

Contents

List of Contributors	xv
Preface	xvii
1 Introduction	1
Bob Hargitt	
1.1 Early history	1
1.2 The growth of carbonates – production	3
1.3 Technological development	4
1.3.1 Carbon dioxide	4
1.3.2 Sweeteners	5
1.3.3 Flavours and colours	7
1.3.4 Packaging	8
1.4 Recent technological development	10
1.5 The growth of carbonates – consumption	10
1.6 Changing public perception and future challenges	13
Acknowledgements	14
Bibliography	14
2 Water treatment	16
Walter Tatlock	
2.1 Introduction	16
2.2 Water quality	18
2.3 Town mains water	21
2.4 Boreholes	23
2.5 How to achieve the desired water quality	24
2.6 Sand filtration	25
2.7 Coagulation	27
2.8 Alkalinity reduction	28
2.9 Membrane filtration	29
2.10 Chlorination and carbon filtration	34
2.11 Iron removal	35
2.12 Nitrate removal	36
2.13 Polishing filters	38
2.14 Ultraviolet systems	41
2.15 Ozone technology	42

CONTENTS

2.16	De-aeration	43
2.17	Factory water distribution systems	44
2.18	Factory water systems	46
	References	46
3	Ingredients and formulation of carbonated soft drinks	48
	Barry Taylor	
3.1	Introduction	48
3.2	Factors influencing development of the industry	48
3.3	The move towards standardisation	51
3.4	The constituents of a soft drink	52
3.5	Water	54
3.5.1	Requirements	54
3.5.2	Quality of fresh water	55
3.5.3	Water hardness	55
3.5.4	Water treatment	55
3.5.5	Water impurities and their effect	55
3.5.5.1	Suspended particles	55
3.5.5.2	Organic matter	56
3.5.5.3	High alkalinity	56
3.5.5.4	Nitrates	57
3.6	Saccharides and high-intensity sweeteners	57
3.6.1	Bulk sweeteners	57
3.6.2	Intense sweeteners	58
3.7	Carbon dioxide	58
3.8	Acidulants	59
3.8.1	Citric acid	60
3.8.2	Tartaric acid	60
3.8.3	Phosphoric acid	61
3.8.4	Lactic acid	61
3.8.5	Acetic acid	62
3.8.6	Malic acid	62
3.8.7	Fumaric acid	62
3.8.8	Ascorbic acid	63
3.9	Flavourings	63
3.9.1	Flavourings and legislation	65
3.9.2	Flavourings in application	66
3.9.3	Water-miscible flavourings	66
3.9.3.1	Flavouring mixtures	66
3.9.3.2	Flavouring essence	67
3.9.3.3	Flavouring extract	68
3.9.4	Water-dispersible flavourings	68
3.9.4.1	Brominated vegetable oil (BVO) emulsions	72

CONTENTS

3.10	Colours	73
3.11	Preservatives	75
3.11.1	Micro-organisms and beverages	76
3.11.2	Sulphur dioxide	77
3.11.3	Benzoic acid and benzoates	78
3.11.4	Sorbic acid and sorbates	79
3.12	More functional ingredients	79
3.12.1	Stabilisers	79
3.12.2	Saponins	80
3.12.3	Antioxidants	80
3.12.4	Calcium disodium EDTA	81
3.13	Retrospective investigation of a soft drink	81
3.14	Food safety	84
3.15	Future trends	85
	Bibliography	86
4	Syrup preparation and syrup room operations	87
	John Horman	
4.1	Introduction	87
4.2	Syrup composition	88
4.3	Syrup rooms and proportioning systems	90
4.4	The modern syrup room	91
4.5	Instrumentation	96
4.6	Sugar	97
4.6.1	Sugar dissolving	97
4.6.2	Liquid sugar storage	99
4.7	Pre-mixes	100
4.8	Pasteurisation	101
4.8.1	Tunnel pasteurisation	101
4.8.2	Flash pasteurisation	104
4.9	Clean-in-place (CIP) systems	105
4.10	Process plant hygiene requirements	108
4.11	Syrup room building design	109
4.12	Future developments	110
5	Carbon dioxide, carbonation and the principles of filling technology	112
	David P. Steen	
5.1	Introduction	112
5.2	Carbon dioxide	113
5.3	Production of carbon dioxide	115
5.3.1	Fermentation	116

CONTENTS

5.3.2	Flue gas recovery	116
5.3.3	Membrane separation systems	118
5.4	Specification of carbon dioxide	119
5.5	Delivery to the customer	120
5.6	Carbon dioxide storage	123
5.7	Carbonation	124
5.7.1	Basic considerations	124
5.7.2	Carbonation measurement	126
5.7.3	De-aeration	128
5.8	Carbonation systems	129
5.8.1	Carbonators	129
5.8.2	Gas bubble sparging	131
5.8.3	Bubbles in a glass of carbonated liquid	133
5.8.4	Process control	133
5.9	Filling principles	133
5.9.1	Gravity filler	135
5.9.2	Counter-pressure filler	137
5.10	Nitrogen	142
	Further reading	142
6	Modern filling systems for carbonated soft drinks	144
	Andrew Wilson and John Medling	
6.1	Introduction	144
6.2	Modern carbonation systems	147
6.3	Counter-pressure fillers	149
6.3.1	Operation	149
6.3.2	Level filling	154
6.4	Glass bottle filling	156
6.4.1	Operation	156
6.4.2	Bottle burst protection	159
6.5	PET (polyethylene terephthalate) bottle filling	161
6.5.1	Operation	161
6.5.2	Size changing	162
6.6	Can filling	166
6.6.1	The volumetric can (VOC) filler	166
6.6.2	System expansion – the VOC-C can filler	168
6.6.3	Product level- and pressure-control system in a free-standing product tank	170
6.6.3.1	Level control	170
6.6.3.2	Filling pressure control	170
6.6.4	Procedural steps of the filling cycle	170
6.6.4.1	Flushing phase I	171
6.6.4.2	Flushing phase II	171

CONTENTS

6.6.4.3	Pressurising	171
6.6.4.4	Filling	171
6.6.4.5	Snifting	172
6.6.4.6	Recharging the metering chamber	172
6.6.4.7	CIP cleaning	173
6.7	Other filler options	174
6.8	Clean-in-place	175
6.9	Filler hygienic design	177
6.10	Conclusions	178
7	Bottle design and manufacture and related packaging	181
	David Syrett	
7.1	Introduction – the objectives of packaging	181
7.2	Glass	182
7.2.1	History of glass making	182
7.2.2	Bottle supplier identification marks	184
7.2.3	Bottle design and headspace considerations	184
7.2.4	Glass bottle manufacturing processes	185
7.2.4.1	The melting process	185
7.2.4.2	Glass bottle forming	187
7.2.5	Glass quality faults	189
7.2.5.1	Critical defects	189
7.2.5.2	Major defects	189
7.2.5.3	Minor defects	190
7.2.6	Single and multiple trip bottles	192
7.2.7	Lightweighting	193
7.2.8	Recycling	194
7.3	Plastic bottles	194
7.3.1	Introduction – advantages and limitations	194
7.3.1.1	Advantages	194
7.3.1.2	Limitations	1951
7.3.2	Polyethylene terephthalate	195
7.3.3	History	195
7.3.4	PET bottles today	196
7.3.4.1	Preforms	196
7.3.4.2	Bottle blowing	196
7.3.5	Multilayer and barrier coating	198
7.3.6	Carbonation loss	198
7.3.7	Permeability of polymers	198
7.3.8	Recycling methods	200
7.4	Closures for carbonated soft drinks	200
7.4.1	Introduction	200
7.4.2	Headspace pressure	201

CONTENTS

7.4.3	Roll on metal closures	202
7.4.4	Plastic closures	202
7.4.5	Development of the PET bottle finish	203
7.4.6	Crown corks (pry off/twist off)	205
7.4.7	Other closures (vacuum lug/rip off)	205
7.5	Cans and ends	206
7.5.1	Introduction	206
7.5.2	The can making process	206
7.5.2.1	Front-end processes	206
7.5.2.2	Decoration processes	207
7.5.2.3	Back-end processes	207
7.5.3	Graphics decoration	208
7.5.4	Ends	208
7.5.5	The double seam	208
7.5.6	Can end stress corrosion	208
7.6	Labels and labelling	209
7.6.1	Introduction	209
7.6.2	Paper manufacturing	210
7.6.3	Labelling	210
7.6.4	Patch labellers	212
7.6.5	Wraparound labellers	213
7.6.6	Sleeving	215
7.6.7	Labelling in production	215
7.6.8	Date coding (ink jet/laser)	216
7.7	Future trends – putting it all together	216
	Further reading	217
8	Secondary packaging considerations	218
	David Rose	
8.1	Introduction	218
8.2	Requirements of the supply chain	219
8.2.1	Overview	219
8.2.2	Major multiple	221
8.2.2.1	Pallet receipt	221
8.2.2.2	Pallet breakdown and load picking	221
8.2.2.3	Bar codes	221
8.2.2.4	Store delivery	222
8.2.3	Cash & Carry	224
8.2.3.1	Pallet breakdown and load picking	224
8.2.3.2	Pack graphics	224
8.2.3.3	Bar codes	224
8.2.4	Bulk break	224
8.2.5	Poor packs – no sale?	225

CONTENTS

8.2.6	Material – performance versus specification	225
8.3	Pack styles	227
8.3.1	Shrink wrap	227
8.3.2	Trade ready display unit (TRDU)	228
8.3.3	Shelf ready packing	229
8.3.4	Returnable crate	231
8.4	Shrink film production	231
8.4.1	Film considerations	231
8.4.2	Shrink wrap packers	233
8.4.3	Printed shrink wrap	234
8.5	Corrugated fibreboard	239
8.5.1	Specifications	239
8.5.2	Corrugated board manufacture	240
8.6	Stretch wrap	240
8.6.1	Material	240
8.6.2	Stretch wrapping systems	244
8.6.3	Pallet wrapping	247
8.7	Pallets and pallet stacking	248
8.7.1	Pallets	248
8.7.2	Pallet stacking	248
8.8	Case and pallet labelling	249
8.9	Getting it wrong	253
8.10	Developments and testing	257
8.11	Putting it all together	258
9	Production systems	259
	David Steen	
9.1	Introduction	259
9.2	Philosophy of line layouts	259
9.3	Glass bottle filling lines	260
9.4	Can filling lines	267
9.5	PET bottle filling lines	268
9.6	Conveying systems	270
9.7	Inspection systems	272
9.8	Breakdown characteristics	274
9.9	Line control and management systems	277
9.10	Complete factory layouts	280
9.11	Buildings	283
9.12	Performance measurement and benchmarking	285
9.13	Future trends	288
	Further reading	289

CONTENTS

10 Production planning and distribution	290
Philip A. Wood	
10.1 Introduction	290
10.2 Supply chain principles	291
10.2.1 Make versus buy	292
10.2.2 Make to order or make to stock	293
10.2.3 Purchasing	294
10.2.4 The soft drinks supply chain	296
10.2.5 The bullwhip effect	298
10.3 Forecasting	299
10.3.1 Forecast breakdown or types	300
10.3.2 Forecast preparation and accuracy	301
10.4 Planning	301
10.4.1 The planning and order cycle	301
10.4.2 Central or local planning	304
10.5 Warehousing	307
10.5.1 Environment	314
10.5.2 Stock control	314
10.6 Transport and legislation	315
10.7 Measuring supply chain performance	316
10.7.1 Service	316
10.7.2 Costs	317
10.7.3 People	317
10.7.4 Resources	317
10.8 Conclusions and future developments	317
Bibliography	318
11 Quality, environment and food safety systems	319
Ray Helliwell	
11.1 Why have systems?	319
11.1.1 Definitions	319
11.1.2 Space shuttle fails	319
11.1.3 Risk management	320
11.1.4 A solution?	320
11.2 Management control	321
11.2.1 Constraints – legislation	321
11.2.2 Stakeholders determine your future	321
11.2.3 Size matters	322
11.2.4 Experts, but not owners	322
11.3 Management systems	323
11.3.1 Four stages	323
11.3.2 Decisions	323

CONTENTS

11.3.3	Make the product	323
11.3.4	Test and record results	324
11.3.5	Review	324
11.4	International management systems – why?	325
11.4.1	Notice board systems	325
11.4.2	Detect and protect	325
11.4.3	Automation = automatically wrong	326
11.4.4	Quantity and quality	326
11.4.5	Systems converge	327
11.5	The standards – a brief background	327
11.5.1	ISO 9001 is the master	327
11.5.2	Customer pressure	327
11.5.3	Customer audits	328
11.5.4	A standard is born	328
11.5.5	Is ISO 22000 necessary?	329
11.5.6	Other standards	330
11.5.7	Systems director	330
11.5.8	Standards improvement mechanisms	331
11.6	ISO Standards – common elements	331
11.7	The quality management system (QMS) – BS EN ISO 9001	332
11.7.1	Resource management [6]	332
11.7.2	Contract review [7.2]	332
11.7.3	Purchasing [7.4]	332
11.7.4	Product realization [7]	332
11.7.5	Product development [7.3]	333
11.7.6	Control or test [7.5.2]	333
11.7.7	Quality assurance – process control	333
11.7.8	Quality control – sample testing	334
11.7.9	Warehousing [7.5.5] and distribution [7.5.1]	335
11.7.10	Control of non-conforming product [8.3]	335
11.8	The food safety management system (FSMS) – BS EN ISO 22000	335
11.8.1	The standard of the future?	335
11.8.2	Policy [5.2]	335
11.8.3	Pre-requisite programmes [7.2]	336
11.8.4	Product characteristics [7.3.3]	336
11.8.5	HACCP [7.6]	336
11.8.6	Decision tree	337
11.8.7	No foolproof systems	339
11.9	The environmental management system (EMS) – BS EN ISO 14001	339
11.9.1	Drains and skips – duty of care	339
11.9.2	Producer responsibility	339
11.9.3	Climate change levy	340
11.9.4	Pollution prevention and control permits	340
11.9.5	EMS policy [4.2]	340
11.9.6	Aspects and impacts [4.3.1]	340

CONTENTS

11.9.7	Significance [4.3.1(b)]	341
11.9.8	Legislation updates [4.3.2]	341
11.9.9	Emergency preparedness and response [4.4.7]	341
11.10	Systems – a summary	342
	Index	343

Colour plate section appears after page 174