Executive Summary

This issue brings you 21 papers divided into four sections.

Drilling and Transport of Fines. The section starts with two papers authored by Bizhani and Kuru. The first reports an experimental study to investigate turbulent flow of water over a cuttings bed. Measurements of the instantaneous local velocity at the sandbed/fluid interface are used for critical evaluation of assumptions and correlations commonly used in mechanistic and semimechanistic sediment-transport models. In the second paper, the authors present the results of an experimental study of how fluid viscoelastic properties induced by polymer additives influence the removal of sandbed deposited in horizontal annuli.

Davudov et al. seek to quantify how various hydrodynamic controls affect asphaltene deposition. Using scaling analysis of the momentum and mass-balance equations, the authors identify four dimensionless groups. One of these groups appears to have a significant effect on the rate of asphaltene deposition and is discussed in detail.

Zhao et al. discuss whirl, which is a specific bending vibration formed by the eccentricity of the rotational drill collar. Whirl may lead to cumulative fatigue, and the authors develop a two-degree-of-freedom nonlinear-lumped-mass model to conclude that chaotic lateral vibrations and fatigue damage happen at lower rotational speed than previously reported.

Huang et al. propose a modified tubular mechanical model, which they use to study the mechanical behavior of tubular strings with connectors under nonbuckling/lateral-buckling, interhelical-buckling, and intrahelical-buckling modes in vertical and inclined wellbores.

Finally, Wang et al. present a new analytical model to reveal the liquid-loading mechanisms in horizontal gas wells.

History Matching and Optimization. Chang and Zhang propose a new method to history match the stimulated reservoir volume (SRV) of shale-gas reservoirs to production data. The method consists of two parts: First, the fracture network is parameterized with one major fracture and an SRV region for each fracture stage. Then, an iterative ensemble smoother is used for history matching.

Guo et al. present an improved version of the interwell-numerical-simulation model (INSIM), a data-driven model for history-matching and prediction of future performance of waterflooding operations. The method approximates the reservoir by a set of 1D interwell connections, which unlike in streamline/streamtube methods are defined a priori before any computations are performed. In the improved version of INSIM, a semianalytical front-tracking method is used to compute saturation distribution within each 1D interwell connection.

To avoid high computational costs in ensemble-based history matching, it is common to use relatively small ensemble sizes. To mitigate resulting numerical issues such as ensemble collapse, Luo et al. propose a data-selection algorithm that only uses the observations that have relatively high correlations with the model variables to be matched.

He et al. present a new method for evaluating the effectiveness of and quantifying the value of data-acquisition programs. Their so-called ensemble-variance analysis method uses an ensemble of simulations to estimate the covariance between the observed data and the objective function, and then in turn uses this information to quantify the expected uncertainty reduction. Results of this analysis are combined with a decision tree to quantify the value of information of a given design so that different data-acquisition designs can be compared and the most cost-effective chosen.

Elahi and Jafarpour discuss how tracer-test and production data can be used to dynamically characterize important parameters of hydraulically fractured reservoirs such as matrix permeability and porosity, fracture half-length and hydraulic conductivity, discrete-fracture-network density and conductivity, and fracture-closing rate during production. An ensemble Kalman filter is used to first assimilate tracer-test data and then production data.

Model-based production optimization is a promising technique for improving reservoir management and asset development. Computed solutions are nonetheless in many cases not readily accepted by engineers because they are difficult to understand and implement in practice. Fu and Wen present a new method for generating smoother solutions and improving computational convergence.

In the last paper of the section, Shirangi et al. present a nested procedure for the joint optimization of economic project life and time-varying well controls. The outer loop uses an interpolation technique to optimize economic project life, whereas well settings are optimized by use of an adjoint-gradient approach in the inner loop.

Compositional Simulation. Conventional methods for multiphase flash calculations first obtain multiple phase solutions in a phase-split calculation and then correct these in a phase-stability analysis. Zhu et al. propose a unified algorithm that avoids finding multiple false solution. This increases robustness for complex phase behavior, in which multiple local minima of the Gibbs free energy are present.

Khait and Voskov present a new linearization method for thermal/compositional flow. Their key idea is to transform the discrete mass/energy equations so that space-dependent and state-dependent terms are separated, and then parameterize and interpolate the state-dependent terms over a uniform mesh.

Paterson et al. suggest two algorithms for isothermal flash calculations. The first algorithm uses chemical potentials and molar-phase amounts as iteration variables, whereas the second uses chemical potentials and phase volumes to co-solve a pressure-explicit equation of state with the equilibrium equations.

Gosh and Johns discuss how a dimensionless equation of state that is based on the HLD-NAC model can be extended to model alkali/surfactant/polymer flooding. Compared with Hand's rule, which is currently used in most chemical-flooding simulators, the new equation of state is noniterative, has fewer fitting parameters, and can determine tie lines/triangles accurately outside the range of experimental data.

Coarsening, Discretizations, and Solvers. Wang et al. present an embedded grid-free approach to improve the resolution of streamline simulation in the near-well region. A more-accurate flow field is computed inside each well block by the use of a virtual-boundary-element method. Streamlines are then traced accurately near the well by a fourth-order Runge-Kutta method and connected to the global streamlines computed by the standard Pollock algorithm.

The state-of-the-art approach to solve black-oil and isothermal compositional flow problems is to use a constrained-pressure residual (CPR) method with a scalar algebraic multigrid method (AMG) solving the extracted pressure subsystem. The paper by Gries discusses how system-AMG alternatively can be used to solve the whole discrete problem without the need to decouple pressure and fluid transport.

Hui et al. develop a general discrete-fracture-matrix framework for simulating complex recovery processes in fractured reservoirs. Fractures are represented as lower-dimensional objects, whereas a polyhedral-gridding technique is used to construct a volumetric representation of the matrix with adaptive mesh refinement near the fractures. A coarser representation of the model is generated by first aggregating cells from the fine mesh into coarse blocks, and then a general flow-based procedure is used to upscale two-point transmissibilities.

Du et al. propose a new method for coarsening the aquifer zone of high-resolution simulation models. Aquifer cells are amalgamated vertically into a single block or multiple blocks that are disconnected by flow barriers. To better preserve transient-water influx, fine-scale information is not upscaled a priori, but instead restricted to the coarse grid during each Newton iteration. Fine-scale variations can subsequently be reconstructed by use of a vertical-equilibrium assumption or by 1D solvers in the vertical direction.

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It is a great pleasure to welcome six new Associate Editors: **Luis Ayala** (Pennsylvania State University), **Zhiming Chen** (China University of Petroleum, Beijing), **Remus Hanea** (Statoil), **Chris Jablonowski** (Shell), **Saeid Khorsandi** (Pennsylvania State University), and **Mohammad Mian** (Saudi Aramco).

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