



Membrane Technology

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

Z. F. Cui
H. S. Muralidhara



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and Applications in Food and Bioprocessing

Edited by

Z.F. Cui and H.S. Muralidhara



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Membrane Technology

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).

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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.

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Contents

Preface	xi
About the Editors	xiii
About the Contributors	xv
1. Fundamentals of Pressure-Driven Membrane Separation Processes	1
<i>Z.F. Cui, Y. Jiang and R.W. Field</i>	
1.1 Introduction	1
1.2 Processes	2
1.2.1 Process Classification	2
1.2.2 Definitions	3
1.3 Membranes	5
1.3.1 Membrane Structures	5
1.3.2 Membrane Materials	6
1.3.3 Membrane Modules	8
1.4 Operation	8
1.4.1 Concentration Polarization	8
1.4.2 Membrane Fouling	12
1.5 Prediction and Enhancement of Permeate Flux	13
1.5.1 Flux Prediction Models	13
1.5.2 Flux Enhancement and Fouling Control	16
1.6 Summary	18
Further Readings	18
2. Challenges of Membrane Technology in the XXI Century	19
<i>H.S. Muralidhara</i>	
2.1 History Overview	19
2.2 Membrane Industry	23
2.3 Current Challenges of Membrane Technology	25
2.4 Emerging Applications and Hybrid Processes	28
2.5 Summary	32
References	32
3. Membrane Processes in Fruit Juice Processing	33
<i>Allen Merry</i>	
3.1 Introduction	33
3.2 Clarification	33
3.2.1 Apple	35
3.2.2 Other Juices	38

3.2.3	Concentration	39
3.2.4	Special Applications	42
	References	43
4.	Membrane Application in Soy Sauce Processing	45
	<i>Yinhua Wan, Jianquan Luo and Zhanfeng Cui</i>	
4.1	Introduction	45
4.2	Microfiltration and Ultrafiltration for Sterilization and Clarification of Soy Sauce	47
4.2.1	Membrane Selection	47
4.2.2	Optimization of Process Parameters	51
4.2.3	Industrial Application of Soy Sauce Ultrafiltration	52
4.3	Reverse Osmosis and Nanofiltration for Desalination and Decoloration of Soy Sauce	53
4.3.1	Performance of Different Membranes	54
4.3.2	Effect of Operating Conditions	55
4.3.3	A Pilot-Plant Test	55
4.4	Membrane Fouling and Regeneration	58
4.5	Summary	60
	Acknowledgments	61
	References	61
5.	Application of Membrane Technology in Vegetable Oil Processing	63
	<i>Abhay R. Ladhe and N.S. Krishna Kumar</i>	
5.1	Introduction	63
5.2	Membrane-Based Applications in Vegetable Oil Processing	65
5.2.1	Degumming	66
5.2.2	Deacidification	70
5.2.3	Bleaching	73
5.2.4	Dewaxing	73
5.2.5	Vegetable Oil Hydrogenation Catalyst Recovery and Reuse	73
5.2.6	Other General Applications in Oilseed Processing	74
5.3	Conclusion	75
	Abbreviations	75
	References	76
6.	Membrane Applications in Monoclonal Antibody Production	79
	<i>Jim L. Davies and Martin P. Smith</i>	
6.1	Introduction	80
6.1.1	Monoclonal Antibody Purification Overview	80

6.1.2	Membrane Operations in Monoclonal Antibody Production	81
6.1.3	The Future of Use of Membranes	82
6.2	Direct Filtration for Particle Reduction	82
6.2.1	Modeling of Pore Blockage	82
6.2.2	Membrane Filtration of Process Buffers	83
6.2.3	Using Membranes as Column Guard Filters	85
6.2.4	Intermediate Product Filtration	86
6.3	Tangential Flow Filtration	86
6.3.1	Primary Separation by Microfiltration	87
6.3.2	Ultrafiltration	89
6.3.3	Scale-Up and Membrane Reuse	95
6.3.4	Tangential Flow Filtration in Summary	97
6.4	Virus Reduction Filtration	97
6.4.1	Introduction	97
6.4.2	Filter Sizing	98
6.4.3	Virus Clearance Studies	98
6.4.4	Flux-Decay Profiles	99
6.4.5	Location of Virus Filter Within a Purification Process	100
6.4.6	Modeling Filtration Throughput	100
6.4.7	Assessing Virus Clearance	102
6.4.8	Balancing Practical Filtration Area, Process Economics and LRV	104
6.4.9	Conclusions	107
6.5	New Techniques for Membranes in Antibody Manufacture	107
6.5.1	Tangential Flow Filtration	107
6.5.2	Membrane Adsorbers	115
6.5.3	Conclusions	118
6.6	Summary	119
	References	119

7. Membrane Processes for the Production of Bulk Fermentation Products 121

Frank Lipnizki

7.1	Introduction	121
7.2	Antibiotics	125
7.2.1	Special Section: Diafiltration	129
7.3	Enzymes	131
7.4	Organic Acids	135
7.4.1	Acetic Acid	135
7.4.2	Citric Acid	137
7.4.3	Lactic Acid	137
7.5	Amino Acids	138
7.5.1	Glutamic Acid	139
7.5.2	Lysine	139

7.6	Vitamins	140
7.6.1	Vitamin C	140
7.7	Biopolymers	142
7.7.1	Xanthan Gum	142
7.8	Yeast	144
7.8.1	Baker's Yeast	144
7.8.2	Yeast Extract	146
7.9	Water and Wastewater in the Bulk Biotech Industry	148
7.10	Outlook	149
	References	151
8.	Membrane Technologies for Food Processing Waste Treatment	155
	<i>Val S. Frenkel</i>	
8.1	Introduction	155
8.2	Overview of Membrane Technology	156
8.3	Application of Membrane Technology in Food Processing Waste Treatment	158
8.3.1	Membrane Bioreactors for Food Processing Waste Treatment	159
8.4	Membranes for Food Processing Wastewater Reuse	159
8.4.1	Membrane Versus Conventional Wastewater Treatment for Food Processing Waste Treatment and Wastewater Reuse	160
8.4.2	Methodology for Treating Food Processing Wastes	163
8.4.3	Regulatory Aspects of Food Processing Effluent Treatment	169
8.5	Case Examples	172
8.6	Food Processor	173
8.6.1	Restaurant	174
8.6.2	Olive Processing Facility	174
8.6.3	Squid Processing Plant	175
8.7	Summary	176
	References	177
9.	Practical Aspects of Membrane System Design in Food and Bioprocessing Applications	179
	<i>Bassam F. Jirjis and Susana Luque</i>	
9.1	Introduction	180
9.2	Membrane Performance Characterization	181
9.3	Selection of the Membrane Process and Membrane Type	183
9.3.1	Membrane Screening	183
9.3.2	Bench-Scale Testing	186
9.3.3	Pilot Testing	189
9.4	Feed Pretreatment	193

9.5	Designing a Full-Scale Membrane System	195
9.5.1	Batch versus Continuous Operation	196
9.5.2	Modes of Operation	196
9.5.3	System Operation Control	198
9.6	Calculating Membrane Surface Area	200
9.6.1	Feed Spacer Design	201
9.7	Estimating the Cost of a Membrane System	203
9.7.1	Membrane Elements	205
9.7.2	Membrane Performance Changes, Cleaning, and Membrane Lifetime	205
9.7.3	Number of Elements in Housing	206
9.7.4	Membrane Housings and Skids	206
9.7.5	Storage Tanks and Transfer Tanks	207
9.7.6	Pumps for the Membrane Skids	207
9.8	Economic Evaluation	208
9.9	Summary: Step by Step Recommendation for Membrane System Design	210
	References	211

10. Membrane Fouling and Cleaning in Food and Bioprocessing **213**

Hongyu Li and Vicki Chen

10.1	Introduction	213
10.2	Membrane Fouling in Food and Bioprocessing	216
10.2.1	Factors Affecting Membrane Fouling	217
10.3	Membrane Cleaning	224
10.3.1	Physical Cleaning	224
10.3.2	Chemical Cleaning	225
10.3.3	Cleaning Mechanisms of Common Chemicals	227
10.3.4	Design of Cleaning Protocols	232
10.3.5	Evaluation of Cleaning Efficiency	234
10.3.6	Examples of Cleaning Agents for Specific Applications	235
10.3.7	Factors Influencing Membrane Cleaning Efficiency	239
10.4	Modeling of Cleaning Mechanisms	246
10.5	Current Trends and Challenges	247
	Acknowledgment	248
	References	248

11. US Regulatory Approval of Membrane Technology **255**

Joseph Scimeca

11.1	Introduction	255
11.2	US Regulatory Approval	256
11.2.1	Regulatory Framework: General	256

11.2.2	Food Contact Regulation	257
11.2.3	Feed Additive Regulation	261
11.3	Achieving US Legal/Regulatory Compliance	261
11.3.1	Approval Under an Existing Regulation	261
11.3.2	Prior to Choosing the Regulatory Pathway	262
11.3.3	Choosing the Regulatory Pathway	263
11.3.4	GMP and Regulatory Compliance	270
11.4	Concluding Remarks	271
	References	271
Index		273