# A posteriori error estimates, stopping criteria, and adaptivity for multiphase compositional Darcy flows in porous media

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## ABSTRACT

We derive a posteriori error estimates for the compositional model of multiphase Darcy flow in porous media, consisting of a system of strongly coupled nonlinear unsteady partial differential and algebraic equations. We show how to control the dual norm of the residual augmented by a nonconformity evaluation term by fully computable estimators. We then decompose the estimators into the space, time, linearization, and algebraic error components. This allows to formulate criteria for stopping the iterative algebraic solver and the iterative linearization solver when the corresponding error components do not affect significantly the overall error. Moreover, the spatial and temporal error components can be balanced by time step and space mesh adaptation. Our analysis applies to a broad class of standard numerical methods, and is independent of the linearization and of the iterative algebraic solvers employed. We exemplify it for the two-point finite volume method with fully implicit Euler time stepping, the Newton linearization, and the GMRes algebraic solver. Numerical results on two real-life reservoir engineering examples confirm that significant computational gains can be achieved thanks to our adaptive stopping criteria, already on fixed meshes, without any noticeable loss of precision.

**Key words**: a posteriori error analysis, adaptive algorithms, compositional Darcy flow, finite volume methods.

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