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New simulation framework for flow modeling of complex physical system

By

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A novel simulation framework for simulating flow in porous media for mixtures having an arbitrary number of phases will be presented. The behavior of components in any phase is computed using mixed phase equilibrium assumptions. This type of simulation is very important for modeling of natural and industrial processes, such as development of natural hydrocarbon resources, including gas-hydrates, CO2 injection into hydrocarbon reservoirs and saline aquifers, and for modeling of thermal processes. We use a Fully Implicit (FI) time approximation with general extension to the Adaptive Implicit Method (AIM) using flexible algebraic reduction. The framework is built on top of an Automatic Differentiation with Expression Templates Library (ADETL) which generates the corresponding derivatives for any nonlinear relation and helps to construct Jacobian matrix for the nonlinear solver. In this framework we manage to keep a unified computational structure for different compositional formulations and complex physical models, including thermal. Phase behavior for the new framework is calculated using standard multiphase flash with initial conditions (stability analysis) based on Compositional Space Parameterization (CSP), which helps to improve both efficiency and robustness of the standard Equation of State (EoS) computations. The general extension of two-phase variable substitution is used to handle the phase appearance and disappearance for systems with arbitrary numbers of phases. Examples will be presented including different types of CO2 injection in a hydrocarbon reservoir, such as miscible and immiscible two-phase CO2 injection, thermal injection of CO2+steam (three-phase), and cold CO2 injection (three phase with the second liquid CO2-rich phase).

Dr. Voskov joined Stanford University in 2005. He is currently a Senior Physical Research Associate in the Energy Resource Engineering Department. He received both his MSc (1998) and PhD (2002) degrees from Gubkin Russian University of Oil and Gas, all in Applied Mathematics. Dr. Voskov is a leading researcher in the thermal compositional simulation project. He is involved into development of General Purpose Research Simulator (GPRS) – the main research tool at Energy Resource Engineering Department. Dr. Voskov formerly worked at YUKOS Company as a leading specialist of Software Development Department (2002-2005). He was principal developer of the YUKOS in-house reservoir simulator and participated in several Field Development Projects. Prior to that, he worked at the Institute for Problems in Mechanics within the Russian Academy of Sciences as Senior an Engineer-Mathematician and participated in several projects with Schlumberger Geoquest.

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