultant.

He has over 30 years of industrial experience in separation purification process technologies including application of membranes in food and bioprocessing. He is a coinventor of 27 US patents and 15 patents pending. He has edited two books and has served as a key note speaker in many major international conferences.

About the Contributors

Vicki Chen is the director of the UNESCO Centre for Membrane Science and Technology at The University of New South Wales, Australia.

Jim Davies is a biochemical engineer with a PhD from UCL and is currently a Principal Group Leader in Purification Development at Lonza Biologics UK.

R.W. Field is a Reader in Engineering Science at Oxford University and has many years of experience in membrane technologies.

Val D. Frenkel, PhD, PE, DWRE, Director Membrane Technologies with Kennedy/Jenks Consultants, is the company-wide leader for Membrane Technologies. Dr. Frenkel formed and leads the firm's Membrane Technology Group and has 25 years of experience in engineering, with expertise in water and wastewater treatment, water reuse, and membrane technologies, including desalination.

Yu Jiang was awarded her DPhil in 2009 from Oxford University. Her DPhil thesis was entitled "Emergency drinking water device based on gravity driven ultrafiltration".

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Abhay R. Ladhe is a Research Chemical Engineer at Cargill Inc., Minneapolis, Minnesota, USA. He graduated from University of Kentucky with a Ph.D. in Chemical Engineering. His research interests include membrane functionalization and membrane based separation. He is currently working in the area of vegetable oil processing for process improvement and process development.

Hongyu Li is a Research Fellow in the UNESCO Centre for Membrane Science and Technology, The University of New South Wales, Australia.

Frank Lipnizki, PhD, is currently with Alfa Laval – Business Centre Membranes (previously Danish Separation Systems), Denmark. Since 2010 also Docent at the University of Lund, Sweden. His main research interests are the integration and optimization of membrane process for the food, biotech and process industry.

Jianquan Luo, MEng, Institute of Process Engineering, Chinese Academy of Sciences. Mr Luo is an experienced engineer specializing in membrane applications in bioseparation and wastewater treatment.

Susana Luque is a Full Professor in Chemical Engineering at the University of Oviedo in Spain. Her main interests are in applied membrane research and membrane-based hybrid processes.

Alan Merry has a PhD in Chemical Engineering. He has 30 years' experience at ITT-PCI Membranes Ltd, working with all aspects of membranes including membrane development, applications and production.

Joseph Scimeca, PhD, currently holds the position of Director of Global Regulatory Affairs, in the department of Corporate Food Safety and Regulatory Affairs, at Cargill, Incorporated, where he has responsibility for ensuring that the company's food and feed products and processes are safe, including being protected against intentional acts of adulteration and bioterrorism, and are compliant with the appropriate food/feed regulations.

Martin Smith, also a Biochemical Engineer from UCL, is currently a Bio-Process Consultant at eXmoor Pharma Concepts in the fields of Biopharmaceuticals and Regenerative Medicine.

Yinhua Wan, DPhil, is a Professor of Biochemical Engineering at Institute of Process Engineering, Chinese Academy of Sciences. He has published more than 80 papers in refereed journals and holds a number of patents in membrane separation technologies.

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