Multiphase Flow And Transport Processes In The Subsurface A Contribution To The Modeling Of Hydrosystems Environmental Science And Engineering

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COLEMAN LEBLANC

Convective Heat and Mass Transfer
Springer Science & Business Media
This book provides concise, up-to-date and easy-to-follow information on certain aspects of an ever important research area: multiphase flow in porous media. This flow type is of great significance in many petroleum and environmental engineering problems, such as in secondary and tertiary oil recovery, subsurface remediation and CO2 sequestration. This book contains a collection of selected papers (all refereed) from a number of well-known experts on multiphase flow. The papers describe both recent and state-of-the-art modeling and experimental techniques for study of multiphase flow phenomena in porous media. Specifically, the book analyses three advanced topics: upscaling, pore-scale modeling, and dynamic effects in multiphase flow in porous media. This will be an invaluable reference for the development of new theories and computer-based modeling techniques for solving realistic multiphase flow problems. Part of this book has already been published in a journal. Audience This book will be of interest to academics, researchers and consultants working in the area of flow in porous media.

High Performance Computing in Science and Engineering ’02 Cambridge University Press
This book has been written for graduate students, scientists and engineers who need in-depth theoretical foundations to solve two-phase problems in various technological systems. Based on extensive research experiences focused on the fundamental physics of two-phase flow, the authors present the detailed theoretical foundation of multi-phase flow thermo-fluid dynamics as they apply to a variety of scenarios, including nuclear reactor transient and accident analysis, energy systems, power generation systems and even space propulsion.

Transport Processes in Porous Media Springer Science & Business Media
The study of multiphase flow through porous media is undergoing intense development, mostly due to the recent introduction of new methods. After the profound changes induced by percolation in the eighties, attention is nowadays focused on the pore scale. The physical situation is complex and only recently have tools become available that allow significant progress to be made in the area. This volume on Multiphase Flow in Porous Media, which is also being published as a special issue of the journal Transport in Porous Media, contains contributions on the lattice-Boltzmann technique, the renormalization technique, and semi-phenomenological studies at the pore level. Attention is mostly focused on two-

and three-phase flows. These techniques are of tremendous importance for the numerous applications of multiphase flows in oil fields, unsaturated soils, the chemical industry, and environmental sciences.

Multiphase Flow and Transport in the Subsurface Springer

Treating multiphase systems with emphasis on the aspect of fluid dynamics and as an introduction to research in multiphase flow, this book covers definitive concepts, methods, and theories which have been validated by experimental results. A textbook for college seniors and graduate students and a research reference, it is a coherent presentation that facilitates the understanding of physical interactions. The book's focus is fluid dynamics, with extension to other transport processes of heat and mass transfer, and chemical relations to illustrate applications of multiphase flow. The exercise problems at the end of each chapter assist the reader in formulating and solving physical problems and gaining a sense of magnitude of interacting effects and events. Extended details and corollaries are also included in these exercise problems. Some of the topics in the exercise problems may also be incorporated as topics for the lectures.

Applications to Cities, Vegetative Canopies and Industry Gulf Professional Publishing

Numerical simulation models have become indispensable in hydro- and environmental sciences and engineering. This monograph presents a general

introduction to numerical simulation in environment water, based on the solution of the equations for groundwater flow and transport processes, for multiphase and multicomponent flow and transport processes in the subsurface as well as for flow and transport processes in surface waters. It displays in detail the state of the art of discretization and stabilization methods (e.g. finite-difference, finite-element, and finite-volume methods), parallel methods, and adaptive methods as well as fast solvers, with particular focus on explaining the interactions of the different methods. The book gives a brief overview of various information-processing techniques and demonstrates the interactions of the numerical methods with the information-processing techniques, in order to achieve efficient numerical simulations for a wide range of applications in environment water.

From Pore to Core and Beyond Springer Nature

Open system behavior is predicated on a fundamental relationship between the timescale over which mass is transported and the timescale over which it is chemically transformed. This relationship describes the basis for the multidisciplinary field of reactive transport (RT). In the 20 years since publication of Review in Mineralogy and Geochemistry volume 34: Reactive Transport in Porous Media, RT principles have expanded beyond early applications largely based in contaminant hydrology to become

broadly utilized throughout the Earth Sciences. RT is now employed to address a wide variety of natural and engineered systems across diverse spatial and temporal scales, in tandem with advances in computational capability, quantitative imaging and reactive interface characterization techniques. The present volume reviews the diversity of reactive transport applications developed over the past 20 years, ranging from the understanding of basic processes at the nano- to micrometer scale to the prediction of Earth global cycling processes at the watershed scale. Key areas of RT development are highlighted to continue advancing our capabilities to predict mass and energy transfer in natural and engineered systems.

Multiphase Flow and Transport Processes in the Subsurface Springer Science & Business Media

This volume contains the invited lectures presented during the NATO/ASI conducted in Pullman, Washington, July 9-18, 1989. This is the third in a series of NATO/ASIs on transport phenomena in porous media. The first two, which took place at Newark, Delaware in 1982 and 1985, are devoted to various topics related to the Fundamentals of Transport Processes in Porous Media. The contents of the books resulting from previous NATO/ASIs are given at the end of this book. Transport of extensive quantities such as mass of a fluid phase, mass of chemical species carried by a fluid phase, energy and electric charge in porous media, as encountered in a large

variety of engineering disciplines, is an emerging interdisciplinary field. The groundwater flow, the simultaneous flow of gas, oil and water in petroleum reservoirs, the movement and accumulation of pollutants in the saturated and unsaturated subsurface zones, thermal energy storage in reservoirs, land subsidence in response to charges in overburden loads, or to pumping of fluids from underground formations, wave propagation in seismic investigations or as produced by earthquakes, chemical reactors, water flow through sand filters and the movement of fluids through kidneys, may serve as examples of fields in which the theory of transport in porous media is employed.

Investigation of Fluid Flow and Contaminant Transport Processes in Heterogeneous Multiphase Systems John Wiley & Sons

Convective Heat and Mass Transfer, Second Edition, is ideal for the graduate level study of convection heat and mass transfer, with coverage of well-established theory and practice as well as trending topics, such as nanoscale heat transfer and CFD. It is appropriate for both Mechanical and Chemical Engineering courses/modules.

Efficient Numerical Methods and Information-Processing Techniques for Modeling Hydro- and Environmental Systems Springer Science & Business Media

Recent advances in imaging technology and numerical modeling have greatly enhanced pore-scale investigations of

multiphase flow and transport in porous media. It is now feasible to obtain high resolution 3-dimensional pore-scale data, and numerical methods such as the lattice- Boltzmann (LB) technique have been developed specifically for simulating such phenomena. Traditional macro-scale multiphase flow models rely heavily on empirical relationships. For example, the interaction between fluids at their interfaces is accounted for indirectly through the empirical relative permeability relationship. Nevertheless, it has recently been hypothesized that the single most important variable missing from current macro-scale models is the measure of interfacial dynamics between fluids within the pores. Furthermore, the empirical capillary pressure-saturation relationship used in macro-scale multiphase flow simulators has been shown to be a function of interfacial area per volume. This study focuses on (1) the measurement and modeling of the capillary pressure-saturation relationship; and (2) the characterization of the fluid-fluid interfacial area per volume as a function of saturation. The study synthesizes experimental results derived from pore-scale computerized micro-tomographic (CMT) images with LB simulations. An image analysis algorithm for quantifying fluid-fluid interfacial area per volume from experimental CMT and simulation images was developed and verified. The experimental results were shown to be in good agreement with values reported in the literature. Furthermore, the capillary ressure-

saturation curves were used to validate a recently proposed macro-scale interfacial area model. New LB simulations of drainage and imbibition for an air-water system were developed, in which the full geometry from the experimental system was used to define the lattice. This allowed for the direct comparison of experimental and simulated phase distributions within the pores. LB simulations showed excellent agreement with experimental results, considering no optimization or calibration to the data was required. Collectively, results show that there is a complex functional relationship between capillary pressure, saturation and interfacial area that provides insights into multiphase flow and transport processes that can not be obtained from the capillary pressure-saturation relationship alone.

The TOUGH Codes - a Family of Simulation Tools for Multiphase Flowand Transport Processes in Permeable Media

Springer Science & Business Media

Numerical simulation has become a widely practiced andaccepted technique for studying flow and transport processes in thevadose zone and other subsurface flow systems. This article discusses asuite of codes, developed primarily at Lawrence Berkeley NationalLaboratory (LBNL), with the capability to model multiphase flows withphase change. We summarize history and goals in the development of theTOUGH codes, and present the governing equations for multiphase, multicomponent flow. Special emphasis

is given to space discretization bymeans of integral finite differences (IFD). Issues of code implementationand architecture are addressed, as well as code applications, maintenance, and future developments.

Transport Processes at Fluidic Interfaces
EOLSS Publications
This book presents the state-of-the-art in modeling and simulation on supercomputers. Leading German research groups present their results achieved on high-end systems of the High Performance Computing Center Stuttgart (HLRS) for the year 2002. Reports cover all fields of supercomputing simulation ranging from computational fluid dynamics to computer science. Special emphasis is given to industrially relevant applications. Moreover, by presenting results for both vector sytems and micro-processor based systems the book allows to compare performance levels and usability of a variety of supercomputer architectures. It therefore becomes an indispensable guidebook to assess the impact of the Japanese Earth Simulator project on supercomputing in the years to come.

Multiphase Flow in Porous Media
WIT Press
Multiphase Fluid Flow in Porous and Fractured Reservoirs discusses the process of modeling fluid flow in petroleum and natural gas reservoirs, a practice that has become increasingly complex thanks to multiple fractures in horizontal drilling and the discovery of more unconventional reservoirs and

resources. The book updates the reservoir engineer of today with the latest developments in reservoir simulation by combining a powerhouse of theory, analytical, and numerical methods to create stronger verification and validation modeling methods, ultimately improving recovery in stagnant and complex reservoirs. Going beyond the standard topics in past literature, coverage includes well treatment, Non-Newtonian fluids and rheological models, multiphase fluid coupled with geomechanics in reservoirs, and modeling applications for unconventional petroleum resources. The book equips today's reservoir engineer and modeler with the most relevant tools and knowledge to establish and solidify stronger oil and gas recovery. Delivers updates on recent developments in reservoir simulation such as modeling approaches for multiphase flow simulation of fractured media and unconventional reservoirs Explains analytical solutions and approaches as well as applications to modeling verification for today's reservoir problems, such as evaluating saturation and pressure profiles and recovery factors or displacement efficiency Utilize practical codes and programs featured from online companion website

Theory and Modeling Springer

This book offers a fundamental and practical introduction to the use of computational methods. A thorough discussion of practical aspects of the subject is presented in a consistent

manner, and the level of treatment is rigorous without being unnecessarily abstract. Each chapter ends with bibliographic information and exercises.

Transport Phenomena in Multiphase Flows Courier Corporation

The research included in this volume focuses on using synergies between experimental and computational techniques to gain a better understanding of all classes of multiphase and complex flow. The included papers illustrate the close interaction between numerical modellers and researchers working to gradually resolve the many outstanding issues in our understanding of multiphase flow. Recently multiphase fluid dynamics have generated a great deal of attention, leading to many notable advances in experimental, analytical and numerical studies. Progress in numerical methods has permitted the solution of many practical problems, helping to improve our understanding of the physics involved. Multiphase flows are found in all areas of technology and the range of related problems of interest is vast, including astrophysics, biology, geophysics, atmospheric process, and many areas of engineering.

Hydrodynamics and Transport Processes of Inverse Bubbly Flow Halsted Press

This is the first book that reviews problems in different fluid mechanics disciplines that led to the concept of canopy, or penetrable roughness. Despite their diversity, many flows may be theoretically united by means of introducing distributed sinks and/or

sources of momentum and heat and mass. These and other flows in engineering and environmental situations over surfaces with many obstacles are reviewed in terms of general concepts of fluid mechanics.

Hydraulic Structure,Equipment and Water Data Acquisition Systems - Volume I Routledge

Hydrodynamics and Transport Processes of Inverse Bubbly Flow provides the science and fundamentals behind hydrodynamic characteristics, including flow regimes, gas entrainment, pressure drop, holdup and mixing characteristics, bubble size distribution, and the interfacial area of inverse bubble flow regimes. Special attention is given to mass and heat transfer. This book is an indispensable reference for researchers in academia and industry working in chemical and biochemical engineering. Hydrodynamics and Transport Processes of Inverse Bubbly Flow helps facilitate a better understanding of the phenomena of multiphase flow systems as used in chemical and biochemical industries. A first book in the market dedicated to the hydrodynamics of inverse bubbly flows Includes fundamentals of conventional and inverse bubble columns for different hydrodynamic parameters Includes recommendations for future applications of bubble flows

On the Inclusion of the Interfacial Area Between Phases in the Physical and Mathematical Description of Subsurface Multiphase Flow. 1998 Annual Progress Report Multiphase Flow and Transport Processes in the SubsurfaceA

Contribution to the Modeling of Hydrosystems
Learn the fundamental concepts that underlie the physics of multiphase flow and transport in porous media with the information in Essentials of Multiphase Flow in Porous Media, which demonstrates the mathematical-physical ways to express and address multiphase flow problems. Find a logical, step-by-step introduction to everything from the simple concepts to the advanced equations useful for addressing real-world problems like infiltration, groundwater contamination, and movement of non-aqueous phase liquids. Discover and apply the governing equations for application to these and other problems in light of the physics that influence system behavior.

Transport Processes in Chemically Reacting Flow Systems Springer Science & Business Media
Numerical simulation models have become indispensable in hydro- and environmental sciences and engineering. This monograph presents a general introduction to numerical simulation in environment water, based on the solution of the equations for groundwater flow and transport processes, for multiphase and multicomponent flow and transport processes in the subsurface as well as for flow and transport processes in surface waters. It displays in detail the state of the art of discretization and stabilization methods (e.g. finite-difference, finite-element, and finite-volume methods), parallel methods, and

adaptive methods as well as fast solvers, with particular focus on explaining the interactions of the different methods. The book gives a brief overview of various information-processing techniques and demonstrates the interactions of the numerical methods with the information-processing techniques, in order to achieve efficient numerical simulations for a wide range of applications in environment water.

Transactions of the High Performance Computing Center Stuttgart (HLRS) 2002

Springer

This textbook provides a thorough presentation of the phenomena related to the transport of mass, momentum and energy. It lays all the basic physical principles, then for the more advanced readers, it offers an in-depth treatment with advanced mathematical derivations and ends with some useful applications of the models and equations in specific settings. The important idea behind the book is to unify all types of transport phenomena, describing them within a common framework in terms of cause and effect, respectively represented by the driving force and the flux of the transported quantity. The approach and presentation are original in that the book starts with a general description of transport processes, providing the macroscopic balance relations of fluid dynamics and heat and mass transfer, before diving into the mathematical realm of continuum mechanics to derive the microscopic governing equations at the microscopic level. The book is a modular teaching tool and can be used

either for an introductory or for an advanced graduate course. The last 6 chapters will be of interest to more advanced researchers who might be interested in particular applications in physics, mechanical engineering or biomedical engineering. All chapters are complemented with exercises that are essential to complete the learning process.

In Conventional and Miniature Systems

CRC Press

This volume fills the need for a textbook presenting basic governing and constitutive equations, followed by several engineering problems on multiphase flow and transport that are not provided in current advanced texts, monographs, or handbooks. The unique emphasis of this book is on the sound formulation of the basic equations describing multiphase transport and how they can be used to design processes in selected industrially important fields. The clear underlying mathematical and physical bases of the interdisciplinary description of multiphase flow and transport are the main themes, along with advances in the kinetic theory for particle flow systems. The book may be used as an upper-level undergraduate or graduate textbook, as a reference by professionals in the design of processes that deal with a variety of multiphase systems, and by practitioners and experts in multiphase science in the area of computational fluid dynamics (CFD) at U.S. national laboratories, international universities, research laboratories and institutions, and in the chemical,

pharmaceutical, and petroleum industries. Distinct from other books on multiphase flow, this volume shows clearly how the basic multiphase equations can be used in the design and scale-up of multiphase processes. The authors represent a combination of nearly two centuries of experience and innovative application of multiphase transport representing hundreds of publications and several books. This book serves to encapsulate the essence of their wisdom and insight, and:

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