Concept for Hole Cleaning in Deviated-Well Drilling Based on Top-Side Drillstring Movements
S. Hovda and S. Sangesland

Early Stuck Pipe Sign Detection with Depth-Domain 3D Convolutional Neural Network Using Actual Drilling Data

Characterizing Returning Polymers in Hydraulic-Fracturing Flowback and Produced Water: Implications for Colloid Formation

C. Huang and S. Chen

FracBot Technology for Mapping Hydraulic Fractures
A. A. Alshehri, C. H. Martins, S.-C. Lin, I. F. Akyildiz, and H. K. Schmidt

Geomechanical Template for Distributed Acoustic Sensing Strain Patterns during Hydraulic Fracturing
Y. Tan, S. Wang, M. C. M. Rijken, K. Hughes, I. L. C. Ning, Z. Zhang, and Z. Fang
Analyzing the Dynamics of Mineral Dissolution during Acid Fracturing by Pore-Scale Modeling of Acid-Rock Interaction
J. You and K. J. Lee

Pore-Scale Simulation of Calcite Matrix Acidizing with Hydrochloric Acid
M. HaghaniGalougahi

Production & Facilities

A New Mechanistic Model for Emulsion Rheology and Boosting Pressure Prediction in Electrical Submersible Pumps (ESPs) under Oil-Water Two-Phase Flow

Geometrically Calibrated Network Models for Progressive Cavity Pump Design
K. Simon and A. H. Slocum

A Comparative Experimental Study of Alternative Iron Sulfide Scale Dissolvers in the Presence of Oilfield Conditions and Evaluation of New Synergists to Aminopolycarboxylic Acids
R. Ramanathan and H. A. Nasr-El-Din

Stability Analysis for Severe Slugging Including Self-Lifting
G. R. de Azevedo, J. L. Baliño, and I. Andreolli

A New Wax Removal Empirical Model of Fully Coated Foam Pig
X. Gao, Q. Huang, X. Zhang, X. Zhu, and Y. Zhang
Reduction of Shale Permeability by Temperature-Induced Creep
Q. Zhang, R. Fink, B. Krooss, M. Jalali, and R. Littke

The Impact of Kerogen Tortuosity on Shale Permeability
J. Aljaberi, S. Alafnan, G. Glatz, A. S. Sultan, and C. Afagwu

Transformational-Decomposition-Method-Based Semianalytical Solutions of the 3D Problem of Oil Production from Shale Reservoirs
G. J. Moridis, N. Anantraksakul, and T. A. Blasingame

An Integrated Experimental Workflow for Formation Water Characterization in Shale Reservoirs: A Case Study of the Bazhenov Formation
E. S. Kazak, A. V. Kazak, and F. Bilek

Pore-Scale Perspective of Gas/Water Two-Phase Flow in Shale
T. Zhang, F. Javadpour, J. Li, Y. Zhao, L. Zhang, and X. Li

The Effect of Initial Water Saturation on Enhanced Water Imbibition by Surfactant for Fractured Tight Porous Media

Diffusion-Based Modeling of Gas Transport in Organic-Rich Ultratight Reservoirs
Z. Liu and H. Emami-Meybodi
Mechanisms of Confining Pressure Dependence of Resistivity Index for Tight Sandstones by Digital Core Analysis
H. Dai, I. Shikhov, R. Li, J.-Y. Arns, and C. H. Arns

Reservoir Simulation

An Analysis of Numerically Induced Pulses in Simulations of Low-Salinity Waterflooding and Their Reduction by Flow Upscaling
H. Al-Ibadi, K. D. Stephen, and E. Mackay

Understanding the Multiphysical Processes in Carbon Dioxide Enhanced-Oil-Recovery Operations: A Numerical Study Using a General Simulation Framework
S. Wang, Y. Di, P. H. Winterfeld, J. Li, X. Zhou, Y.-S. Wu, and B. Yao

A New Way of Compositional Simulation without Phase Labeling
S. Khorsandi, L. Li, and R. T. Johns

An Integrated Simulation Approach To Predict Permeability Impairment under Simultaneous Aggregation and Deposition of Asphaltene Particles
X. Su, R. G. Moghanloo, M. Qi, and X. Yue

Machine Learning and Data Analytics

Handling Big Models and Big Data Sets in History-Matching Problems through an Adaptive Local Analysis Scheme
R. V. Soares, X. Luo, G. Evensen, and T. Bhakta
Data-Driven Niching Differential Evolution with Adaptive Parameters Control for History Matching and Uncertainty Quantification
X. Ma, K. Zhang, L. Zhang, C. Yao, J. Yao, H. Wang, W. Jian, and Y. Yan

Subspace Ensemble Randomized Maximum Likelihood with Local Analysis for Time-Lapse-Seismic-Data Assimilation
G. M. Silva Neto, R. V. Soares, G. Evensen, A. Davolio, and D. J. Schiozer

Optimization of Fracturing Parameters by Modified Variable-Length Particle-Swarm Optimization in Shale-Gas Reservoir
J. Yao, Z. Li, L. Liu, W. Fan, M. Zhang, and K. Zhang

Remediation of Heavy Oil Transportation Problems via Pipelines Using Biodegradable Additives: An Experimental and Artificial Intelligence Approach
M. Gudala, T. K. Naiya, and S. K. Govindarajan
Executive Summary
This issue of SPE Journal covers novel theories and emerging concepts spanning several aspects of engineering for oil and gas exploration and production as requested by the journal. I thank all the authors for considering SPE Journal for publishing results of their excellent research, as well as all editors, reviewers, and SPE staff for their hard work and dedication.

A total of 30 peer-reviewed papers are organized in six categories, although obviously there is overlapping among some of the categories. The six categories include drilling, completions, production and facilities, unconventional, reservoir simulation, and machine learning and data analytics. A brief description of the papers in each category is presented next.

Drilling. There are two research papers in this category, discussing hole cleaning in deviated wells and early stuck pipe detection.

- Hovda and Sangesland describe a concept in which lateral drillstring movement between the high side and the cuttings bed induce jet flows that lift cuttings into the main stream for more effective hole cleaning.
- Tsuchihashi et al. propose a 3D convolutional neural network (CNN) approach with depth-domain data clip. The clip illustrates depth-domain data in 2D histogram images with unique abstraction of the time domain. Thirty field well data sets prepared in multivariate time series are used in this study—20 for training and 10 for validation.

Completions. The first four research papers in this category cover hydraulic fracturing followed by two papers dealing with acidizing. The hydraulic-fracturing papers discuss polymers flowback, organic-rich shales, mapping of hydraulic fractures, and geomechanics aspects. The acidizing papers discuss acid-rock interaction and pore-scale simulation.

- von Gunten et al. investigate partially hydrolyzed polyacrylamide (PHPA) friction reducer in produced water from hydraulically fractured wells in the Duvernay and Montney Formations of western Canada.
- Huang and Chen use a fully coupled extended-finite-element-method for analyzing the effects of ductility of organic-rich shale on hydraulic fracturing with the use of a modified cohesive zone model.
- Alshehri et al. describe miniaturized transponder systems for monitoring unconventional reservoirs, mapping hydraulic fractures, and determining other wellbore parameters. An advanced matching circuit design into the FracBot (fracture robot) permits an optimal energy transmission and consistent communication link through sand and stone media.
- Tan et al. indicate that distributed acoustic sensing (DAS) signals show patterns that are intuitively consistent with the understanding of the strain field around hydraulic fractures. Their paper uses a fracture simulator combined with a finite element solver to further understand the various patterns of the strain field caused by hydraulic fracturing.
- You and Lee analyze the impact of acid-rock interaction on multiphase flow behavior with the use of a pore-scale numerical model that uses the Darcy-Brinkman-Stokes (DBS) method. The simulation results of the developed numerical model are validated with experimental results.
- HaghaniGalougahi develops a Navier-Stokes-based continuum hydrodynamic model with immersed solid/fluid interface for simulating calcite dissolution by hydrochloric acid (HCl) at the pore scale, which is considered accurate for a mass-transfer-controlled dissolution regime under laminar flow conditions.

Production and Facilities. The five research papers in this category discuss electrical submergible pumps (ESPs), progressive cavity pumps, dissolver for well tubulars and pipelines, slugging in pipelines, and wax removal from pipelines.

- Zhu et al. develop a new rheology model based on Brinkman's (1952) correlation, which in addition to ESP rotational speed, stage number, and fluid properties, can also predict the phase inversion in oil-water emulsions. Comparison with experimental data provided good results.
- Simon and Slocum present new approaches for implementing linear network progressive cavity pump models and provide new methods to accurately and quickly estimate the values of each resistor in the model from pump geometry for both laminar and turbulent flows.
- Ramanathan and Nasr-El-Din provide guidelines developed from an extensive laboratory study to select the best scale dissolver for well tubulars and pipelines under various oilfield conditions.
• de Azevedo et al. investigate stability for severe slugging, including self-lifting by using a stability solver. Stability maps for severe slugging are built, and experimental data from literature are included, showing a very good agreement; in particular, the two unstable regions are satisfactorily predicted by the stability solver.

• Gao et al. attempt to assess, qualitatively and quantitively, the wax removal process of the fully coated foam pig. The experimental results confirm that the wax-removal process of the fully coated foam pig includes four phases; namely, the buildup phase, preplug phase, plug phase, and production phase.

Unconventionals. The eight research papers in this category discuss shales, including reduction in permeability, tortuosity, 3D problem solutions, water characterization, two-phase flow, water imbibition, gas diffusion and digital core analysis.

• Zhang et al. investigate experimentally the effects of temperature on the permeability coefficients of carbonaceous shales and the underlying mechanisms. The samples showed varying degrees of permeability reduction by up to 71% with increasing temperature. This reduced permeability persisted during the cooling phase.

• Aljaberi et al. present simulation results that suggest a direct link between diffusion and kerogen porosity, allowing for delineation of the diffusion tortuosity factor. They investigated the microscale tortuosity–diffusivity relationship in kerogens at the reservoir scale by means of a shale permeability model.

• Moridis et al. develop fast analytical and/or semianalytical solutions for the problem of liquid flow/production and pressure interference in multifractured systems between parallel horizontal wells in ultralow-permeability reservoirs. Their transformational decomposition method (TDM) shows excellent agreement with analytical and/or numerical solutions.

• Kazak et al. develop a new integrated solution for determining the formation water content and salinity in tight shale rocks holding less than 1 wt% of water. The results fill the knowledge gaps in the petrophysical interpretation of well logs and general reservoir characterization and reserve estimation.

• Zhang et al. study gas/water two-phase flow in shale. Their results show that isolated patches of organic matters (OMs) impede water flow, and the water relative permeability curve cuts off at water saturation [= 1–volumetric total organic carbon (TOC)]. The residual gas saturation is also controlled by the volumetric TOC.

• Wang et al. investigate the effect of initial water saturation on the oil recovery from tight matrices through surfactant-enhanced water imbibition. Results show that the surfactant enhances the brine imbibition into the matrix through wettability alteration. The initial efficiency of the surfactant imbibition increases when brine is initially present in the matrix.

• Liu and Emami-Meybodi present a diffusion-based semianalytical model for a single-component gas transport within an infinite-acting organic-rich ultratight matrix. Multiple transport and storage mechanisms should be considered to model fluid transport within the shale matrix, including molecular diffusion, Knudsen diffusion, surface diffusion, and sorption.

• Dai et al. use digital rock physics to analyze the mechanisms of non-Archie and Archie behavior of formation factor (FF) and resistivity index (RI) of low-porosity Fontainebleau (FB) sandstone for ambient conditions and under high confining pressure. Grain contacts and confining pressure are found to have a significant impact on RI behavior of low-porosity FB sandstone.

Reservoir Simulation. The four research papers in this category discuss low-salinity waterflooding (LSWF), carbon dioxide (CO₂) enhanced oil recovery (EOR), compositional simulation, and asphaltene deposition.

• Al-Ibadi et al. investigate the conditions that lead to numerical errors when simulating LSWF. The authors also examine how to achieve more accurate simulation results by scaling up the flow behavior. This is a novel approach that removes the need for relative permeability interpolation during the simulation.

• Wang et al. aim at understanding the multiphysical processes that occur in CO₂ EOR operations using a modeling approach. They do it by integrating multiple physical simulation modules to form a general simulation framework that captures realistic flow and transport processes during CO₂ flooding.

• Khorsandi et al. develop a fully compositional simulation model using an equation of state (EoS) for relative permeabilities ($k_r$) to eliminate the unphysical discontinuities in flux functions caused by phase labeling issues. The model can capture complex compositional and hysteresis effects for three-phase relative permeability.
Su et al. develop an integrated simulation approach to predict permeability impairment in porous media stemming from simultaneous aggregation and deposition of asphaltenes. The approach integrates various mathematical models that consider porosity reduction, particle aggregation, and pore connectivity loss caused by asphaltenes deposition.

**Machine Learning and Data Analytics.** The five papers in this category discuss the use of machine learning and data analytics for history matching problems, uncertainty quantification, time-lapse-seismic-data assimilation, particle swarm optimization, and heavy-oil transportation in pipelines.

- Soares et al. aim at demonstrating the practical advantages of a new local analysis scheme over the Kalman gain localization in a 4D seismic history-matching problem that involves big seismic data sets. They use a correlation-based adaptive data-selection strategy to choose observations for the update of each group of local model variables.
- Ma et al. propose a novel data-driven niching differential evolution (DE) algorithm with adaptive parameter control for nonuniqueness of inversion. The algorithm integrates a clustering approach, niching technique, and local surrogate assistant method to balance exploration and convergence in solving the multimodal inverse problems.
- Silva Neto et al. propose a scheme using an efficient implementation of the subspace ensemble randomized maximum likelihood (SEnRML) method with local analysis for time-lapse-seismic-data assimilation. This method reduces the computational requirements for assimilating large data sets.
- Yao et al. propose an algorithm named modified variable-length particle-swarm optimization that automatically selects the optimal number of hydraulic fractures as well as the corresponding fracture properties. They show that a multispindle-shaped fracture-distribution pattern reaches a higher net-present-value as compared to a homogeneous fracture distribution.
- Gudala et al. develop a new hybrid artificial intelligence (AI) technique to optimize flow-influencing parameters to minimize the pressure drop and shear viscosity and improve flow behavior index in heavy-oil transportation problems via pipelines using biodegradable additives.

**Roberto Aguilera, SPE J. Executive Editor,**
University of Calgary