Preface

This book evolved from the lectures I presented at the U.S. NSF-CBMS Regional Research Conference, University of Nevada, Las Vegas (UNLV), May 23–27, 2006, on the subject of multiphase flows in porous media and simulation. It can be used as a text for senior undergraduate students and first-year graduate students in geology, petroleum engineering, and applied mathematics. It can also serve as a reference book for geologists, petroleum engineers, applied mathematicians, and scientists in the area of petroleum reservoirs. In addition, it can be used as a handbook for employees in the oil industry who need a basic grasp of modeling and computational method concepts. Calculus, basic physics, and some familiarity with partial differential equations and matrix algebra are necessary prerequisites.

The ten chapters correspond to the ten respective lectures I presented at UNLV. In Chapter 1, an overview of classical reservoir engineering and basic reservoir simulation methods is presented. In Chapter 2, a glossary of terms used in petroleum engineering and their units are reviewed. In Chapters 3 and 5–9, governing partial differential equations and their numerical solutions are, respectively, given for single-phase, two-phase, black oil (three-phase), single phase with multicomponents, compositional, and thermal flows. For each of these flows, (1) basic flow and transport equations are first given; (2) the corresponding rock and fluid properties are stated; (3) peculiar features of these equations are discussed; (4) the procedure to obtain their numerical solution is described in detail; and (5) difficulties and practical issues in the solution are addressed. Particularly, the treatment of rock, fluid, and rock/fluid properties at the internal boundaries of gridblocks is studied in great detail. Well representations used in numerical simulation of these flows are described in Chapter 4. Some practical aspects of reservoir simulation, such as data gathering and analysis, selection of a simulation model, history matching, and reservoir performance prediction, are summarized in Chapter 10. In the numerical solution, as an example, the discretization procedure is carried out in detail for the finite difference method; finite volume and finite element discretizations can be found in the book by Chen, Huan, and Ma (2006). Numerical benchmark examples have been presented for all the flows under consideration by Chen et al. (2006) except for the single phase, multicomponent flow, for which a couple of numerical examples are given.

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