Centro de Investigación en Ingeniería Matemática

Seminario de Análisis Numérico y Modelación Matemática

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Analysis of an augmented pseudostress-based mixed formulation for a nonlinear Brinkman model of porous media flow

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Resumen

In this work we introduce and analyze an augmented mixed finite element method for the two-dimensional nonlinear Brinkman model of porous media flow with mixed boundary conditions. More precisely, we extend a previous approach for the respective linear model to the present nonlinear case, and employ a dual-mixed formulation in which the main unknowns are given by the gradient of the velocity and the pseudostress. In this way, and similarly as before, the original velocity and pressure unknowns are easily recovered through a simple postprocessing. In addition, since the Neumann boundary condition becomes essential, we impose it in a weak sense, which yields the introduction of the trace of the fluid velocity over the Neumann boundary as the associated Lagrange multiplier. We apply known results from nonlinear functional analysis to prove that the corresponding continuous and discrete schemes are well-posed. In particular, a feasible choice of finite element subspaces is given by Raviart-Thomas elements of order $k \geq 0$ for the pseudostress, piecewise polynomials of degree $\leq k$ for the gradient, and continuous piecewise polynomials of degree $\leq k+1$ for the Lagrange multiplier. We also derive a reliable and efficient residual-based a posteriori error estimator for this problem. Finally, several numerical results illustrating the performance and the robustness of the method, confirming the theoretical properties of the estimator, and showing the behaviour of the associated adaptive algorithm, are provided.

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