Preface

The depletion of conventional oil and gas reservoirs as well as the rise in the energy demand has compelled the upstream oil industry to search for alternative energy sources such as unconventional hydrocarbon reservoirs to meet the demand. Shale gas reservoirs as an unconventional energy source are organic-rich formations considered as both the source rock and the reservoir. Gas is stored in the limited pore space of the rock while substantial fraction of gas is adsorbed on the organic material. These reservoirs exhibit extremely low permeability and thus require effective stimulation strategies in place to produce economically.

The "shale gas boom" occurred in the last decade in the USA has stimulated huge production of oil and natural gas from shale gas reservoirs. The advances in production technology and application of combined horizontal drilling and hydraulic fracturing have facilitated such production. However, long-term exploitation of shale gas reservoirs poses some inherent challenges to upstream oil industry. These challenges emanate from the characteristics of shale gas reservoirs which differ from those of conventional gas reservoirs. They contain natural gas both in the pore spaces of reservoir rock and as adsorbed gas on the surface of rock grain. Very low permeability in shale formations means that the fluid flow mechanisms are different and in general more complicated than permeable reservoirs. In addition, a major factor determining the productivity of this type of reservoirs is the existence of a natural fracture network. Drilling long horizontal wells with multiple hydraulic fracturing has been established as the method of depleting shale gas reservoirs. The combination of an ultra-tight shale matrix with hydraulic fractures, natural fractures and a horizontal well results in a complicated flow system that cannot be modelled accurately using the existing conventional models. Exploring these challenges and the relevant advancements in modelling and simulation of shale gas reservoirs has been the main drive for writing this book.

Although there has been a tremendous research to understand the underlying differences between these formations and conventional reservoirs and major steps have been taken towards modelling of shale reservoirs with natural fracture network coupled with hydraulic fracturing, due to the numerous challenges in characterisation of shale formations, the fundamental differences in modelling and simulation

of such formations compared with conventional reservoirs are poorly understood. On the other hand, the results of the investigations on the area are very much scattered and fragmented while the various studies are yet to be integrated and assimilated. The aim of the present book is to try to bring much of the relevant fundamental understandings together into one place and to present a unified approach to the ideas produced for modelling of shale gas reservoirs.

"Challenges in Modelling and Simulation of Shale Gas Reservoirs", therefore, tends to be an insightful book about modelling aspects of shale gas reservoirs considering their ingrained dissimilarities with conventional gas reservoirs. The book starts with an introduction to the shale gas reservoirs and the inherent challenges encountered in simulation of them in Chap. 1. Then, different modelling and simulation challenges such as complexity of fracture network, adsorption phenomena, non-Darcy flow, natural fracture network, etc. are discussed in detail and the latest findings in those areas are presented. These are covered in Chaps. 2 and 3. Chapter 4 addresses the available techniques for evaluation of production performance and the ways they can be adapted to shale gas reservoirs.

We, the authors, believe that the book would be of interest to the scientific community of petroleum industry in both industry and academia and hope that the readers can learn and understand the complications present in developing shale gas models and compare analytical modelling as well as numerical simulation of shale gas with those of conventional reservoirs. They can also benefit from a comprehensive review of the state of the art in developing shale gas models and simulators in the upstream oil industry, which can eventually lead to a better understanding of these reservoirs and facilitate the systematic research on efficient development of shale gas plays.

In this book, we aim to cover the cutting-edge information about analytical and numerical modelling of shale gas reservoirs and elaborate on the various challenges about simulation of these reservoirs which may, if not considered, lead to erroneous results when doing the calculations related to exploration and production of these resources. While we have endeavoured to gather as many research works and publications as possible from the subject experts, it is not unlikely to have missed a particular paper with noticeable outcomes. Furthermore, it is possible to misinterpret some statements from the work of others. In other words, the book we have produced will not be flawless. Therefore, any feedback or comments with regards to the contents of this book will be most welcome and will help us to improve the future editions.

We take this opportunity to thank many people who have helped, in different ways, in the preparation of this book. In particular, we thank Mr. Michael Kenomore for his inputs on the status of shale gas in the UK. We would also like to express our appreciation to the editorial staff of Springer International Publishing Company for their patience and understanding.

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