

## CONTENTS

	Page
<b>Chapter 1 Powder Processing—The Overall View</b>	<b>1</b>
1.1 Introduction	1
1.2 Academic and industrial research needs	2
Bibliography	7
<b>Chapter 2 Characterizing the Single Particle</b>	<b>9</b>
2.1 Introduction	9
2.2 Particle density	11
2.3 The microscope	12
2.4 Sampling	15
2.5 Size measurement	18
2.6 Particle shape	21
2.7 Worked examples	27
2.8 Problems	30
References	31
<b>Chapter 3 Characterization of Powders</b>	<b>35</b>
3.1 Introduction	35
3.2 Sampling	37
3.3 Particle size measurement	40
3.4 Distributions of other particle properties	62
3.5 Problems with answers	66
Notation	67
References	68
<b>Chapter 4 Mixing and Segregation in Powders</b>	<b>71</b>
4.1 Introduction	71
4.2 The Statistics of solids mixing	72
4.3 The segregation of particulate materials	76
4.4 The selection of mixers	79
4.5 The specification of mixer performance	83
4.6 The mixing of cohesive particulate materials	83
4.7 Conclusions	86
4.8 Worked examples	87
Notation	89
Acknowledgment	89
References	90
<b>Chapter 5 The Storage and Flow of Powders</b>	<b>91</b>
5.1 Introduction	91
5.2 Types of storage hoppers	92
5.3 Disadvantages of core flow hoppers	93
5.4 Advantages of mass flow hoppers	98
5.5 Disadvantages of mass flow hoppers	99
5.6 Characterizing the flowability of particulate materials	99
5.7 The analogy between hopper design and soil mechanics	106
5.8 The prediction of stresses inside the hopper	107
5.9 The third stage of the hopper design procedure	108
5.10 Flow factor charts	109
5.11 Other types of mass flow hopper	113
5.12 Time consolidation	115

	5.13	Filling and emptying hoppers	116
	5.14	Problems	117
		Bibliography	118
<b>Chapter 6</b>		<b>Gas Fluidization</b>	<b>119</b>
	6.1	Introduction	119
	6.2	Particle and Powder properties	121
	6.3	Minimum fluidization velocity and bed pressure drop	124
	6.4	Slugging fluidized beds and bubble rise velocities	125
	6.5	Bed expansion	127
	6.6	Entrainment from fluidized beds	127
	6.7	Heat transfer	129
	6.8	Fluid bed chemical reactors	130
	6.9	Applications	132
	6.10	Worked example: design of a fluidized bed heater	136
		Notation	140
		References	142
<b>Chapter 7</b>		<b>Pneumatic Conveying</b>	<b>143</b>
	7.1	Introduction	143
	7.2	Dilute-phase and dense-phase transport	143
	7.3	Dilute-phase conveying	144
	7.4	Dense-phase conveying	155
	7.5	Matching the system to the powder	162
	7.6	Worked example: design of dilute-phase system	162
	7.7	Problems	167
		Notation	168
		References	169
<b>Chapter 8</b>		<b>Solid-Gas Separation.</b>	<b>171</b>
	8.1	Introduction and principles	171
	8.2	General characteristics of gas cleaners	172
	8.3	Aero-mechanical dry separators	175
	8.4	Aero-mechanical wet separators (scrubbers)	181
	8.5	Electrostatic precipitators	184
	8.6	Filters	188
	8.7	Problems with answers	190
		Notation	191
		References	192
<b>Chapter 9</b>		<b>Size Enlargement</b>	<b>193</b>
	9.1	Introduction	193
	9.2	Particle-particle bonding	196
	9.3	Bonding by mechanical force	203
	9.4	Size enlargement (methods and equipment)	207
		References	225
<b>Chapter 10</b>		<b>Size Reduction</b>	<b>227</b>
	10.1	Introduction	227
	10.2	Particle failure and product behaviour	229
	10.3	Models predicting energy requirements for size reduction	
		Processes	234
	10.4	Prediction of the size reduction process	235
	10.5	Material properties and selection criteria for the size reduction process	237
	10.6	Stressing mechanisms	242
	10.7	Crushers and roll mills	243
	10.8	Impact, jet and classifier mills	249
	10.9	Ball, rod and related mills	269
	10.10	Miscellaneous size reduction machines	275

	10.11 Wet and wear protection	276
	10.12 Industrial comminution systems	279
	10.13 Wear and wear protection	290
	10.14 Summary	293
	10.15 Worked example	293
	10.16 Problems	295
	References	296
<b>Chapter 11</b>	<b>Explosion and Fire Hazards of Powders</b>	<b>299</b>
	11.1 Introduction	299
	11.2 Characteristics of dust explosions	300
	11.3 Explosibility tests and their application	303
	11.4 Sources of ignition and their avoidance	312
	11.5 Fires in powders	316
	11.6 Explosion protection	320
	11.7 Application to industrial processes	327
	11.8 Worked examples	330
	References	333
<b>Chapter 12</b>	<b>Health Risks of Fine Powders</b>	<b>335</b>
	12.1 Introduction	335
	12.2 Size of airborne dust	336
	12.3 Dust and the respiratory tree	336
	12.4 Other routes into the body	339
	12.5 Nature of risk to health	340
	12.6 Exposure related risk to health	342
	12.7 Air sampling techniques	346
	12.8 Air standards	348
	12.9 The control of risk to health	350
	12.10 Personal protective equipment (PPE)	356
	12.11 Use of controls	361
	12.12 Examples of dust control	363
	Appendix	364
	Glossary and acronyms	365
	References	366
<b>Chapter 13</b>	<b>Flow of Liquid-Solid Suspensions</b>	<b>367</b>
	13.1 Introduction	367
	13.2 Settling of suspensions	368
	13.3 Homogeneous suspensions	370
	13.4 Heterogeneous suspensions	387
	13.5 Conclusions	391
	Notation	391
	References	393
<b>Chapter 14</b>	<b>Solid-Liquid Separation</b>	<b>395</b>
	14.1 Introduction	395
	14.2 Pre-treatment of suspensions	401
	14.3 Equipment and principles	404
	14.4 Sizing and scale-up of equipment	419
	Notation	427
	References	427
<b>Index</b>		<b>429</b>