



Low Energy Cooling for Sustainable Buildings

Ursula Eicker

 WILEY

Contents

Preface	ix
About the Author	xi
1 Energy Demand of Buildings	1
1.1 Residential Buildings	4
1.1.1 Heating Energy	4
1.1.2 Domestic Hot Water	6
1.1.3 Electricity Consumption	7
1.2 Office Buildings	9
1.2.1 Heating Energy	9
1.2.2 Electricity Consumption	10
1.2.3 Air Conditioning	13
1.3 Conclusions	19
2 Façades and Summer Performance of Buildings	21
2.1 Review of Façade Systems and Energy Performance	23
2.1.1 Single Façades	23
2.1.2 Double Façades	23
2.1.3 Modelling of Ventilated Façades	27
2.2 Experimental Results on Total Energy Transmittance	30
2.2.1 Laboratory Experiments	30
2.2.2 Building Experiments	36
2.3 Cooling Loads through Ventilation Gains	40
2.3.1 Double Façade Experiments	40
2.3.2 Parameter Study Using Simulation	43
2.4 Energy Production from Active Façades	47
2.4.1 Thermal and Electrical Energy Balance of the Façade	53
2.5 Conclusions on Façade Performance	58
3 Passive Cooling Strategies	61
3.1 Building Description and Cooling Concepts	62
3.1.1 Lamparter Building, Weilheim	62
3.1.2 Rehabilitated Office Building in Tübingen	64
3.1.3 Low-energy Office Building in Freiburg	65

3.2	Passive Night Ventilation Results	65
3.2.1	Internal Loads and Temperature Levels	65
3.2.2	Air Changes and Thermal Building Performance	68
3.2.3	Simulation of Passive Cooling Potential	71
3.2.4	Active Night Ventilation	74
3.3	Summary of Passive Cooling	79
4	Geothermal Cooling	83
4.1	Earth Heat Exchanger Performance	88
4.1.1	Earth to Air Heat Exchanger in a Passive Standard Office Building	88
4.1.2	Performance of Horizontal Earth Brine to Air Heat Exchanger in the ebök Building	93
4.1.3	Performance of Vertical Earth Brine to Air Heat Exchanger in the SIC Building	95
4.1.4	Modelling of Geothermal Heat Exchangers	102
4.1.5	Conclusions on Geothermal Heat Exchangers for Cooling	108
5	Active Thermal Cooling Technologies	111
5.1	Absorption Cooling	113
5.1.1	Absorption Cycles	113
5.1.2	Solar Cooling with Absorption Chillers	117
5.2	Desiccant Cooling	125
5.2.1	Desiccant Cooling System in the Mataró Public Library	129
5.2.2	Desiccant Cooling System in the Althengstett Factory	132
5.2.3	Monitoring Results in Mataró	133
5.2.4	Monitoring Results in Althengstett	137
5.2.5	Simulation of Solar-Powered Desiccant Cooling Systems	145
5.2.6	Cost Analysis	152
5.2.7	Summary of Desiccant Cooling Plant Performance	155
5.3	New Developments in Low-Power Chillers	155
5.3.1	Development of a Diffusion–Absorption Chiller	156
5.3.2	Liquid Desiccant Systems	175
6	Sustainable Building Operation Using Simulation	197
6.1	Simulation of Solar Cooling Systems	198
6.1.1	Component and System Models	201
6.1.2	Building Cooling Load Characteristics	207
6.1.3	System Simulation Results	211
6.1.4	Influence of Dynamic Building Cooling Loads	216
6.1.5	Economic Analysis	219
6.1.6	Summary of Solar Cooling Simulation Results	225
6.2	Online Simulation of Buildings	226
6.2.1	Functions and Innovations in Building Management Systems	227
6.2.2	Communication Infrastructure for the Implementation of Model-Based Control Systems	228
6.2.3	Building Online Simulation in the POLYCITY Project	229
6.3	Online Simulation of Renewable Energy Plants	238
6.3.1	Photovoltaic System Simulation	239
6.3.2	Communication Strategies for Simulation-Based Remote Monitoring	241

6.3.3	Online Simulation for the Commissioning and Operation of Photovoltaic Power Plants	242
6.3.4	Summary of Renewable Energy Plant Online Simulation	245
7	Conclusions	249
	References	253
	Index	263