Preface

In recent years, transport phenomena in porous media have attracted significant attention from multiple branches of science and engineering. The reasons for such renewed interest are twofold. First, the past two decades have experienced the emergence of a variety of porous media applications, primarily involving energy, environment, and biological systems. Second, the rapid increase in computing power has facilitated theoretical advancement in porous media transport modeling. In this context, the present monograph appends classical theories of porous media transport with recent advancements in the domain. The monograph aims at providing a strong support to the graduate and senior undergraduate students interested in porous media research.

This book is primarily divided into two parts: theory and applications. Types of porous media and the importance of mathematical modeling of transport through such media are discussed in Chap. 1. While Chaps. 2 and 3 discuss the theories of transport phenomena in porous media, Chaps. 4–7 deal with engineering applications and their modeling considerations. Finally, Chap. 8 summarizes the present understanding as well as the imminent challenges of modeling transport phenomena through porous media.

Modeling of transport through porous media may be undertaken at various scales. Chapter 2 examines the fundamental distinction of continuum- to pore-scale models. The chapter then follows the historical development from the Darcian transport model to the contemporary phenomenological formalisms. Chapter 2 also includes the treatment of multiphase flow and heat transfer through porous media. Finally, charge transport and chemical reactions are also included. In continuation with the continuum models developed in Chaps. 2 and 3 outlines the mesoscale models for transport in porous media. In particular, Chap. 3 delineates the application of Lattice Boltzmann method (LBM) in understanding transport phenomena at the pore scale. The chapter compares relative advantages of LBM in complex geometries, particularly in porous media with the continuum formulation.

The theoretical development, discussed in Chaps. 2 and 3, provides the essential background for the applications contained in Chaps. 4–7. Chapters 4 and 5 describe models of transport phenomena in electrochemical and biological systems. While

Chap. 4 includes the modeling of fuel cells and batteries, Chap. 5 describes blood flow through aneurysms in human arteries. Chapter 6 includes a novel approach of modeling oscillatory flow in heat exchangers within a porous media framework. Finally, Chap. 7 encompasses the reservoir simulation for CO_2 sequestration in hydrate form. Overall, Chaps. 5–7 cover broad areas of contemporary applications in porous media, encouraging interested researchers to delve into their chosen areas.

While this book provides theoretical and modeling support with examples to porous media researchers, it does not intend to substitute well-established monographs on transport phenomena. Fundamental knowledge of fluid mechanics, heat and mass transfer, and electrochemical systems is necessary to efficiently utilize this book. Finally, the references included in this book will provide additional resources of study for early researchers in the subject.

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