

CONTENTS

| | |
|---|-----------|
| 1. Introduction | 9 |
| 2. An overview of geothermal energy utilization | |
| János Szanyi, Tamás Medgyes, Balázs Kóbor, Imre Czinkota, Zoran Stipic, István Vass, Máté Oswald, Elemér Pál-Molnár, Emőke Egyed | 11 |
| 2.1. The history and origins of geothermal energy | 11 |
| 2.1.1. The sources of geothermal energy, types of thermal convection | 11 |
| 2.1.2. The fundamentals of groundwater movement | 14 |
| 2.1.3. The history of utilization of geothermal energy in Hungary | 16 |
| 2.2. The utilization of geothermal energy | 17 |
| 2.2.1. General terms of energy and work | 17 |
| 2.2.2. The conversion of thermal energy into another form of energy (Carnot cycle) | 19 |
| 2.2.3. Electricity production through mechanical work | 23 |
| 2.2.4. Direct heat utilization | 28 |
| 2.2.5. Balneology | 30 |
| 2.2.6. Utilization with heat pumps | 31 |
| 2.2.7. The elements of geothermal systems | 33 |
| 3. Methodological issues of thermal water reinjection | |
| János Szanyi, Tamás Medgyes, Balázs Kóbor, Imre Czinkota, András Bálint, Máté Oswald, Péter Bába, Márton Papp | 41 |
| 3.1. The theory of reinjection | 41 |
| 3.1.1. International practices of reinjection | 41 |
| 3.1.2. The advantages of reinjection | 42 |
| 3.1.3. The most common problems of reinjection | 43 |
| 3.1.4. The binding forces between the grains of the rock structure | 48 |
| 3.1.5. Aqueous solutions – the thermal water to be reinjected | 49 |
| 3.1.6. The boundary of the solid and fluid phases | 54 |
| 3.1.7. Chemical reactions determining the composition of water | 57 |
| 3.1.8. Chemical processes during reinjection | 61 |
| 3.1.9. Biological processes during reinjection | 63 |
| 3.1.10. A few important parameters of reinjection | 66 |
| 3.2. Practical problems of reinjection | 67 |
| 3.2.1. Technical issues of reinjection | 67 |
| 3.2.2. Sustainability issues of reinjection | 68 |
| 3.2.3. International practices of reinjection | 71 |

| | |
|---|------------|
| 4. Reinjection into sandstone in Hungary | |
| János Szanyi, Tamás Medgyes, Gábor Bozsó, Imre Czinkota, András Bálint, Mihály Kurunczi, Gábor Szongoth, Dénes Gartner, András Prohászka, István Gyenese, Balázs Kovács, Tamás Bozsó, Róbert Bozsó, Péter Bajcsi, Tivadar M.Tóth, Félix Schubert | 75 |
| 4.1. The hydrogeological features of the Carpathian Basin's south-eastern region | 75 |
| 4.1.1. Geological, hydrogeological conditions | 75 |
| 4.1.2. The chemical composition of thermal waters and its importance in the utilization | 82 |
| 4.2. Well logging | 87 |
| 4.2.1. Construction of new thermal wells | 87 |
| 4.2.2. Inspection of old wells | 94 |
| 4.2.3. The inspection of unused thermal wells (dry hydrocarbon wells) | 96 |
| 4.2.4. Exploration of well damages | 96 |
| 4.2.5. Special problems of reinjection wells | 98 |
| 4.2.6. Pumping tests | 101 |
| 4.2.7. Measurement of operational parameters of thermal wells | 103 |
| 4.3. The delimitation of cones of influence | 105 |
| 4.3.1. Active and passive water resource protection | 105 |
| 4.3.2. An overview of the hydraulic and thermal effect of geothermal systems | 107 |
| 4.3.3. Definition of the hydrodynamic and thermal effects of geothermal systems | 110 |
| 4.4. Case studies on establishment and operation | 111 |
| 4.4.1. Principles of operation | 112 |
| 4.4.2. The thermal system in Hódmezővásárhely | 118 |
| 4.4.3. The thermal system in Makó | 122 |
| 4.4.4. The system in Gyopárosfürdő | 125 |
| 4.4.5. The Majsai geothermal greenhouse in Orosháza | 126 |
| 4.4.6. Kurucsai geothermal greenhouse in Pálmonostora | 127 |
| 4.4.7. Varga greenhouse in Tömörkény | 127 |
| 4.4.8. The greenhouse of Fadominó Ltd. in Fülöpjakab | 128 |
| 4.4.9. The thermal systems in Mórahalom | 128 |
| 4.4.10. The geothermal district heating system of University of Szeged | 132 |
| 4.5. Experimental research results | 135 |
| | |
| 5. Suggested methodology for thermal water reinjection | |
| János Szanyi, Balázs Kóbor, Tamás Medgyes, Emőke Egyed, András Bálint, Mihály Kurunczi, Máté Oswald | 143 |
| 5.1. The reinjection plant | 143 |
| 5.1.1. Construction principles of reinjection wells | 143 |
| 5.1.2. Surface filtration, the filter prototype | 145 |
| 5.1.3. The reinjection pump system | 148 |
| 5.1.4. Buffer tank | 148 |
| 5.2. The operation of the reinjection plant | 148 |
| 5.3. The maintenance of the reinjection plant | 149 |
| 5.4. Selection of reinjection well location | 150 |
| | |
| References | 151 |