Pressure-Difference Method for Gas-Kick Detection in Risers
G. Zhou, C. Leach, V. S. Denduluri, G. K. Wong, A. Amritkar, R. Krishnamoorti, and A. Prosperetti

A Transient Solids Transport Model for Solids Removal Evaluation in Coiled-Tubing Drilling
T. A. Tong, E. Ozbayoglu, and Y. Liu

Ultrasonic-Assisted Removal of Undesirable Submicron-Sized Particulates To Realize Sustainable and Eco-Friendly Circulation of Drilling Fluid
C. Wang, Z. Chen, E. Chen, J. Liu, F. Xiao, and H. Zhao

Prediction of High-Pressure/High-Temperature Rheological Properties of Drilling Fluids from the Viscosity Data Measured on a Coaxial Cylinder Viscometer
S. Gautam, C. Guria, and L. Gope

Gas-Kick Simulation in Oil-Based Drilling Fluids with Nonequilibrium Gas-Dissolution and -Evolution Effects
Z. Xu, X. Chen, X. Song, Z. Zhu, and W. Zhang

Modeling and Analysis of Carbonate Matrix Acidizing Using a New Two-Scale Continuum Model
C. Jia, K. Sepehrnoori, Z. Huang, and J. Yao
A Three-Phase Study on Preflush Stage in Sandstone Acidizing: Experimental and Modeling Analysis of Evolved Carbon Dioxide in a Hydrocarbon and Aqueous Environment
S. Muhemmed, H. Kumar, N. Cairns, and H. A. Nasr-El-Din

Poroelastoplastic Modeling of Complex Hydraulic-Fracture Development in Deep Shale Formations
W. Liu, Q. Zeng, and J. Yao

Coupling Peridynamics with the Classical Methods for Modeling Hydraulic Fracture Growth in Heterogeneous Reservoirs
S. Agrawal, J. York, J. T. Foster, and M. M. Sharma

Developing Upscaling Approach for Swarming Hydraulic Fractures Observed at Hydraulic Fracturing Test Site through Multiscale Simulations
W. Fu, J. P. Morris, P. Fu, J. Huang, C. S. Sherman, R. R. Settgast, and F. J. Ryerson

3D Numerical Model for Hydraulic Fracture Propagation in Tight Ductile Reservoirs, Considering Multiple Influencing Factors via the Entropy Weight Method
Y. Ju, G. Wu, Y. Wang, P. Liu, and Y. Yang

Hydraulic-Fracture-Width Inversion Using Low-Frequency Distributed-Acoustic-Sensing Strain Data Part II: Extension for Multifracture and Field Application
Y. Liu, G. Jin, K. Wu, and G. Moridis

Investigation on the Controlling Factors of Pressure Wave Propagation Behavior Induced by Pulsating Hydraulic Fracturing
Comprehensive Characterization and Mitigation of Hydraulic Fracturing-Induced Seismicity in Fox Creek, Alberta
G. Hui, S. Chen, Z. Chen, F. Gu, M. Ghoroori, and M. A. Mirza

Stimulation of Wells Damaged by Barite Present in Filter Cake or Scale
I. Ivanishin, H. A. Nasr-El-Din, D. Solnyshkin, and A. Klyubin

Geomechanics

Mechanical Behavior of Berea Sandstone under Cyclic Loading: An Application to Dynamic Loading of a Wellbore
M. Meng, S. Miska, M. Yu, and E. M. Ozbayoglu

Carbonate Caprock–Brine–Carbon Dioxide Interaction: Alteration of Hydromechanical Properties and Implications on Carbon Dioxide Leakage
G. Sang and S. Liu

Experimental Investigation of Depletion- and Injection-Induced Changes in Poromechanical, Transport, and Strength Properties of High-Porosity Sandstone

Dimensionless Solutions for the Time-Dependent and Rate-Dependent Productivity Index of Wells in Deformable Reservoirs
W. Zhang and A. Mehrabian

Effect of Hydrate Dissociation and Axial Strain on the Permeability of Hydrate-Bearing Sand during the Creep Process
The Pressure Dependence of the Archie Cementation Exponent for Samples from the Ordovician Goldwyer Shale Formation in Australia
Z. Zhong, L. Esteban, R. Rezaee, M. Josh, and R. Feng

Objective-Driven Solid-Surface-Roughness Characterization for Enhanced Nuclear-Magnetic-Resonance Petrophysics
S. M. Ma, G. Singer, S. Chen, and M. Eid

New Technique for Evaluating Fracture Geometry and Preferential Orientation Using Pulsed Field Gradient Nuclear Magnetic Resonance
M. Elsayed, A. El-Husseiny, H. Kwak, S. R. Hussaini, and M. Mahmoud

Better Automatic Interpretation of Cement Evaluation Logs through Feature Engineering
E. M. Viggen, L. Løvstakken, S.-E. Måsøy, and I. A. Merciu

Sensitivity of Digital Rock Method for Pore-Space Estimation to Heterogeneity in Carbonate Formations
R. Sharma, S. Malik, and A. S. Shettar

Transient Modeling of Plunger Lift for Gas Well Deliquification
Q. Zhao, J. Zhu, G. Cao, H. Zhu, and H.-Q. Zhang

Design and Development of All-Electric Surface-Controlled Subsurface Safety Valve System
C. Gao, B. Cai, C. Sheng, Y. Zhang, Z. Liu, R. Ji, and Y. Liu
A Gas Separation Model for a Downhole Gravitational Separator
P. J. Miranda-Lugo, L. Enrique Ortiz-Vidal, and O. M. H. Rodriguez

Particle-Transport Mechanism in Liquid/Liquid/Solid Multiphase Pipeline Flow of High-Viscosity Oil/Water/Sand
A. Archibong-Eso, Y. Baba, A. Aliyu, J. Ribeiro, F. Abam, and H. Yeung

Experimental Analysis of Water/Oil Displacement Tests in Horizontal Pipe
R. F. Leuchtenberger, J. L. Biazussi, W. Monte Verde, M. de Souza Castro, and A. C. Bannwart

Algorithm for Detecting Multiple Partial Blockages in Liquid Pipelines by Using Inverse Transient Analysis
C. Zhang, J. J. Zhang, C. B. Ma, and G. E. Korobkov

Effect of Wettability on Vaporization of Hydrocarbon Solvents in Capillary Media
I. Al-Kindi and T. Babadagli

Short-Term Production Optimization Under Water-Cut Uncertainty
G. Chaves, D. Monteiro, M. C. Duque, V. Ferreira Filho, J. Baioco, and B. Ferreira Vieira

Modeling the Effect of Reaction Kinetics and Dispersion during Low-Salinity Waterflooding
D. Magzymov, P. Purswani, Z. T. Karpyn, and R. T. Johns

An Improved Study of Emulsion Flooding for Conformance Control in a Heterogeneous 2D Model with Lean Zones
B. Ding, Q. Sang, Z. Nie, Z. Li, M. Dong, Z. Chen, and A. Kantzas
Understanding the Plugging Performance of HPAM-Cr (III) Polymer Gel for CO2 Conformance Control
X. Sun, B. Bai, A. K. Alhuraishawy, and D. Zhu

A Laboratory Investigation of the Effect of Ethanol-Treated Carbon Dioxide Injection on Oil Recovery and Carbon Dioxide Storage
Saira, E. Ajoma, and F. Le-Hussain

Flow Profiling Using Fiber Optics in a Horizontal Steam Injector with Liner-Deployed Flow Control Devices
M. Javaheri, M. Tran, R. S. Buell, T. Gorham, J. D. Munoz, J. Sims, and S. Rivas

An Integrated Simulation Approach for Wellbore Blockage Considering Precipitation, Aggregation, and Deposition of Asphaltene Particles
M Qi, R. G. Moghanloo, X. Su, and M. Li

Laboratory Investigation of Permeability Impairment Caused by Asphaltene Precipitation during Screening for Gas-Injection Enhanced Oil Recovery and Pressure Change in a Major Gulf of Mexico Field

Asphaltene Thermodynamic Flocculation during Immiscible Nitrogen Gas Injection
M. Elturki and A. Imqam

A New Effective Multiwalled Carbon Nanotube-Foam System for Mobility Control
R. Ramanathan, O. Abdelwahab, and H. A. Nasr-El-Din

Artificial Diagenesis of Carbonates: Temperature-Dependent Inorganic and Organic Modifications in Reservoir Mimetic Fluids
A. Rao, S. Kumar, C. Annink, D. Le-Anh, S. C. Ayirala, M. B. Alotaibi, I. Siretanu, M. H. G. Duits, A. A. Yousef, and F. Mugele
Implementation of an Integrated Geochemical Approach Using Polar and Nonpolar Components of Crude Oil for Reservoir-Continuity Assessment: Verification with Reservoir-Engineering Evidences
M. Asemani, A. R. Rabbani, and H. Sarafdokht

Unconventionals

Novel Near-Wellbore Fracture Diagnosis for Unconventional Wells Using High-Resolution Distributed Strain Sensing during Production
G. Jin, G. Ugueto, M. Wojtaszek, A. Guzik, D. Jurick, and K. Kishida

A Novel Approach To Predict Gas Flow in Entire Knudsen Number Regime through Nanochannels with Various Geometries
Y. Pang, D. Fan, and S. Chen

Water-Oil Displacement in Shale: New Insights from a Comparative Study Integrating Imbibition Tests and Multiscale Imaging
S. Peng, P. Shevchenko, P. Periwal, and R. M. Reed

Experimental Investigation on Enhanced-Oil-Recovery Mechanisms of Using Supercritical Carbon Dioxide as Prefracturing Energized Fluid in Tight Oil Reservoir

An Improved Multicomponent Diffusion Model for Compositional Simulation of Fractured Unconventional Reservoirs
Y. Tian, C. Zhang, Z. Lei, X. Yin, H. Kazemi, and Y.-S. Wu

Quantitative Multiparameter Prediction of Fractured Tight Sandstone Reservoirs: A Case Study of the Yanchang Formation of the Ordos Basin, Central China
J. Liu, W. Ding, H. Yang, and Y. Liu
Errata

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

This erratum was issued to correct typographical errors in the fourth and sixth sentences of the second paragraph in the Sample Acquisition and Bulk Analysis subsection on page 564 of paper SPE-203848-PA.

SPE-203960-PA  (SPE J. in press)
Biobjective Optimization of Well Placement: Algorithm, Validation, and Field Testing
F. Alpak, V. Jain, Y. Wang, and G. Gao

These errata were issued to correct typographical errors on pages 6 and 7 of paper SPE-203960-PA.
**Editorial Notes**

**Paper Length Limits.** Beginning 1 October 2021, all new submissions to SPE’s peer-reviewed journals must meet SPE’s paper length limit requirements. Under these requirements, technical papers should be no more than 10,000 words, including the abstract, main text, tables, figure captions, and appendices (but not including the title, affiliations, acknowledgments, nomenclature, or references). In addition, a maximum of 20 figures that are sized half-page or smaller (full-page figures will be counted as two figures) will be allowed.

Papers that exceed the length limit will be returned by SPE staff with a request to shorten the manuscript before the paper will be submitted for peer review. We encourage authors to run a word count check before submission to avoid processing delays, and we also encourage use of the Supplementary Materials template (available in Author Resources) for submission of additional data, figures, and tables that support the main paper. Supplements submitted with the paper for review will be later published with the accepted paper. Note that review papers do not have a length limit, and the length limit will not apply to revisions or resubmissions in progress as of the effective date.
Executive Summary
It has been 3 years since I had the privilege of starting activities as an executive editor of *SPE Journal*. It has been a great run—lots of work, lots of learnings, lots of fun, and, also, lots of pain when I had to provide those letters declining papers for so many friends and distinguished colleagues. It has been an honor working with excellent editors-in-chief (Russell T. Johns and Birol Dindoruk) and executive editors (Luis Ayala and Reza Fassihi). It has been also very rewarding seeing the impact factor of *SPE Journal* grow from 3.095 to 3.372 to 3.478.

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. 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.

A total of 50 peer-reviewed papers are organized in seven categories, although obviously there is overlapping among some of the categories. The seven categories include drilling, completions, geomechanics, petrophysics, production and facilities, reservoir engineering, and unconventional.

**Drilling.** There are five research papers in this category discussing gas-kick detection problems, coiled-tubing drilling, solid control methods, and drilling fluids in high-pressure/high-temperature environments.

- Zhou et al. describe a pressure-difference method for gas-kick detection in risers. This is critical because undetected gas kicks are at the root of many disastrous accidents in the oil industry.
- Tong et al. propose a transient solids transport model for solids removal evaluation in coiled-tubing drilling. This is significant because poor hole cleaning is a major concern in coiled-tubing drilling, and it is often associated with long nonproductive time that contributes significantly to the operational cost.
- Wang et al. discuss ultrasonic-assisted removal of undesirable submicron-sized particulates to realize sustainable and eco-friendly circulation of drilling fluid. This is crucial because current solid-control methods, such as electronic-adsorption and chemical-flocculation methods, are associated with high cost and low efficiency and/or pollution of drilling fluid.
- Gautam et al. predict high-pressure/high-temperature rheological properties of drilling fluids from the viscosity data measured on a coaxial cylinder viscometer. The approach applies to pressures > 15,000 psi and temperatures > 350°F and the data help to achieve safe and trouble-free drilling operations.
- Xu et al. describe a gas-kick simulation approach in oil-based drilling fluids with nonequilibrium gas dissolution and evolution effects. This is important because the ratio of free gas to dissolved gas in the wellbore influences the prediction accuracy of the wellbore-pressure and surface responses.

**Completions.** The first two papers in this category discuss acidizing. The next seven papers concentrate on different aspects of hydraulic fracturing. The last paper discusses stimulation of reservoirs damaged by barite present in the filter cake.

- Jia et al. analyze carbonate matrix acidizing using a new two-scale continuum model.
- Muhemmed et al. present experimental and modeling analysis of evolved carbon dioxide (CO2) in a hydrocarbon and aqueous environment. The research aims at understanding the mechanics of preflush stages in sandstone-acidizing processes.
- Liu et al. describe poroelastoplastic modeling of complex hydraulic-fracture development in deep shale formations using the Drucker-Prager plasticity theory, Darcy’s law, Reynolds’ lubrication theory, and Kirchoff’s laws.
- Agrawal et al. couple peridynamics with classical methods for modeling hydraulic-fracture growth in heterogeneous reservoirs. The method aims at achieving significant improvement in computational performance.
- Fu et al. develop an upscaling approach for studying swarming hydraulic fractures observed at a hydraulic-fracturing test site through multiscale simulations. The method is illustrated with data of Middle Wolfcamp Formation.
- Ju et al. use a 3D numerical model for studying hydraulic-fracture propagation in tight ductile reservoirs. The yielding and softening of ductile rocks hamper fracture propagation, leading to the formation of a simple network, small fracture area, large fracture volume, and the need for higher initiation pressure.
- Liu et al. study hydraulic-fracture-width inversion with the use of low-frequency distributed-acoustic-sensing strain data. The study proposes possible mitigation to the challenges raised by completion designs and field data acquisition through a synthetic case study.
• Hou et al. investigate the controlling factors of pressure wave propagation induced by pulsating hydraulic fracturing, which could improve hydraulic-fracturing efficiency by inducing fatigue failure of reservoir rocks.
• Hui et al. describe the characterization and mitigation of hydraulic-fracturing-induced seismicity in Fox Creek, Alberta, Canada, where events with a moment magnitude (Mw) greater than 2.5 are caused by the increase in pore pressure and poroelastic stress during the fracturing operation.
• Ivanishin et al. describe the stimulation of deep high-temperature wells drilled in naturally fractured carbonate reservoirs. In this case, the natural fractures are damaged by barite present in filter cake or scale stemming from the invasion of mud filtrate during drilling operations.

**Geomechanics.** The five research papers in this category discuss mechanical behavior of Berea sandstone, leakage of CO$_2$ through a carbonate caprock, effects of depletion and injection on high porosity sandstone, productivity index in deformable rocks, and relative permeabilities in hydrates.

• Meng et al. research the mechanical behavior of Berea sandstone under cyclic loading. This is important because with cyclic loading the wellbore rock may fail even if the stress level is lower than the predetermined static rock strength because of fatigue.
• Sang and Liu investigate the interaction of carbonate caprock–brine–CO$_2$, and the alteration of hydromechanical properties and implications on CO$_2$ leakage. Caprocks play a crucial role in the geological storage of CO$_2$ by preventing its escape.
• Rafieepour et al. conduct an experimental investigation of depletion- and injection-induced changes in poromechanical, transport, and strength properties of high-porosity sandstone. Changes are attributed to the existence and distribution of compliant components such as pores, microcracks, and clay minerals.
• Zhang and Mehrabian develop analytical dimensionless solutions for time-dependent and rate-dependent productivity index of wells in deformable reservoirs. The solutions are verified against results from the finite-element simulation of the same problems using industry simulation software.
• Zhou et al. investigate the effect of hydrate dissociation and axial strain on the relative permeability of hydrate-bearing sand during the creep process. They find that the preferential flow directions of the gas and water change from vertical to horizontal along with the progression of creep.

**Petrophysics.** The five research papers in this category discuss Archie exponent $m$ in shales, nuclear magnetic resonance (NMR) technology, cement evaluation logs, and rock physics for estimating pore volume.

• Zhong et al. perform experiments to determine the cementation exponent ($m$) in Ordovician shales of Australia under different confining pressures. Archie exponent $m$ for shale is sensitive to depth of burial because of the soft nature of the shale pore system. An equation is developed to predict the values of $m$.
• Ma et al. focus primarily on details in characterizing solid-surface roughness and its applications in NMR pore-size analysis.
• Elsayed et al. present a new method for evaluating fracture tortuosity and preferential orientation of natural fractures based on the pulsed field gradient NMR technique.
• Viggen et al. develop an automatic interpretation of cement evaluation logs through feature engineering.
• Sharma et al. propose a new digital rock physics method for reliable determination of the pore volume, which can be verified with the field observation of porosity obtained using industry-standard laboratory methods and well logs.

**Production and Facilities.** The six research papers in this category discuss a plunger-lift system, an all-electric surface-controlled subsurface safety valve system, a downhole gravitational separator, and various aspects of flow in pipelines.

• Zhao et al. develop a transient mechanistic model to simulate the dynamic process of a plunger-lift system that is cyclically paced by a surface control valve.
• Gao et al. present the design and development of all-electric surface-controlled subsurface safety valve system. The innovative structural designs include electric-drive mechanisms and a magnetic coupler that can transfer linear motion.
• Miranda-Lugo et al. develop a gas separation model for a downhole gravitational separator. The authors present new experimental data of the statistical distributions of bubble diameters during the gas entrainment process.
• Archibong-Eso et al. present results of an investigation dealing with particle-transport mechanism in liquid/liquid/solid multiphase pipeline flow of high-viscosity oil/water/sand.
• Leuchtenberger et al. perform experimental work to study the displacement of a viscous liquid by a less-viscous liquid in a horizontal pipeline through footages in different segments, varying the injection velocity.
• Zhang et al. develop a method for calibrating multiple irregular partial blockages inside a liquid pipe by using the pressure response in the time domain at certain measuring points along the pipe under the transient state.

**Reservoir Engineering.** The thirteen research papers in this category discuss problems ranging from wettability to water-cut uncertainty, low-salinity waterflooding, emulsion flooding, CO₂ injection, fiber optics in a horizontal steam injector, asphaltene deposition, artificial diagenesis of carbonates, and Fourier-transform infrared (FTIR) spectroscopy of asphaltenes.

• Al-Kindi and Babadagli study the influence of the medium wettability on phase-transition temperatures of liquid hydrocarbons in macrochannels (greater than 1000 nm) and nanochannels (less than 500 nm) by using different types of rock samples.
• Chaves et al. discuss short-term production optimization under water-cut uncertainty. Their methodology is applied to wells of a Brazilian field. The authors report an up-to-4.5% gain in oil production using their approach.
• Magzynov et al. model the effect of reaction kinetics and dispersion during low-salinity waterflooding. This is important because wettability alteration is the primary mechanism responsible for improved oil recovery during low-salinity waterflooding.
• Ding et al. present a study of emulsion flooding for conformance control in a heterogeneous 2D model with lean zones. This is an improvement of a previously proposed emulsion flow model by the authors.
• Sun et al. aim at understanding the plugging performance of hydrolyzed polyacrylamide-chromium HPAM-Cr (III) polymer gel for CO₂ conformance control.
• Saira et al. present results of a laboratory investigation of the effect of ethanol-treated CO₂ injection on oil recovery and CO₂ storage. If economically viable, ethanol-treated CO₂ injection could be used as a carbon capture, usage, and storage method in low-pressure reservoirs, for which pure CO₂ injection would be infeasible.
• Javahehri et al. discuss flow profiling using fiber optics in a horizontal steam injector with liner-deployed flow-control devices (FCDs). The conformance of the injected steam can be achieved by FCDs deployed on either tubing or liner.
• Qi et al. indicate that asphaltene deposition triggers serious flow-assurance issues and can significantly restrict the production capacity. They investigate this problem using an integrated simulation approach for wellbore blockage considering precipitation, aggregation, and deposition of asphaltene particles.
• Fassihi et al. present results of a laboratory investigation of permeability impairment caused by asphaltene precipitation during screening for gas-injection enhanced oil recovery (EOR) and pressure change in a major Gulf of Mexico field.
• Elturki and Imqam indicate that during nitrogen injection, its interaction with crude oil can induce asphaltene deposition, which may result in severe formation damage. The resulting asphaltene thermodynamic flocculation is investigated in this paper.
• Ramanathan et al. present an experimental investigation of a new alpha olefin sulfonate–multiwalled carbon nanotube system for mobility control during gas EOR operations.
• Rao et al. use artificial diagenesis of carbonates to investigate the temperature dependence of the inorganic and organic modifications of calcite by reservoir pertinent fluids as well as its consequences on mineral wettability and reactivity.
• Asemani et al. implement a geochemical approach using polar and nonpolar components of crude oil for reservoir-contingency assessment. The authors use FTIR spectroscopy of asphaltenes to obtain oil fingerprints from the polar fraction of crude oils.

**Unconventionals.** The six research papers in this category discuss various topics of interest including fiber-optic-based distributed strain sensing technology to measure and characterize near-wellbore fractures, gas flow in entire Knudsen number regime, water-oil displacement in shales, use of supercritical CO₂ as prefracturing energized fluid in a tight oil reservoir, huff ‘n’ puff gas injection in the Permian basin, and a multiparameter 4D model for a naturally fractured tight sandstone reservoirs.

• Jin et al. indicate hydraulic fractures in the near-wellbore region contain critical information related to the production performance of unconventional wells. The authors demonstrate a novel application of a fiber-optic-based distributed strain sensing technology to measure and characterize near-wellbore fractures and perforation cluster efficiency during production.
Pang et al. present a novel approach to predict gas flow in entire Knudsen number regime through nanochannels with various geometries. Their approach can predict gas transport and gas velocity profile in such nanochannels.

Peng et al. discuss water-oil displacement in shale matrix after hydraulic fracturing and in water-based EOR. They perform a comparative study integrating imbibition tests and multiscale imaging.

Li et al. discuss results of an experimental investigation on EOR mechanisms using supercritical CO$_2$ as prefracturing energized fluid in a tight oil reservoir. The application of their method is of great significance to the protection of water resources and the improvement of hydraulic fracturing.

Ye at al. develop an improved multicomponent diffusion model for compositional simulation of fractured unconventional reservoirs. The authors simulate a huff ‘n’ puff gas injection well in the Permian Basin to investigate the effect of diffusion within the fractured tight oil reservoir.

Liu et al. develop a quantitative multiparameter prediction 4D model for a naturally fractured tight sandstone reservoirs. The model is applied successfully in the Ordos Basin in central China.

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