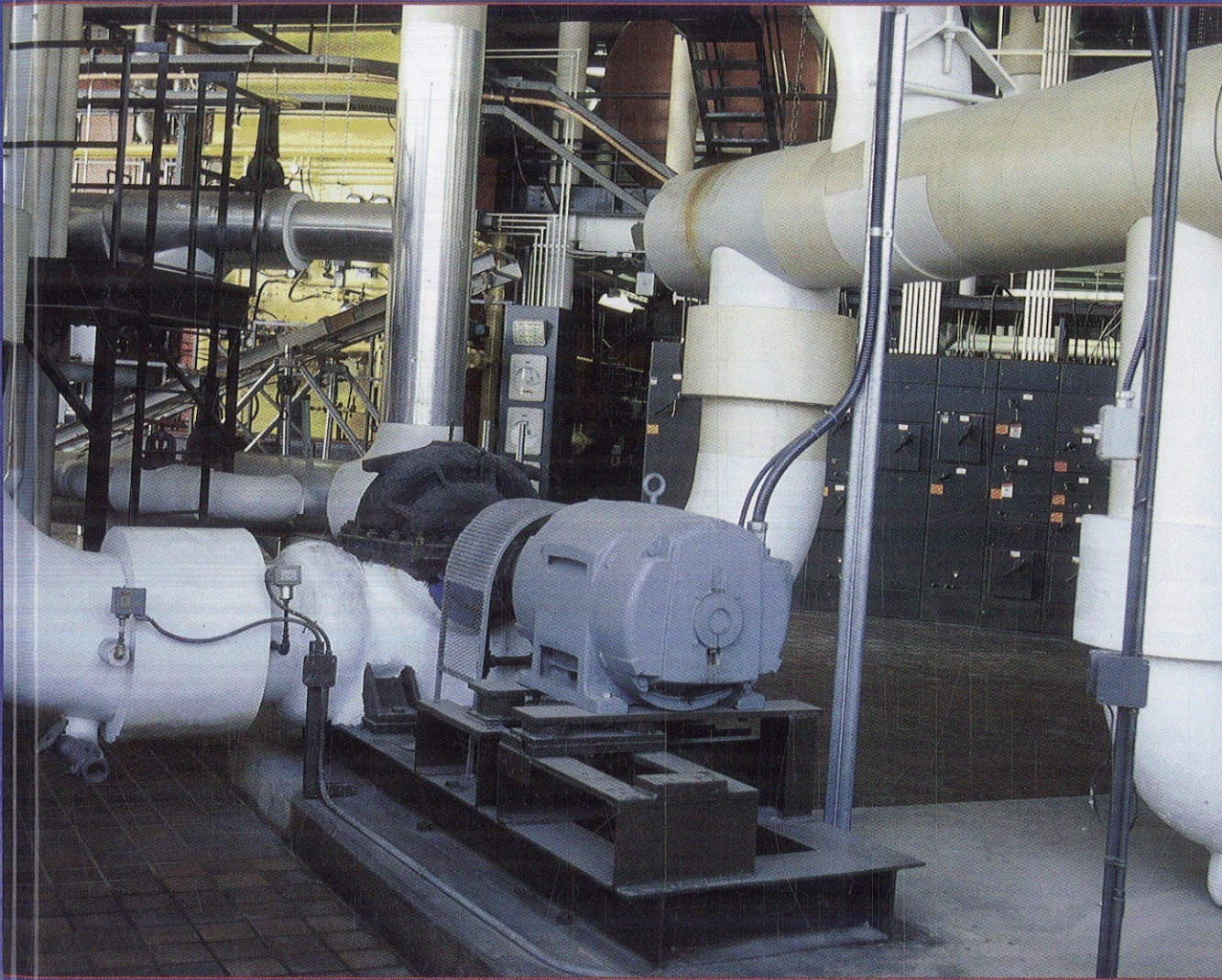


HEATING, VENTILATING, AND AIR CONDITIONING

Sixth Edition

Analysis and Design



McQuiston / Parker / Spitler

Contents

Preface	xi
About the Authors	xiii
Symbols	xv

1. Introduction 1

1-1	Historical Notes	1
1-2	Common HVAC Units and Dimensions	3
1-3	Fundamental Physical Concepts	6
1-4	Additional Comments	18
	References	18
	Problems	19

2. Air-Conditioning Systems 22

2-1	The Complete System	22
2-2	System Selection and Arrangement	26
2-3	HVAC Components and Distribution Systems	28
2-4	Types of All-Air Systems	29
2-5	Air-and-Water Systems	36
2-6	All-Water Systems	37
2-7	Decentralized Cooling and Heating	39
2-8	Heat Pump Systems	41
2-9	Heat Recovery Systems	44
2-10	Thermal Energy Storage	45
	References	46
	Problems	46

3. Moist Air Properties and Conditioning Processes 49

3-1	Moist Air and the Standard Atmosphere	49
3-2	Fundamental Parameters	51
3-3	Adiabatic Saturation	53
3-4	Wet Bulb Temperature and the Psychrometric Chart	55
3-5	Classic Moist Air Processes	56
3-6	Space Air Conditioning—Design Conditions	65
3-7	Space Air Conditioning—Off-Design Conditions	75
	References	79
	Problems	79

4.	Comfort and Health—Indoor Environmental Quality	85
4-1	Comfort—Physiological Considerations	85
4-2	Environmental Comfort Indices	86
4-3	Comfort Conditions	89
4-4	The Basic Concerns of IAQ	92
4-5	Common Contaminants	93
4-6	Methods to Control Humidity	95
4-7	Methods to Control Contaminants	97
	References	115
	Problems	116
5.	Heat Transmission in Building Structures	119
5-1	Basic Heat-Transfer Modes	119
5-2	Tabulated Overall Heat-Transfer Coefficients	138
5-3	Moisture Transmission	153
	References	154
	Problems	154
6.	Space Heating Load	158
6-1	Outdoor Design Conditions	158
6-2	Indoor Design Conditions	159
6-3	Transmission Heat Losses	160
6-4	Infiltration	160
6-5	Heat Losses from Air Ducts	173
6-6	Auxiliary Heat Sources	175
6-7	Intermittently Heated Structures	175
6-8	Supply Air For Space Heating	175
6-9	Source Media for Space Heating	176
6-10	Computer Calculation of Heating Loads	177
	References	178
	Problems	179
7.	Solar Radiation	181
7-1	Thermal Radiation	181
7-2	The Earth's Motion About the Sun	184
7-3	Time	185
7-4	Solar Angles	187
7-5	Solar Irradiation	190
7-6	Heat Gain Through Fenestrations	197
7-7	Energy Calculations	212
	References	213
	Problems	213

8. The Cooling Load 216

8-1	Heat Gain, Cooling Load, and Heat Extraction Rate	216
8-2	Application of Cooling Load Calculation Procedures	219
8-3	Design Conditions	220
8-4	Internal Heat Gains	221
8-5	Overview of the Heat Balance Method	226
8-6	Transient Conduction Heat Transfer	228
8-7	Outside Surface Heat Balance—Opaque Surfaces	231
8-8	Fenestration—Transmitted Solar Radiation	237
8-9	Interior Surface Heat Balance—Opaque Surfaces	240
8-10	Surface Heat Balance—Transparent Surfaces	246
8-11	Zone Air Heat Balance	249
8-12	Implementation of the Heat Balance Method	254
8-13	Radiant Time Series Method	255
8-14	Implementation of the Radiant Time Series Method	266
8-15	Supply Air Quantities	273
	References	273
	Problems	275

9. Energy Calculations and Building Simulation 279

9-1	Degree-Day Procedure	279
9-2	Bin Method	282
9-3	Comprehensive Simulation Methods	289
9-4	Energy Calculation Tools	293
9-5	Other Aspects of Building Simulation	294
	References	295
	Problems	297

10. Flow, Pumps, and Piping Design 299

10-1	Fluid Flow Basics	299
10-2	Centrifugal Pumps	310
10-3	Combined System and Pump Characteristics	314
10-4	Piping System Fundamentals	317
10-5	System Design	335
10-6	Steam Heating Systems	343
	References	358
	Problems	359

11. Space Air Diffusion 366

11-1	Behavior of Jets	366
11-2	Air-Distribution System Design	374
	References	391
	Problems	391

12. Fans and Building Air Distribution	394
12-1 Fans	394
12-2 Fan Relations	394
12-3 Fan Performance and Selection	399
12-4 Fan Installation	407
12-5 Field Performance Testing	414
12-6 Fans and Variable-Air-Volume Systems	416
12-7 Air Flow in Ducts	418
12-8 Air Flow in Fittings	425
12-9 Accessories	437
12-10 Duct Design—General	439
12-11 Duct Design—Sizing	444
References	454
Problems	454
13. Direct Contact Heat and Mass Transfer	461
13-1 Combined Heat and Mass Transfer	461
13-2 Spray Chambers	464
13-3 Cooling Towers	472
References	479
Problems	479
14. Extended Surface Heat Exchangers	482
14-1 The Log Mean Temperature Difference (LMTD) Method	483
14-2 The Number of Transfer Units (NTU) Method	484
14-3 Heat Transfer—Single-Component Fluids	485
14-4 Transport Coefficients Inside Tubes	492
14-5 Transport Coefficients Outside Tubes and Compact Surfaces	496
14-6 Design Procedures for Sensible Heat Transfer	504
14-7 Combined Heat and Mass Transfer	513
References	524
Problems	525
15. Refrigeration	529
15-1 The Performance of Refrigeration Systems	529
15-2 The Theoretical Single-Stage Compression Cycle	531
15-3 Refrigerants	534
15-4 Refrigeration Equipment Components	540
15-5 The Real Single-Stage Cycle	553
15-6 Absorption Refrigeration	560
15-7 The Theoretical Absorption Refrigeration System	570
15-8 The Aqua—Ammonia Absorption System	572
15-9 The Lithium Bromide—Water System	576
References	578
Problems	579

Appendix A. Thermophysical Properties 583

Table A-1a	Properties of Refrigerant 718 (Water–Steam)— English Units	584
Table A-1b	Properties of Refrigerant 718 (Water–Steam)—SI Units	585
Table A-2a	Properties of Refrigerant 134a (1,1,1,2-Tetrafluoroethane)— English Units	586
Table A-2b	Properties of Refrigerant 134a (1,1,1,2-Tetrafluoroethane)— SI Units	588
Table A-3a	Properties of Refrigerant 22 (Chlorodifluoromethane)— English Units	590
Table A-3b	Properties of Refrigerant 22 (Chlorodifluoromethane)— SI Units	592
Table A-4a	Air—English Units	594
Table A-4b	Air—SI Units	595

Appendix B. Weather Data 596

Table B-1a	Heating and Cooling Design Conditions—United States, Canada, and the World—English Units	597
Table B-1b	Heating and Cooling Design Conditions—United States, Canada, and the World—SI Units	600
Table B-2	Annual Bin Weather Data for Oklahoma City, OK	603
Table B-3	Annual Bin Weather Data for Chicago, IL	603
Table B-4	Annual Bin Weather Data for Denver, CO	604
Table B-5	Annual Bin Weather Data for Washington, DC	604

Appendix C. Pipe and Tube Data 605

Table C-1	Steel Pipe Dimensions—English and SI Units	606
Table C-2	Type L Copper Tube Dimensions—English and SI Units	607

Appendix D. Useful Data 608

Table D-1	Conversion Factors	609
-----------	--------------------	-----