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Numerical Investigation of Multiphase Flow in Pipelines

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Abstract : We present and analyze reliable numerical techniques for simulating complex flow and transport phenomena related to natural gas transportation in pipelines. Such kind of problems are of high interest in the field of petroleum and environmental engineering. Modeling and understanding natural gas flow and transformation processes during transportation is important for the sake of physical realism and the design and operation of pipeline systems. In our approach a two fluid flow model based on a system of coupled hyperbolic conservation laws is considered for describing natural gas flow undergoing hydratization. The accurate numerical approximation of two-phase gas flow remains subject of strong interest in the scientific community. Such hyperbolic problems are characterized by solutions with steep gradients or discontinuities, and their approximation by standard finite element techniques typically gives rise to spurious oscillations and numerical artefacts. Recently, stabilized and discontinuous Galerkin finite element techniques have attracted researchers’ interest. They are highly adapted to the hyperbolic nature of our two-phase flow model. In the presentation a streamline upwind Petrov-Galerkin approach and a discontinuous Galerkin finite element method for the numerical approximation of our flow model of two coupled systems of Euler equations are presented. Then the efficiency and reliability of stabilized continuous and discontinous finite element methods for the approximation is carefully analyzed and the potential of the either classes of numerical schemes is investigated. In particular, standard benchmark problems of two-phase flow like the shock tube problem are used for the comparative numerical study.

Keywords : discontinuous Galerkin method, Euler system, inviscid two-fluid model, streamline upwind Petrov-Galerkin method, twophase flow
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