CONTENTS

Pre	oface	ix
Ac	knowledgments	xiii
Nc	te about Units	XV
1	SHELL-AND-TUBE HEAT EXCHANGERS-I: GENERAL	1
	Introduction	1
	Nomenclature and Parts	2
	Principal Types of Shell-and-Tube Constructions	5
	Types of Tube, Tube Thickness, Pitch, Layout Angle, and Tube Count	10
	Baffles, Baffle Cut, Spacing, and Orientation	22
	Uses of Multi-Pass Units	37
	Tubesheet, Double Tubesheet	38
	Tie-Rods and Spacers	39
	Seal Strips	40
	Nozzles	41
	Flanges	42
	Expansion Joints	42
	Packing Glands and Gaskets	43
	Vents and Drain Connections	44
	Pressure Relief Devices	45
	Supports and Lifting Lugs	46
	Insulation	47
	Heat Exchanger Specification Sheet	48

Bibliografische Informationen http://d-nb.info/860151867



iii

iv	COI	NT	EN	TS
----	-----	----	----	----

References 53 2 SHELL-AND-TUBE HEAT EXCHANGERS—II: PROCESS DESIGN WITHOUT PHASE CHANGE 55 Introduction 55 Flow through Shell and Tubes 55 Overall Heat Transfer Coefficient 60 Log Mean Temperature Difference ΔT _{LMTD} and Corrections Factor F _T 64 Average and Pipe Wall Temperatures 76 Allocation of Fluids to Shell Side and Tube Side 77 Rating and Design 85 Salient Features of Shell-Side Design Methods 87 Effects of Various Geometrical and Process Parameters 94 Allowable Pressure Drop 108 Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers 112 Coolers and Cooling Water 113 Closed Feedwater Heaters 116 Double Pipe Heat Exchangers 120 Nomenclature 121 References 123 3 SHELL-AND-TUBE HEAT EXCHANGERS—III: PROCESS DESIGN WITH PHASE CHANGES 123 SHELL-AND-TUBE HEAT EXCHANGERS—III: PROCESS DESIGN WITH PHASE CHANGE 7 Condensers 126 Reboilers 166 Evaporators a		Bid Evaluation Developments and Future Trends in Heat Exchangers	50 51
2 SHELL-AND-TUBE HEAT EXCHANGERS-II: PROCESS DESIGN WITHOUT PHASE CHANGE 55 Introduction 55 Flow through Shell and Tubes 55 Overall Heat Transfer Coefficient 60 Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64 Average and Pipe Wall Temperatures 76 Allocation of Fluids to Shell Side and Tube Side 77 Rating and Design 78 Use of Computers in Rating and Design 85 Salient Features of Shell-Side Design Methods 87 Effects of Various Geometrical and Process Parameters 94 Allowable Pressure Drop 108 Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers 112 Coolers and Cooling Water 113 Closed Feedwater Heaters 116 Duble Pipe Heat Exchangers 120 Nomenclature 121 References 123 SHELL-AND-TUBE HEAT EXCHANGERS –III: 127 Introduction 127 Condensers 128 Reboilers 166 Evaporators and Vaporizers 187 Nomenclature		References	53
PROCESS DESIGN WITHOUT PHASE CHANGE55Introduction55Flow through Shell and Tubes55Overall Heat Transfer Coefficient60Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64Average and Pipe Wall Temperatures76Allocation of Fluids to Shell Side and Tube Side77Rating and Design78Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS-III:127 Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Turbulators and Static Mixers225References238Compact Heat Exchangers214Nomenclature238 <trt< td=""><td>2</td><td>SHELL-AND-TUBE HEAT EXCHANGERS-II:</td><td></td></trt<>	2	SHELL-AND-TUBE HEAT EXCHANGERS-II:	
Introduction55Flow through Shell and Tubes55Overall Heat Transfer Coefficient60Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64Average and Pipe Wall Temperatures76Allocation of Fluids to Shell Side and Tube Side77Rating and Design78Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS-III:127 Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surfaces233Enhanced Surf		PROCESS DESIGN WITHOUT PHASE CHANGE	55
Flow through Shell and Tubes55Overall Heat Transfer Coefficient60Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64Average and Pipe Wall Temperatures76Allocation of Fluids to Shell Side and Tube Side77Rating and Design78Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS-III: PROCESS DESIGN WITH PHASE CHANGE 127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Nomenclature225References238Compact Heat Exchangers214Nomenclature235References238Compact Heat Exchangers214 </td <td></td> <td>Introduction</td> <td>55</td>		Introduction	55
Overall Heat Transfer Coefficient60Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64Average and Pipe Wall Temperatures76Allocation of Fluids to Shell Side and Tube Side77Rating and Design78Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS –III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Rebilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces233Enhanced Surfaces233Condatares241Nomenclature253References253		Flow through Shell and Tubes	55
Log Mean Temperature Difference ΔT_{LMTD} and Corrections Factor F_T 64 Average and Pipe Wall Temperatures 76 Allocation of Fluids to Shell Side and Tube Side 77 Rating and Design 85 Salient Features of Shell-Side Design Methods 87 Effects of Various Geometrical and Process Parameters 94 Allowable Pressure Drop 108 Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers 112 Coolers and Cooling Water 113 Closed Feedwater Heaters 116 Double Pipe Heat Exchangers 120 Nomenclature 121 References 123 3 SHELL-AND-TUBE HEAT EXCHANGERS—III: PROCESS DESIGN WITH PHASE CHANGE PROCESS DESIGN WITH PHASE CHANGE 127 Introduction 127 Condensers 128 Reboilers 166 Evaporators and Vaporizers 187 Nomenclature 205 References 207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213 Introduction 213 Extended (or Finned) Surface Heat Exchangers 214 Tur		Overall Heat Transfer Coefficient	60
Average and Pipe wan remperatures 70 Allocation of Fluids to Shell Side and Tube Side 77 Rating and Design 78 Use of Computers in Rating and Design Methods 87 Effects of Various Geometrical and Process Parameters 87 on the Performance of an Exchanger 94 Allowable Pressure Drop 108 Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers 112 Coolers and Cooling Water 113 Closed Feedwater Heaters 116 Double Pipe Heat Exchangers 120 Nomenclature 121 References 123 3 SHELL-AND-TUBE HEAT EXCHANGERS—III: PROCESS DESIGN WITH PHASE CHANGE PROCESS DESIGN WITH PHASE CHANGE 127 Introduction 127 Condensers 128 Reboilers 166 Evaporators and Vaporizers 187 Nomenclature 205 References 207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213 Introduction 213 Extended (or Finned) Surface Heat Exchangers 214 Turbulators and Static Mixers <t< td=""><td></td><td>Log Mean Temperature Difference $\Delta T_{\rm LMTD}$ and Corrections Factor F_T</td><td>64</td></t<>		Log Mean Temperature Difference $\Delta T_{\rm LMTD}$ and Corrections Factor F_T	64
Anocation of Findus to Shiel Side and Tube Side77Rating and Design78Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS –III:PROCESS DESIGN WITH PHASE CHANGE PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Nomenclature205References233Enhanced Surfaces238Compact Heat Exchangers214Nomenclature252References253References253References253References253References253References253References253 <td></td> <td>Average and Pipe wall Temperatures</td> <td>70 77</td>		Average and Pipe wall Temperatures	70 77
Name and Dosign10Use of Computers in Rating and Design85Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS – III:PROCESS DESIGN WITH PHASE CHANGE PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Nomenclature252References252References252References253		Rating and Design	78
Salient Features of Shell-Side Design Methods87Effects of Various Geometrical and Process Parameters94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS –III: PROCESS DESIGN WITH PHASE CHANGE 127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References252		Use of Computers in Rating and Design	85
Effects of Various Geometrical and Process Parameters on the Performance of an Exchanger94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS – III: PROCESS DESIGN WITH PHASE CHANGE 127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature253References238Compact Heat Exchangers241Nomenclature252References238Compact Heat Exchangers241Nomenclature252References253	,	Salient Features of Shell-Side Design Methods	87
on the Performance of an Exchanger94Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References123 3 SHELL-AND-TUBE HEAT EXCHANGERS – III: PROCESS DESIGN WITH PHASE CHANGE 127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References207 4 AUGMENTED SURFACE HEAT EXCHANGERS 213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References238Compact Heat Exchangers241Nomenclature252References238Compact Heat Exchangers241Nomenclature252References253		Effects of Various Geometrical and Process Parameters	
Allowable Pressure Drop108Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References1233 SHELL-AND-TUBE HEAT EXCHANGERS—III:PROCESS DESIGN WITH PHASE CHANGEPROCESS DESIGN WITH PHASE CHANGE127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		on the Performance of an Exchanger	94
Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers112Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References1233 SHELL-AND-TUBE HEAT EXCHANGERS—III:PROCESS DESIGN WITH PHASE CHANGEPROCESS DESIGN WITH PHASE CHANGE127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Allowable Pressure Drop	108
Coolers and Cooling Water113Closed Feedwater Heaters116Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References1233 SHELL-AND-TUBE HEAT EXCHANGERS—III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature253References238Compact Heat Exchangers241Nomenclature252References241Nomenclature252References241Surfaces238Compact Heat Exchangers241Nomenclature252References253		Uses of Liquid-Liquid, Liquid-Gas, and Gas-Gas Exchangers	112
Closed Feedwater Heaters110Double Pipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References1233 SHELL-AND-TUBE HEAT EXCHANGERS – III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Coolers and Cooling Water	113
Double Tipe Heat Exchangers117Bayonet Tube Heat Exchangers120Nomenclature121References1233 SHELL-AND-TUBE HEAT EXCHANGERS – III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References251		Closed Feedwater Heaters	110
Nomenclature121References1213 SHELL-AND-TUBE HEAT EXCHANGERS –III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Bayonet Tube Heat Exchangers	120
References1233 SHELL-AND-TUBE HEAT EXCHANGERS – III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References251		Nomenclature	120
3SHELL-AND-TUBE HEAT EXCHANGERS-III: PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		References	123
PROCESS DESIGN WITH PHASE CHANGE127Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253	3	SHELL-AND-TUBE HEAT EXCHANGERS-III:	
Introduction127Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		PROCESS DESIGN WITH PHASE CHANGE	127
Condensers128Reboilers166Evaporators and Vaporizers187Nomenclature205References2074AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Introduction	127
Reboilers166Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Condensers	128
Evaporators and Vaporizers187Nomenclature205References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Reboilers	166
Nomenciature203References2074 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Evaporators and Vaporizers	187
4 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Nomencialure References	203
4 AUGMENTED SURFACE HEAT EXCHANGERS213Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		References	207
Introduction213Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253	4	AUGMENTED SURFACE HEAT EXCHANGERS	213
Extended (or Finned) Surface Heat Exchangers214Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Introduction	213
Turbulators and Static Mixers229Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Extended (or Finned) Surface Heat Exchangers	214
Air-Fin Coolers233Enhanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Turbulators and Static Mixers	229
Ennanced Surfaces238Compact Heat Exchangers241Nomenclature252References253		Air-Fin Coolers	233
Compact freat Exchangers241Nomenciature252References253		Enhanced Surfaces	238
References 253		Vompaci neal Excitangers	241
		References	252

5	HEAT EXCHANGERS FOR SPECIAL SERVICES	257
	Introduction	257
	High-Temperature Heat Exchangers	257
	Cryogenic Heat Exchangers	262
	Heat Exchangers for Corrosive Services	267
	Nuclear Power Plant Heat Exchangers	276
	Liquid Metals and Molten Salt Heat Exchangers	281
	Nomenclature	286
	References	. 287
6	PLATE AND SPIRAL PLATE HEAT EXCHANGERS	289
	Introduction	289
	Plate Heat Exchangers	290
	Spiral Plate Heat Exchangers	314
	Nomenclature	319
	References	319
7	HEAT EXCHANGER DYNAMICS AND OPTIMIZATION	321
	Introduction	321
	Heat Exchanger Dynamics	322
	Heat Exchanger Optimization	326
	Parametric Studies	334
	Heat Exchanger Network Optimization	335
	Nomenclature	337
	References	338
8	CODES AND STANDARDS	341
	Introduction	341
	Codes	342
	TEMA, API, and HEI Standards	351
	References	357
9	MECHANICAL DESIGN; STRESS, SEISMIC,	
	AND FAILURE ANALYSIS	359
	Introduction	359
	Mechanical Design	359
	Stress Analysis	392
	Seismic Analysis	404
	Failure Analysis	406
	Nomenciature	410
	NEICICILES	410

10	MATERIAL SELECTION, FABRICATION, AND WELDING	413
	Introduction	413
	Material Selection	414
	Fabrication	424
	Welding	435
	Nomenclature	458
	References	459
11	QUALITY ASSURANCE, QUALITY CONTROL,	
	INSPECTION, AND TESTING	461
	Introduction	461
	Quality Assurance	462
	Quality Control	463
	Inspection	403
	l'esting	407
	References	490
	Kelelences	470
12	HIGH-PRESSURE VESSELS	491
	Introduction	491
	Definition and Uses	491
	Types of High-Pressure Vessels	492
	Fabrication	494
	Testing	499
	Ultra-High-Pressure Vessels	500
	Keferences	500
13	CORROSION, EROSION, FOULING,	
	AND WATER TREATMENT	501
	Introduction	501
	Corrosion	501
	Erosion	510
	Fouling	511
	Water Treatment	523
	Nomenclature	527
	References	527
14	INSTALLATION, OPERATION, MAINTENANCE,	
	AND REPAIR	529
	Introduction	529
	General	529
	Installation	530

CONTENTS vii

•

Operation	532
Maintenance and Repair	534
References	547
15 FLOW-INDUCED VIBRATIONS	549
Introduction	549
General	549
Definitions of Interest	551
Factors Causing Vibrations	555
Effects of Shell-Side Flow	555
Resonance	556
Damaging Effects of Vibrations	558
Natural Frequency of Tubes	558
Phenomena of Tube Vibrations	563
Vibrations in Two-Phase Systems	576
Vibration Analysis	577
Vibration Prevention	578
Information Collection and Future Research	580
Nomenclature	581
References	582
Author Index	585
Subject Index	593