GLOBAL IMPLICIT SOLVER FOR MULTIPHASE MULTICOMPONENT FLOW IN POROUS MEDIA WITH MULTIPLE GAS PHASES AND GENERAL REACTIONS

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In order to predict the gas and liquid flow and the efficiency of trapping mechanisms (mineral trapping) for CO_2 storage in deep layers, the system to be solved consists of diffusion-advection-reaction partial differential equations (PDEs), algebraic equations (AEs) and ordinary differential equations (ODEs).

The choice of a suitable formulation of the equations is important for efficient numerical solution. We apply the Kräutle-Knabner PDE reduction method [1] which enables to eliminate the equilibrium reactions based upon specific variable transformations. Separating the resulting remaining PDE/ODE/AE system into a global and a local system, we apply a nested Newton solver method [2] which enables fast and efficient computation of the dynamics of the system by means of the application of parallel solvers to the Finite Element discretized / Finite Volume stabilized PDE system. Our computations of the behavior of the concentrations of the different species of the multiphase multicomponent flow are highly resolved in space and time. We study the mineral trapping scenario [3] using splines derived from experiments for the equations of state (EOS) which describe the interphase mass exchange of CO_2 and the density of CO_2. To this end, we present the work in progress concerning the elaboration and implementation of our methods into the software package M++ for the computation of a recent benchmark which inherits multiple gas phases [4].

References

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