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A fully-coupled discontinuous Galerkin spectral element method for two-phase flow in petroleum reservoirs[1] ANKUR TANEJA, JONATHAN HIGDON, University of Illinois at Urbana-Champaign — A spectral element method (SEM) is presented to simulate two-phase fluid flow (oil and water phase) in petroleum reservoirs. Petroleum reservoirs are porous media with heterogeneous geologic features, and the flow of two immiscible phases involves sharp, moving interfaces. The governing equations of motion are time-dependent, non-linear PDEs with strong hyperbolic nature. A fully-coupled numerical scheme using discontinuous Galerkin (DG) method with nodal spectral element basis functions for spatial discretization, and an implicit Runge-Kutta type time-stepping is developed to solve the PDEs in a robust, stable manner. Isoparameteric mapping is used to generate grids for reservoir and well geometry. We present the performance capabilities of the DG scheme with high-order basis functions to accurately resolve sharp fluid interfaces and a variety of heterogeneous geologic features. High-order convergence of SEM is demonstrated. Numerical results are presented for reservoir flows with various injection-production patterns. Typical reservoir heterogeneities like low-permeable regions, impermeable shale barriers, etc. are included in the numerical tests. Comparisons with commonly used finite volume methods and linear and quadratic finite element methods are presented.

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