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Editorial: Advancements of Phase Behavior and Fluid Transport in Petroleum Reservoirs

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Editorial on the Research Topic

Advancements of Phase Behavior and Fluid Transport in Petroleum Reservoirs

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MOTIVATION AND BACKGROUND

Petroleum reservoirs are one of the most important energy resources in the world. In such a difficult time, its efficient development plays an important role for the security of world energy supply. Specifically, during the recovery process of petroleum reservoirs, fluid phase behavior and transportation in porous media are always the two most important issues. The former can determine the fluid state in reservoirs, and the latter controls the fluid flowability. Thus, an accurate description of the two issues usually guarantees the development efficiency of a petroleum reservoir. Especially, in recent decades, with the successful development of various unconventional petroleum resources, the Research Topic of phase behavior and fluid transport in such unconventional reservoirs have also attracted significant attention.

Firstly, for conventional petroleum reservoirs, during the recovery process, with the reduction of reservoir pressure and the injection of different additives (e.g., N_2, CO_2, solvent, and chemical additives, etc.), the original fluid phase state in the reservoir will change, simultaneously, the fluid transportation characteristics also vary because of the continuous change of reservoir conditions. Then, for unconventional reservoirs, because of the complicated porous medium condition, an accurate description of the fluid phase behavior and transportation is a challenge. Therefore, the focus of this Research Topic is therefore placed on an improved understanding of the phase behavior and fluid transport mechanisms in different types of petroleum reservoirs. It addresses the most recent advances in experimental and numerical simulation methods to study the fluid phase behavior and transportation process in different petroleum reservoirs.

CONTENTS OF THE RESEARCH TOPIC

Fluid Phase Behavior and Transportation in Unconventional Reservoirs

By considering the various fluid flow mechanisms in shale, Guo et al. propose an apparent permeability model for shale gas reservoirs. They comparatively analyze the contribution of viscous slippage flow, Knudsen diffusion, and surface diffusion to the apparent permeability of shale. This work provides a good basis for an accurate measurement on the permeability of shale rocks.

Wang et al. develop a water–oil flow model for the behavior of water imbibition and the oil drainage process in hydraulically fractured shales. Based on their model, the main characteristics of post-fracturing soaking are simulated. Simultaneously, the oil–water exchange efficiency and exchange volume are also evaluated. This work provides some new insights to understanding the oil–water exchanging behavior in shale oil reservoirs.

Jia et al. investigate the mechanisms of the shut-in process in shale reservoirs after fracturing and summarize the EOR mechanisms of the well shut-in process. Then, a single well shut-in numerical simulation model is established and the oil-water distribution and change laws of shut-in shale reservoirs after fracturing are analyzed. This work provides a deep understanding of the EOR mechanisms of shut-in wells in shale reservoirs.

Qiao et al. experimentally and numerically discuss the CO_2 mass transfer behavior and oil replacement capacity in fractured shale oil reservoirs. It is found that CO_2 can gradually exchange the oil in a matrix into fractures and improve oil fluidity in a matrix until an equilibrium state is achieved. This work provides a good reference for the evaluation of well shut-in time and production management after CO_2 fracturing in shale oil reservoirs.

Based on a series of tests on the physical properties of shale in Sichuan Basin, Wu et al. numerically evaluate the post-fracturing flowback behavior of shale gas wells. Some sensitive factors and their mechanisms are analyzed. This work provides a good basis to understanding the shale gas drainage–production system after hydraulic fracturing.

Fluid Phase Behavior and Transportation in Conventional Reservoirs

Zheng et al. develop a visual fluid flow experimental device to investigate the flow behavior of N_2 water in porous media. Then, by using a field scale reservoir simulation model, the water-coning behavior of edge water is systematically studied through two novel indicators. This work further clarifies the mechanisms of the N_2 injection process to control water coning in heavy oil reservoirs and provides a useful reference for the EOR process of heavy oil reservoirs with edge water.

Kang et al. simulate the unsteady flow behavior of gas and water in dual-medium gas reservoirs from a proposed two-phase flow model. They fully consider the effect of stress sensitivity and non-Darcy flow. Then, by introducing the perturbation theory, a productivity evaluation model is developed for the dual-medium gas reservoir. This work provides a good reference to understanding the recovery performance of dual-medium gas reservoirs.

Aiming at the productivity of gas wells, Er-hu et al. establish a single-point deliverability formula from the binomial productivity equation and modified isochronous well test method. Based on their proposed method, the productivity of the Jingbian sector in Yan'an gas field is evaluated. It is found that the one-point productivity formula has high precision and is suitable for the productivity analysis of gas wells.

Aiming at a sour gas reservoir in Sichuan Basin, Zhang et al. experimentally discuss elemental sulfur solubility by using a static method. The effect of pressure and H_2S content is experimentally discussed. Furthermore, some published models are also used to history match the experimental data. Considering the important role of elemental sulfur solubility, this work provides some important basic data for the development process of a sour gas reservoir.

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