

Table of Contents

Preface	5
Authors and Editor	7

Pre-sterilization of products

1	Basic principles	
1.1	Fundamentals of UHT and HTST sterilization of foodstuffs	
	<i>H. Reuter</i>	
1.1.1	Introduction	25
1.1.2	Deduction of optimal sterilizing conditions from reaction kinetics	25
1.1.3	Improvement of sterilization conditions by pre-sterilization	28
1.1.4	Calculation of thermal effect in sterilization	31
1.1.5	Advantages and disadvantages of aseptic processing	31
1.1.6	References	32
1.2	Ohmic heating of particulate food products	
	<i>W. Reitler</i>	
1.2.1	Introduction	33
1.2.2	Indirect heating of particulate food products	33
1.2.3	Ohmic heating of particulate food products	34
1.2.4	Computer simulation of the heating behavior of heterogeneous foodstuff suspensions	37
1.2.5	References	42
1.3	Dielectric heating of foodstuffs and temperature distribution in the product	
	<i>H. Reuter</i>	
1.3.1	Introduction	43
1.3.2	Effect of the electromagnetic alternating field	43
		11

Table of contents

1.3.3	Energy conversion	45
1.3.4	Temperature distribution in the product	48
1.3.4.1	Penetration depth	49
1.3.4.2	Temperature change in the product	50
1.3.4.3	Influence on shape, edge or corner effect	52
1.3.4.4	Dielectric unhomogeneity of foodstuffs	52
1.3.4.5	Engineering reasons for nonuniform temperature distribution	53
1.3.4.6	More uniform temperature distribution	54
1.3.5	Industrial applications	55
1.3.6	References	57
2	Process and equipment for UHT and HTST pre-sterilization	
2.1	Tubular heat exchangers systems for liquid foods with solid particles and criteria for structural behavior	
	<i>N. Nicolaus</i>	
2.1.1	Comparing views: The product - expectations and requirements	59
2.1.2	Application of tubular heat exchangers - system concept	61
2.1.3	Tubular heat exchangers - test stand and test run	63
2.1.4	Findings from test results and presentation of a nomogram for getting the degree of damage	67
2.2	Thermal stabilization of soups and sauces containing particles by double flow processing	
	<i>E. Plett</i>	
2.2.1	Characteristics of aseptic processing technology	69
2.2.2	Areas of application	69
2.2.3	Heat-transfer systems for aseptic technology	70
2.2.3.1	Criteria for construction	71
2.2.3.2	Possible uses of indirect heat-exchangers	71
2.2.3.3	Possible uses of direct heat exchangers	75
2.2.4	System family for aseptic processing technology	76
2.2.5	Possibilities for combining different heat exchangers	79
2.2.6	Alternative processes for continuous flow-sterilization of foodstuffs with particles	79
2.2.7	Outlook	84

2.3	Single-Flow Fraction Specific Thermal Processing ("Single-Flow FSTP") of liquid foods containing particulates <i>W.F. Hermans</i>	
2.3.1	Introduction	87
2.3.2	Single-Flow Fraction Specific Thermal Processing (Single-Flow FSTP)	87
2.3.3	Selective Holding Sections (SHS)	88
2.3.4	Time-temperature profiles and processing values	89
2.3.5	Stork STERIPART System	91
2.3.6	Stork STERIPART Pilotplant	92
2.4	New system for the sterilization of particulate food products by ohmic heating <i>P. J. Skudder</i>	
2.4.1	Introduction	95
2.4.2	Principle of ohmic heating	95
2.4.2.1	Design of the ohmic heater	97
2.4.2.2	Measurement of electrical conductivity of particulate food products	97
2.4.2.3	Temperature control of the ohmic heater	97
2.4.2.4	Aseptic processing using the ohmic heater	99
2.4.3	Product quality	101
2.4.4	Conclusions	105
2.4.5	Acknowledgements	106
2.4.6	Reference	106
2.5	Pasteurization and sterilization of unpackaged liquid food containing solid parts in a continuous process by means of microwaves <i>K. Koch</i>	
2.5.1	Introduction	107
2.5.2	Heat treatment by means of microwaves	109
2.5.3	Constructional requirements for an even temperature distribution inside the product	110
2.5.4	Sterilization under atmospheric conditions	111
2.5.5	Sterilization of unpackaged cubed food by means of microwaves	112

Table of contents

2.5.6	Measuring techniques	114
2.5.7	Hygienic operating conditions for microwave lines for the sterilization of unpackaged food containing solid (cubed) parts	115
2.5.8	Safety aspects	115
2.5.9	Performance data	115
2.5.10	Conclusion	117
3	Sterile conveyance of liquids	119
	<i>Ph. Berdelle-Hilge</i>	
4	Products	
4.1	Soups and sauces UHT processed and aseptically packed	
	<i>F. Wilhelm</i>	
4.1.1	Introduction	125
4.1.1.1	Importance of heat sterilized soups and sauces	125
4.1.1.2	Classification of heat sterilized soups and sauces	125
4.1.2	Heat processing of soups and sauces	126
4.1.2.1	Conventional sterilization	126
4.1.2.2	UHT heating	126
4.1.3	Aseptic packing systems	128
4.1.3.1	Combibloc	128
4.1.3.2	Tetra -Pak, Pure-Pak	128
4.1.3.3	New systems under development	128
4.1.4	Product quality and quality assurance	129
4.1.4.1	Ingredients suitable for UHT processing	129
4.1.4.2	Recipes, working instructions and product descriptions	132
4.1.4.3	Minimum shelf-life-date of "best before"	133
4.1.4.4	Sensory evaluation of products and corresponding standard methods	133
4.1.5	Varieties for UHT processed and aseptically filled soups and sauces	134
4.1.5.1	Soups	134
4.1.5.2	Sauces	134
4.1.6	References	135
	Annex 1	136

	Annex 2	
	Functional properties of starches	
	Suitability test - check list	137
	Annex 3	
	Functional properties of hydrocolloids (except starches)	
	Suitability test - check list	139
	Annex 4	
	Raw material and ingredients specification	140
	Annex 5	
	Quality assessment heat sterilized soups	141
	Annex 6	
	Quality assessment heat sterilized soups - conventional sterilization	142
4.2	Flavorings for UHT-treated and aseptically packed soups and sauces	
	A. van Eijk	
4.2.1	Flavor and flavorings	145
4.2.2	Physico-chemical interactions	146
4.2.3	Flavoring of UHT-treated soups and sauces	150
4.2.4	Summary	151

Aseptic packaging

5	Processes for packaging materials sterilization and system requirements	
	H. Reuter	
5.1	Introduction	155
5.2	Sterilization of the packaging material	156
5.2.1	Time-law	156
5.2.2	Commercially applied sterilization processes	157
5.2.3	Required germ reduction of sterilization process	159
5.2.4	Non-sterility rate in packaging material sterilization	160
5.3	Aseptic packaging machines	160

Table of contents

5.3.1	Consideration of faults of pre-sterilized and aseptically packed products	160
5.3.2	Acceptable rate of total error	162
5.4	Commercially applied aseptic packaging systems	162
5.5	Packaging materials	162
5.6	Pros and cons of aseptic packaging	164
5.7	Reference	165
6	Aseptic filling and packaging	
6.1	Roll-fed carton packaging	
	<i>E. Schoefert</i>	
6.1.1	Introduction	167
6.1.2	Why carton packages from the roll?	168
6.1.3	Packaging material	168
6.1.4	Aseptic filling process	169
6.1.4.1	Sterilization of the filling machine	169
6.1.4.2	Sterilization of the packaging material	171
6.1.4.3	Forming, filling, sealing, and separating the packages	172
6.1.4.4	Filling with head space	173
6.1.4.5	Final folding of the separated packages	174
6.1.5	The Tetra Brik Aseptic TBA/8 filling machine	175
6.1.5.1	Filling machine functions	175
6.1.5.2	Safety and hygiene	177
6.1.5.3	Available package volumes and sizes	177
6.1.6	Summary	178
6.2	Carton packaging from sleeves	
	<i>A. E. Ostermann</i>	
6.2.1	Introduction	179
6.2.2	Pre-made sleeve	179
6.2.3	Combibloc aseptic FFS machine	180
6.2.3.1	Container base forming	181
6.2.3.2	Machine sterilization	181
6.2.3.3	Container sterilization	182
6.2.3.4	Filling system	183
6.2.3.5	Container top closure	184
6.2.4	Combibloc system flexibility	184

6.2.5	Field of application	184
6.2.6	Future options	187
6.2.7	References	187
6.3	Vertical form-fill-seal machines for bags	
	<i>S. Linder</i>	
6.3.1	Bag sizes and secondary packaging	189
6.3.2	Machines and operating principle	189
6.3.3	Product range and filling systems	191
6.3.4	Packaging materials	192
6.3.5	Summary	194
6.4	Thermoform filling and sealing machines for plastic cups	
	<i>S. Linder</i>	
6.4.1	Introduction	197
6.4.2	Package related machine design	197
6.4.3	Operating principle	198
6.4.4	Filling systems	201
6.4.5	Packaging materials	202
6.5	Thermoform filling and sealing machines for plastic cups with steam sterilization	
	<i>K. Walter</i>	
6.5.1	Introduction	207
6.5.2	Possible sterilization methods	207
6.5.3	Selection of the method	208
6.5.4	Description and operating sequence	209
6.5.4.1	Base material degerming	209
6.5.4.2	Lidding material degerming	210
6.5.4.3	Economy	211
6.5.5	Results	211
6.5.6	Metering method	211
6.5.7	Concluding remarks	212

Table of contents

6.6	Aseptic handling of particulate products	
	<i>J. Perigo</i>	
6.6.1	Introduction	213
6.6.2	Problems	213
6.6.3	Solutions	215
6.6.3.1	Process solids in viscous carrying medium	215
6.6.3.2	Sterilize extra water separately and mix at filler	215
6.6.3.3	Select a suitable feed pump for the solids fraction	215
6.6.3.4	Select a backpressure system which handles particles without damage	216
6.6.3.5	Select pipeline valves which handle particles without damage	219
6.6.3.6	Design fillers to minimize particle damage	220
6.6.3.7	Develop simplified interface between the UHT process and the aseptic packaging system	221
6.6.3.8	Functions of a surge tank	222
6.6.4	Conclusions	224
6.7	Manufacturing, filling and sealing of plastic bottles in the blow mould	
	<i>L. Zimmermann</i>	
6.7.1	General information	225
6.7.2	Packagable fill products, volumes and capacities	225
6.7.3	Suitable plastic materials	226
6.7.4	Sterility of the plastic material	226
6.7.5	Process engineering and measures to maintain sterility	226
6.7.6	Forming of the containers in the blow mould	226
6.7.7	Aseptic filling in the blow mould	228
6.7.8	Sealing in the blow mould	229
6.7.9	Machine systems	230
6.8	Aseptic packaging in glass and plastic bottles	
	<i>N. Buchner</i>	
6.8.1	For which containers is aseptic filling of interest?	235
6.8.2	Advantages of aseptic packaging in glass and plastic containers	236
6.8.3	Aseptic plants	237
6.8.4	Sterilization of containers	237

6.8.5	Sterilization of closures	239
6.8.6	Filling the containers	240
6.8.7	Closing the containers	241
6.8.8	Characteristics of the procedure and of the plant	241
6.8.9	Plants in practice	242
6.8.10	Pre-requisites for the containers	242
6.9	Aseptic packaging line for aerosol cans	
	<i>R. Nicolas</i>	
6.9.1	Sterilization of cans	245
6.9.2	Aseptic filling of cans	245
6.9.3	Capping and gassing of cans	250
6.9.4	Conclusion	252
6.10	Bulk aseptic packaging, the bag-in-box system	
	<i>E. Plett</i>	
6.10.1	Summary	255
6.10.2	Aseptic packaging	255
6.10.3	The filler	256
6.10.4	The bag	259
6.10.5	Aseptic emptying	262
6.10.6	Overall Safety	264
6.11	Sterile room techniques in the food industry	
	<i>H. Blümke</i>	
6.11.1	Introduction	265
6.11.2	Definition of sterile room technique	265
6.11.3	Particles	265
6.11.4	Sources of contamination	266
6.11.5	Filter systems	267
6.11.6	Air flow in sterile room technique	268
6.11.7	Sterile room specifications	269
6.11.8	Examples for application of sterile room technique	269

Table of contents

6.11.9	Conclusion	270
6.11.10	References	270
7	Packaging materials for aseptic packaging	
7.1	Gamma sterilization of packaging	
	<i>P.J.G. Neijssen</i>	
7.1.1	Introduction	271
7.1.2	Gamma radiation	272
7.1.3	Gamma sterilization process	273
7.1.4	Influence of gamma radiation on materials	273
7.1.5	Gamma sterilization of packaging materials	275
7.1.6	References	279
7.2	Thermoformable barrier sheets for shelf stable container in dairy applications	
	<i>B. de Groof</i>	
7.2.1	Abstract	281
7.2.2	Introduction	281
7.2.3	Production of thermoformable barrier sheets and shelf stable packs	282
7.2.3.1	Formable barrier sheet	282
7.2.3.2	Production of shelf stable packs	283
7.2.4	Barrier performance	284
7.2.5	Applications of shelf stable packs	285
7.2.5.1	Chilled chain	286
7.2.5.2	Modified atmosphere packaging	286
7.2.5.3	Hot fill packaging	288
7.2.5.4	Aseptic packaging	288
7.2.5.5	Retortable packaging	290
7.2.6	Environment	291
7.2.7	Conclusion	291

7.3	Glass for aseptic packaging	
	<i>B. Sachs</i>	
7.3.1	Introduction	293
7.3.2	Advantages of aseptic filling method	293
7.3.3	Advantage of using glass for aseptic filling methods	294
7.3.4	The aseptic market	294
7.3.4.1	Europe	294
7.3.4.2	Eastern countries	294
7.3.5	Benefits for economy and environment	295
7.3.6	Market share of returnable and disposable glass packaging for drinks	295
7.3.7	Glaseptik - a basis for achieving market targets	296
7.3.8	Responsibility in production of glass containers	296
8	Quality protection	
8.1	Hazard analysis in aseptic good manufacturing practice	
	<i>D. Rose</i>	
8.1.1	Summary	297
8.1.2	Introduction	297
8.1.2.1	Good Manufacturing Practice (GMP)	297
8.1.2.2	HACCP concept	298
8.1.3	Components of HACCP analysis	298
8.1.4	Analysis	299
8.1.4.1	Flow diagram	299
8.1.4.2	Essential product characteristics	299
8.1.4.3	Process analysis	300
8.1.4.4	Devising control options	303
8.1.5	Stylized flow diagram	303
8.1.6	Conclusion	305
8.1.7	References	305

8.2	Testing of aseptic machines for their efficiency of sterilization of packaging materials by means of hydrogen peroxide	
	G. Cerny	
8.2.1	Importance of packaging sterilization in aseptic packaging	307
8.2.2	Origin of microbial problems in aseptic processing and packaging	307
8.2.3	Methods for sterilization of packaging materials	307
8.2.4	Reasons for establishing testing methods	308
8.2.5	Test microorganism and its culture conditions	309
8.2.6	Count reduction testing procedure	310
8.2.7	Endpoint test procedure	311
8.2.8	Concluding remarks	313