

Contents

1	Membrane Processes	1
1.1	Membrane Separation	1
1.1.1	Pore Sizes	1
1.1.2	Operation Modes	3
1.1.3	Modules	5
1.1.4	Configurations	6
1.1.5	Fouling of Membranes	10
1.2	Mathematical Modelling of Membrane Processes	11
1.3	Diafiltration Process	14
1.3.1	Process Model	16
1.3.2	Fouling Models	18
1.3.3	Operational Modes of Diafiltration	19
1.3.4	Optimisation of Diafiltration Process	20
	References	24
2	Optimal Control Problem	27
2.1	Objective Functional	27
2.1.1	Typical Optimal Control Tasks	28
2.2	Constraints	30
2.3	Process Model	32
2.3.1	Linear Time-Invariant System	33
2.3.2	Input Affine System	34
2.4	Summary of Problem Definition	34
	References	35
3	Solution of Optimal Control Problems	37
3.1	Necessary Conditions for Optimality	37
3.2	Analytical Methods	41
3.2.1	Calculus of Variations	41
3.2.2	Dynamic Programming	42
3.2.3	Pontryagin's Minimum Principle	42

3.3	Numerical Methods	44
3.3.1	Control Vector Iteration	45
3.3.2	Boundary Condition Iteration	45
3.3.3	Complete Discretisation	46
3.3.4	Control Vector Parametrisation	47
3.3.5	Direct Multiple Shooting	49
3.4	Methods for Computing Gradients	50
3.5	Feedback Strategies for Optimal Control	52
3.5.1	Model Predictive Control	53
	References	55
4	Operation at Limiting Flux	57
4.1	Process Model and Definition of Optimisation Problem	57
4.1.1	Filtration Modes	58
4.1.2	Optimisation Problem.	61
4.2	Optimal Operation	62
4.2.1	Numerical Results	62
4.2.2	Theoretical Results	63
4.2.3	Discussion	66
4.3	Case Studies	69
4.3.1	Example 1	69
4.3.2	Separation of Pectin from Sugar	71
4.3.3	Purification of Soybean Water Extracts	74
4.4	Models Derived from Limiting Flux.	79
4.4.1	Viscosity Dependent Mass Transfer Coefficient.	79
4.4.2	Osmotic Pressure Model.	80
	References	82
5	Perfect Rejection of Both Solutes	83
5.1	Optimal Operation	83
5.2	Case Studies	85
5.2.1	Separation of Lactose from Proteins.	85
5.2.2	Albumin–Ethanol Separation.	95
	References	107
6	Perfect Rejection of Macro-Solute	109
6.1	Optimal Operation	109
6.2	Case Studies	114
6.2.1	Dye–Salt Separation.	114
6.2.2	Radiopaque–Ethylene Glycol Separation.	117
6.2.3	Sucrose–Sodium Chloride Separation	120
	References	128

7	Constant Incomplete Rejection of Solutes	129
7.1	Optimal Operation	129
7.2	Case Studies	132
7.2.1	Extended Limiting Flux Model	132
7.2.2	Three Component Separation	137
	References	140
8	General Membrane Model	143
8.1	Optimal Operation	143
8.1.1	Singular Control	145
8.2	Case Studies	147
8.2.1	Radiopaque–Ethylene Glycol Separation	147
8.2.2	Separation of Peptide from Trifluoroacetic Acid	148
	References	151
9	Conclusions and Future Research	153
9.1	Discussion	153
9.2	Conclusions	154
	References	155
	Index	157

<http://www.springer.com/978-3-319-20474-1>

Optimal Operation of Batch Membrane Processes

Paulen, R.; Fikar, M.

2016, XXV, 158 p. 60 illus., 42 illus. in color. With online files/update., Hardcover

ISBN: 978-3-319-20474-1