MULTIPHYSICS MODELING VOLUME 4

# Computational Modeling of Shallow Geothermal Systems

Rafid Al-Khoury



**Rafid Al-Khoury** 

Computational Modeling of Shallow Geothermal Systems Rafid Al-Khoury, 2011-09-30 A Step by step Guide to Developing Innovative Computational Tools for Shallow Geothermal SystemsGeothermal heat is a viable source of energy and its environmental impact in terms of CO2 emissions is significantly lower than conventional fossil fuels Shallow geothermal systems are increasingly utilized for heating and cooling of buildings and green **Computational Modeling of Shallow** Geothermal Systems Rafid Al-Khoury, 2011-09-30 A Step by step Guide to Developing Innovative Computational Tools for Shallow Geothermal SystemsGeothermal heat is a viable source of energy and its environmental impact in terms of CO2 emissions is significantly lower than conventional fossil fuels Shallow geothermal systems are increasingly utilized for heating and cooling of buildings and green Computational Modeling of Shallow Geothermal Systems Rafid Al-Khoury, 2011-09-30 A Step by step Guide to Developing Innovative Computational Tools for Shallow Geothermal Systems Geothermal heat is a viable source of energy and its environmental impact in terms of CO2 emissions is significantly lower than conventional fossil fuels Shallow geothermal systems are increasingly utilized for heating and cooling of buildings and greenhouses However their utilization is inconsistent with the enormous amount of energy available underneath the surface of the earth Projects of this nature are not getting the public support they deserve because of the uncertainties associated with them and this can primarily be attributed to the lack of appropriate computational tools necessary to carry out effective designs and analyses For this energy field to have a better competitive position in the renewable energy market it is vital that engineers acquire computational tools which are accurate versatile and efficient This book aims at attaining such tools This book addresses computational modeling of shallow geothermal systems in considerable detail and provides researchers and developers in computational mechanics geosciences geology and geothermal engineering with the means to develop computational tools capable of modeling the complicated nature of heat flow in shallow geothermal systems in rather straightforward methodologies Coupled conduction convection models for heat flow in borehole heat exchangers and the surrounding soil mass are formulated and solved using analytical semi analytical and numerical methods Background theories enhanced by numerical examples necessary for formulating the models and conducting the solutions are thoroughly addressed The book emphasizes two main aspects mathematical modeling and computational procedures In geothermics both aspects are considerably challenging because of the involved geometry and physical processes However they are highly stimulating and inspiring A good combination of mathematical modeling and computational procedures can greatly reduce the computational efforts This book thoroughly treats this issue and introduces step by step methodologies for developing innovative computational models which are both rigorous and computationally efficient Geochemical Modeling of Groundwater, Vadose and Geothermal Systems Jochen Bundschuh, Michael Zilberbrand, 2011-12-23 Geochemical modeling is an important tool in environmental studies and in the areas of subsurface and surface hydrology pedology water resources

management mining geology geothermal resources hydrocarbon geology and related areas dealing with the exploration and extraction of natural resources The book fills a gap in the literature through **Advanced Modelling with the MATLAB** Reservoir Simulation Toolbox Knut-Andreas Lie,Olav Møyner,2021-11-25 Presents advanced reservoir simulation methods used in the widely used MRST open source software for researchers professionals students **Numerical Simulation in** Hydraulic Fracturing: Multiphysics Theory and Applications Xinpu Shen, William Standifird, 2017-03-27 The expansion of unconventional petroleum resources in the recent decade and the rapid development of computational technology have provided the opportunity to develop and apply 3D numerical modeling technology to simulate the hydraulic fracturing of shale and tight sand formations This book presents 3D numerical modeling technologies for hydraulic fracturing developed in recent years and introduces solutions to various 3D geomechanical problems related to hydraulic fracturing In the solution processes of the case studies included in the book fully coupled multiphysics modeling has been adopted along with innovative computational techniques such as submodeling In practice hydraulic fracturing is an essential project component in shale gas oil development and tight sand oil and provides an essential measure in the process of drilling cuttings reinjection CRI It is also an essential measure for widened mud weight window MWW when drilling through naturally fractured formations the process of hydraulic plugging is a typical application of hydraulic fracturing 3D modeling and numerical analysis of hydraulic fracturing is essential for the successful development of tight oil gas formations it provides accurate solutions for optimized stage intervals in a multistage fracking job It also provides optimized well spacing for the design of zipper frac wells Numerical estimation of casing integrity under stimulation injection in the hydraulic fracturing process is one of major concerns in the successful development of unconventional resources. This topic is also investigated numerically in this book Numerical solutions to several other typical geomechanics problems related to hydraulic fracturing such as fluid migration caused by fault reactivation and seismic activities are also presented This book can be used as a reference textbook to petroleum geotechnical and geothermal engineers to senior undergraduate graduate and postgraduate students and to geologists hydrogeologists geophysicists and applied mathematicians working in this field This book is also a synthetic compendium of both the fundamentals and some of the most advanced aspects of hydraulic fracturing technology

Mathematical and Numerical Modeling in Porous Media Martin A. Diaz Viera, Pratap Sahay, Manuel Coronado, Arturo Ortiz Tapia, 2012-07-24 Porous media are broadly found in nature and their study is of high relevance in our present lives In geosciences porous media research is fundamental in applications to aquifers mineral mines contaminant transport soil remediation waste storage oil recovery and geothermal energy deposits Despite their importance there is as yet no complete

Tubular String Characterization in High Temperature High Pressure Oil and Gas Wells Jiuping Xu, Zezhong Wu, 2018-10-30 High temperature high oil pressure oil and gas well completion testing have always been a technical challenge and basic theoretical research is one of the key factors needed to ensure a successful completion test The

completion test basic theory includes a stress analysis of the completion string completion string buckling behavior and temperature and pressure distribution prediction The completion string is the main bearing and power transmission component for oil and gas well operations and production and it is required to take on a combination of loads which result in completion string deformation Because of these complex relationships completion string stress analysis has become increasingly more complicated This book discusses the characters of tubular strings in HTHP High Temperature High Pressure oil and gas wells These characters include the mechanical behavior of tubular strings and the temperature and pressure variation of tubular strings in different conditions Mathematical models are established for different conditions and solution existence and uniqueness of some models is discussed providing algorithms corresponding to the different models Numerical experiments are presented to verify the validity of models and the feasibility of algorithms and the impact of the parameters of models for oil and gas wells is also discussed This book is written for production and testing engineers to provide them with the tools to deal more effectively with the numerical decisions they have to take and for researchers and technicians in petroleum and gas testing and production engineering Finally it is also intended to serve as a reference book Thermo-Hydro-Mechanical-Chemical Processes in Fractured Porous for mathematicians college teachers and students Media: Modelling and Benchmarking Olaf Kolditz, Thomas Nagel, Hua Shao, Wenging Wang, Sebastian Bauer, 2018-03-01 The book comprises the 3rd collection of benchmarks and examples for porous and fractured media mechanics Analysis of thermo hydro mechanical chemical THMC processes is essential to a wide area of applications in environmental engineering such as geological waste deposition geothermal energy utilization shallow and deep systems carbon capture and storage CCS as well as water resources management and hydrology In order to assess the feasibility safety as well as sustainability of geoenvironmental applications model based simulation is the only way to quantify future scenarios This charges a huge responsibility concerning the reliability of conceptual models and computational tools Benchmarking is an appropriate methodology to verify the quality and validate the concept of models based on best practices Moreover benchmarking and code comparison are building strong community links The 3rd THMC benchmark book also introduces benchmark based tutorials therefore the subtitle is selected as From Benchmarking to Tutoring The benchmark book is part of the OpenGeoSys initiative an open source project to share knowledge and experience in environmental analysis and scientific computation The new version of OGS 6 is introduced and first benchmarks are presented therein see appendices Thermal Use of Shallow Groundwater Fritz Stauffer, Peter Bayer, Philipp Blum, Nelson Molina Giraldo, Wolfgang Kinzelbach, 2013-12-12 The thermal use of the shallow subsurface is increasingly being promoted and implemented as one of many promising measures for saving energy A series of questions arises concerning the design and management of underground and groundwater heat extraction systems such as the sharing of the thermal resource and the assessment of its long term potential For the proper design of thermal systems it is necessary to assess their impact on underground and groundwater temperatures Thermal Use

of Shallow Groundwater introduces the theoretical fundamentals of heat transport in groundwater systems and discusses the essential thermal properties It presents a complete overview of analytical and numerical subsurface heat transport modeling providing a series of mathematical tools and simulation models based on analytical and numerical solutions of the heat transport equation It is illustrated with case studies from Austria Germany and Switzerland of urban thermal energy use and heat storage and cooling This book gives a complete set of analytical solutions together with MATLAB computer codes ready for immediate application or design It offers a comprehensive overview of the state of the art of analytical and numerical subsurface heat transport modeling for students in civil or environmental engineering engineering geology and hydrogeology and also serves as a reference for industry professionals

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