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Thermal Compositional Simulator for Multiphase Flows in Near Wellbore Zone

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Extended Abstract

Simulation of the fluid flow in the rock formation near the wellbore has numerous applications in the oil and gas industry. Accurate simulation of the flows in the vicinity of the well, coupled with an adequate physical model and boundary conditions, provides an instrument for understanding the complex processes accompanying the production of natural hydrocarbons below saturation point, estimating the impact of these processes on well productivity, and developing the well production and the well stimulation strategies.

We consider a flow of multicomponent two-phase fluid. Each component could be present in the liquid and vapor phases and the phase transitions could occur. The fluid description is based on the cubic equation of state (e.g., Peng-Robinson). The system of component transport equations is complemented by the energy transport equations where the phase heat capacities and Joule-Thomson coefficients depend on pressure, temperature, and phase composition.

The simulation domain is assumed to be a generalized cylinder parallel to the wellbore axis OZ. The arbitrary triangulation in the OXY plane is needed for discretization of the well surface together with a possible fracture. The control volumes are formed around the nodes in 3D obtained as a Cartesian product of 2D nodes in OXY with 1D nodes in OZ. Time-dependent data from a sensor (e.g., pressure signal) could be used as a condition specified at the boundary.

We present several validation tests where the results of our simulator are compared with the results from a well-established commercial reservoir simulator and demonstrate capabilities of our code on the case with a typical production scenario.