

Preface	ix
Acknowledgements	xi
Notation	xiii

TP 155-C7
A 75 1995

PART I. BASIC PRINCIPLES

Chapter 1. Prospect of Melt Crystallization 3

1.1	General Introduction	3
1.2	The Method of Melt Crystallization	6
1.3	Energy Efficiency, Environmental Impact	10
1.4	Process Options	11
1.5	Some Alternative Techniques	13

Chapter 2. Basic Principles in Crystallization 19

2.1	Introduction	19
2.2	Crystal Structure, Morphology	19
2.3	Crystal Growth Mechanisms	38

Chapter 3. Thermodynamic Limits 57

3.1	Solid-Liquid Equilibria	57
3.2	Product Purity	64
3.3	Recovery	68
3.4	Prediction of Eutectic Compositions	69
3.5	Prediction of Miscibility in the Solid Phase	73
3.6	Methods to Improve Recovery	78
3.7	Conclusions	83

Chapter 4. Kinetic Limits	85
4.1 Incorporation of Impurities into Crystals	85
4.2 Effective and Integral Distribution Coefficient	88
4.3 Purification Efficiency in Dependence on Process Conditions	93
4.4 Purity Attainable by One Single Crystallization Operation	97
Chapter 5. Further Purification	103
5.1 Scope of Techniques	103
5.2 Washing	104
5.3 Sweating	108
5.4 Recrystallization	115
PART II. PROCESS OPTIONS	
Chapter 6. Layer Growth	123
6.1 Normal Freezing	123
6.2 Operation Principle	128
6.3 Multistage Operation	135
6.4 Continuous Layer Growth	141
Chapter 7. Suspension Growth	145
7.1 Growth Kinetics	145
7.2 Proper Crystal Size	150
7.3 Agglomeration, Breakage	157
7.4 Approach to Technical Crystallizer	159
7.5 Crystallizer Configuration	162
7.6 Crystallizer Cascades	167
Chapter 8. Crystal-Melt Separation	173
8.1 The Washing Operation	173
8.2 Countercurrent Separation Columns Based on Gravity Transport	176
8.3 The Kureha Continuous Crystal Purifier	180
8.4 Wash-Columns Based on Forced Transport	181
8.5 Two-Stage Crystal-Melt Separation	191
8.6 Comparison between the Two Types of Wash-Columns	195

Chapter 9. On the Choice of the Process Option	197
9.1 Crystal Layer Processes	197
9.2 Suspension Growth Processes	201
9.3 Flow Diagrams for Suspension Growth	203
9.4 Comparison between Layer and Suspension Growth	209
Chapter 10. Melt Crystallization's Feasibility	213
10.1 Applicability	213
10.2 Collection of Physical Data	215
10.3 Orientating Tests	217
10.4 Laboratory-Scale Experiments	222
10.5 Pilot Plant Tests	227
10.6 Technological Study	232
PART III. TECHNICAL EQUIPMENT, APPLICABILITY	
Chapter 11. Technical Equipment for Crystal Layer Growth	239
11.1 Survey of Commercially Available Equipment	239
11.2 Commercial Static Layer Growth Processes	242
11.3 Commercial Dynamic Layer Growth Processes	250
Chapter 12. Technical Equipment for Suspension Growth	265
12.1 Survey of Commercially Available Equipment	265
12.2 Installations with Gravity Transport Columns	271
12.3 Installations with Forced Transport Columns	283
Chapter 13. Technical Applicability	291
13.1 Scope of Technique	291
13.2 Para-Xylene	292
13.3 Acetic Acid	298
13.4 Acrylic Acid	299
13.5 Cyclohexane	301

13.6	para-Dichlorobenzene	302
13.7	Maleic Anhydride	303
13.8	Phenol	304
13.9	Caprolactam	306
13.10	Naphthalene	312
13.11	para-Chloronitrobenzene	314
13.12	4,4-Diphenylmethanediisocyanate (MDI)	315
13.13	Survey of Technical Applications	316

Chapter 14. Technical Implementation of Melt Crystallization 323

14.1	Introduction	323
14.2	Increase of Product Purity	324
14.3	Increase of Recovery	325
14.4	Replacement of Solution Crystallization by Melt Crystallization	327
14.5	Recovery of Solvents	331

Chapter 15. Related Fields of Application 333

15.1	Introduction	333
15.2	Freeze Concentration	334
15.3	Dry Fractionation of Fats and Fatty Acids	342
15.4	Dewaxing of Oils	345
15.5	Use of Wash-Columns Outside Melt Crystallization	348

Chapter 16. Status of Development, Future Outlook 355

References 361

Index 377

About the Author 383