Brochure

More information from http://www.researchandmarkets.com/reports/2174113/

An Introduction to Thermogeology. Ground Source Heating and Cooling. 2nd Edition

Description:

This authoritative guide provides a basis for understanding the emerging technology of ground source heating and cooling. It equips engineers, geologists, architects, planners and regulators with the fundamental skills needed to manipulate the ground's huge capacity to store, supply and receive heat, and to implement technologies (such as heat pumps) to exploit that capacity for space heating and cooling.

The author has geared the book towards understanding ground source heating and cooling from the ground side (the geological aspects), rather than solely the building aspects. He explains the science behind thermogeology and offers practical guidance on different design options.

An Introduction to Thermogeology: ground source heating and cooling is aimed primarily at professionals whose skill areas impinge on the emerging technology of ground source heating and cooling. They will be aware of the importance of the technology and wish to rapidly acquire fundamental theoretical understanding and design skills.

This second edition has been thoroughly updated and expanded to cover new technical developments and now includes end-of-chapter study questions to test the reader's understanding.

Contents:

About the Author xi

Preface to the First Edition xiii

Preface to the Second Edition xv

Acknowledgements xvii

- 1 An Introduction 1
- 1.1 Who should read this book? 2
- 1.2 What will this book do and not do? 2
- 1.3 Why should you read this book? 3
- 1.4 Thermogeology and hydrogeology 6
- 2 Geothermal Energy 11
- 2.1 Geothermal energy and ground source heat 11
- 2.2 Lord Kelvin s conducting, cooling earth 12
- 2.3 Geothermal gradient, heat flux and the structure of the earth 14
- 2.4 Internal heat generation in the crust 16
- 2.5 The convecting earth? 17
- 2.6 Geothermal anomalies 19
- 2.7 Types of geothermal system 27
- 2.8 Use of geothermal energy to produce electricity by steam turbines 28

- 2.9 Binary systems 28
- 2.10 Direct use 30
- 2.11 Cascading use 30
- 2.12 Hot dry rock systems [a.k.a. enhanced geothermal systems (EGS)] 32
- 2.13 The sustainability of geothermal energy and its environmental impact 35
- 2.14 And if we do not live in Iceland? 38
- 3 The Subsurface as a Heat Storage Reservoir 40
- 3.1 Specific heat capacity: the ability to store heat 41
- 3.2 Movement of heat 45
- 3.3 The temperature of the ground 51
- 3.4 Insolation and atmospheric radiation 55
- 3.5 Cyclical temperature signals in the ground 59
- 3.6 Geothermal gradient 61
- 3.7 Human sources of heat in the ground 65
- 3.8 Geochemical energy 69
- 3.9 The heat energy budget of our subsurface reservoir 70
- 3.10 Cyclical storage of heat 72
- 3.11 Manipulating the ground heat reservoir 74
- 4 What Is a Heat Pump? 79
- 4.1 Engines 81
- 4.2 Pumps 84
- 4.3 Heat pumps 85
- 4.4 The rude mechanics of the heat pump 88
- 4.5 Absorption heat pumps 91
- 4.6 Heat pumps for space heating 91
- 4.7 The efficiency of heat pumps 93
- 4.8 Air-sourced heat pumps 96
- 4.9 Ground source heat pumps 98
- 4.10 Seasonal performance factor (SPF) 99
- 4.11 GSHPs for cooling 100
- 4.12 Other environmental sources of heat 100
- 4.13 The benefits of GSHPs 101

- 4.14 Capital cost 104
- 4.15 Other practical considerations 107
- 4.16 The challenge of delivering efficient GSHP systems 108
- 4.17 Challenges: the future 109
- 4.18 Summary 112
- 5 Heat Pumps and Thermogeology: A Brief History and
- International Perspective 114
- 5.1 Refrigeration before the heat pump 115
- 5.2 The overseas ice trade 117
- 5.3 Artificial refrigeration: who invented the heat pump? 119
- 5.4 The history of the GSHP 121
- 5.5 The global energy budget: how significant are GSHPs? 129
- 5.6 Ground source heat: a competitor in energy markets? 132
- 6 Ground Source Cooling 133
- 6.1 Our cooling needs in space 133
- 6.2 Scale effects and our cooling needs in time 134
- 6.3 Traditional cooling 135
- 6.4 Dry coolers 136
- 6.5 Evaporation 138
- 6.6 Chillers/heat pumps 141
- 6.7 Absorption heat pumps 143
- 6.8 Delivery of cooling in large buildings 144
- 6.9 Dehumidification 145
- 6.10 Passive cooling using the ground 145
- 6.11 Active ground source cooling 147
- 6.12 An example of open-loop groundwater cooling 148
- 7 Options and Applications for Ground Source Heat Pumps 150
- 7.1 How much heat do I need? 150
- 7.2 Sizing a GSHP 156
- 7.3 Open-loop ground source heat systems 161
- 7.4 Closed-loop systems 173

- 7.5 Domestic hot water by ground source heat pumps? 191
- 7.6 Heating and cooling delivery in complex systems 195
- 7.7 Heat from ice 201
- 8 The Design of Groundwater-Based Open-Loop Systems 202
- 8.1 Common design flaws of open-loop groundwater systems 203
- 8.2 Aguifers, aguitards and fractures 203
- 8.3 Transmissivity 205
- 8.4 Confined and unconfined aguifers 206
- 8.5 Abstraction well design in confined and unconfined aquifers 208
- 8.6 Design yield, depth and drawdown 210
- 8.7 Real wells and real aquifers 215
- 8.8 Sources of information 217
- 8.9 Multiple wells in a wellfield 222
- 8.10 Hydraulic feedback in a well doublet 227
- 8.11 Heat migration in the groundwater environment 234
- 8.12 The importance of three-dimensionality 240
- 8.13 Mathematical reversibility 242
- 8.14 Sustainability: thermally balanced systems and seasonal reversal 243
- 8.15 Groundwater modelling 244
- 8.16 Examples of open-loop heating/cooling schemes 245
- 8.17 Further reading 246
- 9 Pipes, Pumps and the Hydraulics of Closed-Loop Systems 248
- 9.1 Our overall objective 251
- 9.2 Hydraulic resistance of the heat exchanger 252
- 9.3 The hydraulic resistance of pipes 253
- 9.4 Acceptable hydraulic losses 255
- 9.5 Hydraulic resistances in series and parallel 255
- 9.6 An example 256
- 9.7 Selecting pumps 262
- 9.8 Carrier fluids 265
- 9.9 Manifolds 271
- 9.10 Hydraulic testing of closed loops 275

- 9.11 Equipping a ground loop 277
- 10 Subsurface Heat Conduction and the Design of Borehole-Based
- Closed-Loop Systems 279
- 10.1 Rules of thumb? 279
- 10.2 Common design flaws 282
- 10.3 Subsurface heat conduction 283
- 10.4 Analogy between heat flow and groundwater flow 286
- 10.5 Carslaw, Ingersoll, Zobel, Claesson and Eskilson s solutions 289
- 10.6 Real closed-loop boreholes 294
- 10.7 Application of theory an example 304
- 10.8 Multiple borehole arrays 313
- 10.9 Simulating cooling loads 321
- 10.10 Simulation time 322
- 10.11 Stop press 323
- 11 Horizontal Closed-Loop Systems 325
- 11.1 Principles of operation and important parameters 326
- 11.2 Depth of burial 327
- 11.3 Loop materials and carrier fluids 328
- 11.4 Ground conditions 329
- 11.5 Areal constraints 333
- 11.6 Geometry of installation 333
- 11.7 Modelling horizontal ground exchange systems 344
- 11.8 Earth tubes: air as a carrier fluid 351
- 12 Pond- and Lake-Based Ground Source Heat Systems 353
- 12.1 The physics of lakes 354
- 12.2 Some rules of thumb 356
- 12.3 The heat balance of a lake 357
- 12.4 Open-loop lake systems 365
- 12.5 Closed-loop surface water systems 367
- 12.6 Closed-loop systems environmental considerations 371
- 13 Standing Column Wells 372

- 13.1 Standing column systems 372
- 13.2 The maths 376
- 13.3 The cost of SCWs 377
- 13.4 SCW systems in practice 379
- 13.5 A brief case study: Grindon Camping Barn 379
- 13.6 A final twist the Jacob doublet well 381
- 14 Thinking Big: Large-Scale Heat Storage and Transfer 383
- 14.1 The thermal capacity of a building footprint 384
- 14.2 Simulating closed-loop arrays with balanced loads 385
- 14.3 A case study of a balanced scheme: car showroom, Bucharest 390
- 14.4 Balancing loads 392
- 14.5 Deliberate thermal energy storage closed-loop borehole thermal energy storage (BTES) 395
- 14.6 Aquifer thermal energy storage (ATES) 398
- 14.7 UTES and heat pumps 403
- 14.8 Regional transfer and storage of heat 403
- 15 Thermal Response Testing 410
- 15.1 Sources of thermogeological data 410
- 15.2 Laboratory determination of thermal conductivity 411
- 15.3 The thermal response test (TRT) 412
- 15.4 The practicalities: the test rig 417
- 15.5 Test procedure 420
- 15.6 Sources of uncertainty 425
- 15.7 Non-uniform geology 426
- 15.8 Non-constant power input 426
- 15.9 Groundwater flow 427
- 15.10 Analogies with hydrogeology 428
- 15.11 Thermal response testing for horizontal closed loops 429
- 16 Environmental Impact, Regulation and Geohazards 432
- 16.1 The regulatory framework 432
- 16.2 Thermal risks 437
- 16.3 Hydraulic risks 444
- 16.4 Geotechnical risks 449

16.5 Contamination risks 451

16.6 Geochemical risks 453

16.7 Microbiological risks 454

16.8 Excavation and drilling risks 455

16.9 Decommissioning of boreholes 458

16.10 Promoting technology: subsidy 459

16.11 The final word 460

References 463

Study Question Answers 493

Symbols 503

Glossary 509

Units 515

Index 518

Ordering: Order Online - http://www.researchandmarkets.com/reports/2174113/

Order by Fax - using the form below

Order by Post - print the order form below and send to

Research and Markets, Guinness Centre, Taylors Lane, Dublin 8, Ireland.

RESEARCHANDMARKETS Page 1 of 2

Fax Order Form

To place an order via fax simply print this form, fill in the information below and fax the completed form to 646-607-1907 (from USA) or +353-1-481-1716 (from Rest of World). If you have any questions please visit

http://www.researchandmarkets.com/contact/

				No.				
<i>r</i> 1	ra	er	Int	or	m	211	OI	٦
u	ıч			OI.		au	u	п

Please verify that the product information is correct.

Product Name: An Introduction to Thermogeology. Ground Source Heating and Cooling. 2nd Edition

Web Address: http://www.researchandmarkets.com/reports/2174113/

Office Code: SCI57X6L

Product Format

Please select the product for	rmat and quar	ntity you require:					
Quantity							
Hard Copy (l Back):	Hard Copy (Hard LISD 117 + LISD 27 Shipping/Handling						
* Shipping/Handling is only charged	once per order.						
* The price quoted above is only vali	d for 30 days. Plea	ase submit your order	within that time fran	ne to avail of this price	as all prices are su	bject to change.	
Contact Information							
Please enter all the informat	tion below in E	BLOCK CAPITALS	;				
Title:	Mr	Mrs	Dr 🗆	Miss	Ms	Prof	
First Name:			Lá	ast Name:			
Email Address: *							
Job Title:							
Organisation:							
Address:							
City:							
Postal / Zip Code:							
Country:							
Phone Number:							
Fax Number:							

^{*} Please refrain from using free email accounts when ordering (e.g. Yahoo, Hotmail, AOL)

RESEARCHANDMARKETS Page 2 of 2

Payment Information

Please indi	cate the payment method you woul	d like to use by selecting the a	appropriate box.		
	Pay by credit card:	You will receive an email with a link to a secure webpage to enter your credit card details.			
	Pay by check:	Please post the check, accompanied by this form, to:			
		Research and Markets, Guinness Center, Taylors Lane, Dublin 8, Ireland.			
	Pay by wire transfer:				
		Account number	833 130 83		
		Sort code	98-53-30		
		Swift code	ULSBIE2D		
		IBAN number	IE78ULSB98533083313083		
		Bank Address	Ulster Bank, 27-35 Main Street, Blackrock, Co. Dublin, Ireland.		
lf you	u have a Marketing Code please ent	er it below:			
	Marketing Code:				

Please note that by ordering from Research and Markets you are agreeing to our Terms and Conditions at http://www.researchandmarkets.com/info/terms.asp

Please fax this form to: (646) 607-1907 or (646) 964-6609 - From USA +353-1-481-1716 or +353-1-653-1571 - From Rest of World