PREFACE: MULTIPHASE FLOWS IN POROUS MEDIA

This special issue contains invited papers, whose authors presented their work at one or more of the following conferences: The Chinese Congress of Theoretical and Applied Mechanics on August 15–18 in Shanghai, National Conference of Heat Mass Transfer of China on November 1–2 in Dalian, and National Conference of Multiphase Flow of China on November 11–13 in Nanjing, 2015. From over 2000 papers including around 20 keynote lectures, approximately 20 of the highest-quality papers were selected. These papers went through a complete peer review process after which, nine papers were accepted for publication.

Contained herein, for theoretical and numerical studies, the article "Effect of Particle Size on Superheated Steam Generation in a Zeolite–Water Adsorption Heat Transformer" by Xue et al. presents a mathematical model to investigate the effect of zeolite particle size on the transient mass and heat transfer during generation process. Numerical results based on this model show that the maximum temperature in both zeolite and generated steam gradually decreases as zeolite particle size increases. Meanwhile the adsorption rate becomes slower, so it takes a longer time for the packed bed to achieve adsorption equilibrium. Steam generation time is the same for different particle sizes, while the average steam generation temperature declines with an increase in particle sizes. After the preheating process the maximum steam temperature decreases slightly for small particle sizes but as expected increases for larger particle sizes.

The article "Simulation of Spontaneous Imbibition Process in Tight Porous Media with Complex Discrete Fracture Network" by Lei et al. studies the spontaneous imbibition in the displacement mechanism of a non-wetting fluid in naturally fractured reservoirs. They present a numerical method to precisely model the spontaneous countercurrent imbibition of tight oil reservoirs after extensive hydraulic fracturing in order to provide an insight into the oil recovery mechanism. The discrete fracture model is adapted to precisely model the features of the fluid flow inside fractures and the interaction between the matrix and the fracture media. After validations by experimental data, numerical simulations are performed to evaluate the effects of spontaneous imbibition process on enhanced oil recovery, which indicates that the complex fracture network and cyclic injection parameters play an important role through spontaneous imbibition of the total oil recovery.

The article "A Fractal-Based Model for Relative Permeability in Nanoscale Pores with Interfacial Effects" by Wang et al. reports an analytical model of the gas–water relative permeability in nanoscale pores with interfacial effects. After validation, the proposed model considers the influence of surface diffusion and wettability, and establishes relationships between the relative permeability and the nanotube radius, surface diffusion, and contact angle. The results show that with an increase in the film thickness, the fluid velocity and the surface diffusion coefficients decrease and the flow resistance increases in nanoscale pores. Surface diffusion plays a positive role to promote fluid flow. And, the wettability effect has different influences with change of the solid interfacial properties.

The article "Determination of Recovery of Gas Reservoirs with Large Aquifers" by Chang et al. develops the demarcation method to evaluate gas recovery of water-drive gas reservoirs. The influences of aquifer size, types of gas reservoir contacting with aquifers and water productivity index on gas recovery are analyzed.

In the article by Du et al., "Experimental Study on the Pressure Distribution and Dynamic Propagation Behavior for CO_2 Foam Flow in Heterogeneous Porous Media," the authors have measured the pressure distribution in a heterogeneous porous media packed with a two-layer and three-layer quartz sand of different particle sizes through setting pressure transducers on different layers. A computed tomography (CT) scan was also carried out to visualize the dynamic propagation behavior for CO_2 foam flow within the heterogeneous porous medium. The pressure difference between parallel layers, which is much smaller than the pressure drop along the flow direction, was observed through measurements. Corresponding CT images revealed that the injected foam would primarily flow through the layer with the largest particle size and would then penetrate into the neighboring layer packed with smaller particles due to the pressure difference across the layer.

The article "Experiments and Numerical Model of Oil-Chemical Agent Two-Phase Flow with Thermal Stability Effect at High Temperature" by Li et al. is based on the crude oil displacement experiments for the core by a

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chemical agent with good thermal stability. A fitted equation between the chemical agent concentration efficiency and the temperature is obtained. It was found that under a constant temperature condition, a chemical agent flow with better thermal stability could result in a higher oil recovery. There exists an optimum temperature for the highest crude oil recovery with a chemical agent displacement flow.

The article “Experimental Study on the Wettability Alteration Mechanism of Ion Tuning Waterflooding” by Xu et al. presents their experiments, where divalent ions were introduced in liquid films, to reveal the mechanisms of enhancing oil recovery from ions tuning waterflooding (ITW) and the ions tuning effect at the molecular level. Atomic force microscopy (AFM) measurement and zeta-potential measurements are used to analyze the influence factors of disjoining pressure as well as zeta potential at the oil/brine/rock interfaces, to explain the enhanced oil recovery (EOR) mechanism of ITW flooding from a micro scale. Through a direct force-measuring technique of AFM, the functionalized AFM tips felt a solid surface to mimic the oil/rock interactions in brine. Zeta potential and AFM force–distance measurements show that zeta potential and disjoining pressure are influenced by the concentration and iron type of the brine, which determine the detachment of the residual oil from the rock.

The article “Experimental Methods and Applications of Dissolved Gas Driving in Tight Oil Reservoirs” by Wei et al. presents their experiments using a typical block of dense rock in China by combining the means of high-pressure, microscopic with visualized physical simulation technology, revealing the seepage mechanism of dissolved gas driving in tight oil reservoirs. The results show that the seepage resistance occurred during the degasification and accumulation in the dissolved gas.

The article “Experiments on the Permeability Limits of Tight Oil Reservoirs for Gas Flood Recovery” by Lin et al. determines the relationship between the average throat radius and the core permeability through high-pressure mercury penetration experiments based on parallel core samples taken from tight oil reservoir Block A in Changqing, China. The thickness of the bound water film is analyzed and calculated via centrifugal, nuclear magnetic resonance, and cryogenic nitrogen adsorption tests. The lower limit of the throat radius in the gas injection is determined through centrifugal and gas flooding tests, and finally the permeability limit during gas injection in the reservoirs of the block is determined. The results indicate that gas injection flooding is applicable only when the permeability is greater than 0.01 mD. The authors propose a novel method for calculating the bound water film thickness, which can be used as a reference for oil-recovery in similar tight oil reservoirs.

Guest Editors:

Moran Wang
Department of Engineering Mechanics,
Tsinghua University,
Beijing, China

Jianjun Liu
Southwest Petroleum University,
Chengdu, China

Yang Ju
China University of Mining & Technology,
Beijing, China

Kambiz Vafai
Department of Mechanical Engineering,
University of California, Riverside,
Riverside, California, USA