

Contents

<i>List of Contributors</i>	xi
<i>Preface</i>	xiii
<i>General Information</i>	xv
1. Introduction	1
A. A. M. SAYIGH	
2. The Sun and the Celestial Vault	5
ENRICO COFFARI	
2.1 Introduction	5
2.2 The Sun: A Grain of Sand in a Whirling Desert Storm	6
2.3 The Calculation of the Angle of Incidence of Direct Radiation on an Inclined Plane	22
2.4 The Sun: A Spark in a Volcanic Eruption	27
3. Solar Irradiance, Total and Spectral	37
MATHEW P. THEKAEKARA	
3.1 Introduction	37
3.2 The Extraterrestrial Solar Energy	37
3.3 The Solar Constant	38
3.4 Solar Spectral Irradiance for Zero Air Mass	39
3.5 Variations with Sun–Earth Distance	42
3.6 Accuracy of the Standard Values	43
3.7 Variations in Solar Energy Output	44
3.8 Solar Energy Variation at Ground Level	45
3.9 Atmospheric Attenuation of Solar Energy	47
3.10 Total and Spectral Solar Irradiance at Ground Level	49
3.11 Conclusion	58

4. Solar Energy Availability Prediction from Climatological Data	61
A. A. M. SAYIGH	
4.1 Introduction	61
4.2 Estimation of Total Solar Radiation	62
4.3 Estimation of the Total Solar Radiation from Meteorological Data	67
4.4 Some Factors Which Influence Total Solar Radiation	70
4.5 A General Empirical Formula for Estimating Total Solar Radiation	71
4.6 Estimation of Direct and Diffused Radiation	76
4.7 Conclusion	81
5. Heat Transfer for Solar Energy Utilization	83
J. A. SABBAGH	
5.1 Introduction	83
5.2 Conduction	84
5.3 Convection	86
5.4 Heat Transfer with Vapor Condensation	97
5.5 Liquid Vaporization	98
5.6 Thermal Radiation	98
5.7 Some Heat Transfer Problems Related to Heat Exchanges	101
6. Solar Energy Utilization—Liquid Flat Plate Collectors	105
W. W. S. CHARTERS	
6.1 Introduction	105
6.2 Heat Transfer Processes	108
6.3 Steady State Models of Collector Performance	117
6.4 Some Performance Characteristics of Conventional Tube and Plate Collectors	123
6.5 Areas of Research Interest for Future Work	135
7. Convective Heat Transfer Effects within Honeycomb Structures for Flat Plate Solar Collectors	137
W. W. S. CHARTERS	
7.1 Introduction	137
7.2 The General Problem of Heat Transfer within Cellular Structures	139
7.3 Some Theoretical Aspects of the Free Convection Process for Fluid Layers	142
7.4 Experimental Work on Free Convection Effects	150
7.5 Effect of Radiation on Convective Effects in Cells	151

8. Solar Air Heaters and Their Applications 155

M. KUDRET SELÇUK

- 8.1 Introduction 155
- 8.2 Design Variations of Solar Air Heaters 157
- 8.3 Calculation of the Efficiency of a Flat Plate Solar Air Heater 160
- 8.4 Performance of Various Collector Types 166
- 8.5 Applications of Solar Air Heaters 177

9. Concentrating Collectors 183

A. B. MEINEL

- 9.1 Introduction 183
- 9.2 Point Focus Configurations—Parabolic Mirrors 184
- 9.3 Circular Fresnel Lenses 186
- 9.4 The Central Receiver 188
- 9.5 Concentration Limits 190
- 9.6 Point Focus Mountings 192
- 9.7 Fully Tracking Mounting Configurations 194
- 9.8 Kinematics of Fully Tracking Mountings 195
- 9.9 Generalized Heliostat 198
- 9.10 Line Focus Configurations 202
- 9.11 Parabolic Cylinder 202
- 9.12 Cylindrical Optical Mountings 204
- 9.13 Fixed Mirror Line Focus Systems 209
- 9.14 Semifixed Mirror Systems 211
- 9.15 Fixed-Mirror Moving-Absorber Systems 213
- 9.16 Mirror Materials 214

10. Solar Pond 217

S. B. SAVAGE

- 10.1 Introduction 217
- 10.2 Forming and Maintaining the Stable Density Gradient 219
- 10.3 Absorption of Solar Radiation Incident upon the Pond 222
- 10.4 Theoretical Analyses of the Temperature Development in the Pond 226
- 10.5 Extraction of Heat from the Pond 229
- 10.6 Conclusion 231

11. Solar Furnaces 233

TAKEMARO SAKURAI

- 11.1 Introduction 233
- 11.2 Fundamentals of Solar Furnaces 234
- 11.3 Theoretical Concentrations 242

11.4 Design Examples	246
11.5 Procedures in High-Temperature Investigations Using a Solar Furnace	254
11.6 Conclusion	261
12. Photovoltaic Conversion	263
CHARLES E. BACKUS	
12.1 Introduction	263
12.2 Semiconductor Principles	264
12.3 The Band Theory of Solids	264
12.4 Optical Characteristics	269
12.5 Transport Characteristics	272
12.6 Photovoltaic Principles	273
12.7 Cell Fabrication	277
12.8 Photovoltaic Systems with Sunlight Concentration	285
12.9 Conclusions	285
13. Application of Solar Energy in Space	287
CHARLES E. BACKUS	
13.1 Introduction	287
13.2 Solar Cell Systems	288
13.3 Solar Cell Fabrication for Space	290
13.4 Future Space Cells and Systems	300
13.5 Other Solar Systems in Space	303
14. Conversion of Solar Energy into Electricity	305
M. ALI KETTANI	
14.1 Introduction	305
14.2 Direct Energy Conversion	307
14.3 Conversion through a Heat Stage	311
14.4 Conversion through Other Stages	318
14.5 Solar Energy Power System	322
14.6 Conclusions	323
15. Storage of Solar Energy	325
M. ALI KETTANI	
15.1 Introduction	325
15.2 Electrical Storage	326
15.3 Storage in the Form of Heat	329
15.4 Storage in the Form of Fuel	331
15.5 Storage in the Form of Potential Hydraulic Energy	335
15.6 Conclusion	339

16. Refrigeration and Air Conditioning	341
B. J. BRINKWORTH	
16.1 Introduction	341
16.2 Requirements	342
16.3 Refrigeration Systems	348
16.4 Solar Cooling	356
16.5 A Place for Solar Cooling	362
17. Solar Heating and Cooling of Homes	365
JOHN I. YELLOTT	
17.1 Introduction	365
17.2 Solar System Types	368
17.3 System Components	368
17.4 Survey of Significant Solar-Heated and Cooled Residences	371
17.5 Conclusion	382
18. Solar Production of Hydrogen	385
T. N. VEZIROGLU AND S. KAKAC	
18.1 Introduction	385
18.2 Solar-Hydrogen Energy System	386
18.3 Solar-Hydrogen Production	387
18.4 Conclusion	394
19. Solar Energy Measuring Equipment	397
BYARD D. WOOD	
19.1 Historical Background of Solar Radiometry	397
19.2 Basic Principles of Solar Radiometry	402
19.3 Pyrheliometers	406
19.4 Pyranometers	411
19.5 Sunshine Records	413
19.6 Standardization of Solar Radiometers	415
19.7 Commercial Solar Radiometers	421
19.8 Future Instrumentation	425
19.9 Summary of Milestones in Solar Radiometry	425
20. Fundamentals of Water Desalination	431
E. D. HOWE AND B. W. TLEIMAT	
20.1 Introduction	432
20.2 Historical Summary	433

20.3 The Cost of Solar-Distilled Water	438
20.4 Configurations of Basin-Type Solar Stills	440
20.5 Prediction of Performance of Basin-Type Solar Stills	446
20.6 Solar Distillation with the Reuse of Heat Energy	454
20.7 The Use of Waste Heat in Solar Stills	461
20.8 Conclusion	463
21. The Economics of Solar Energy	465
A. A. M. SAYIGH	
21.1 Introduction	465
21.2 Economic Criteria	466
21.3 Cost of Some Solar Appliances	468
21.4 Conclusion	475
References	477
<i>Index</i>	499

