CI²MA
Centro de Investigación en Ingeniería Matemática

Seminario de Análisis Numérico y Modelamiento Matemático de Estudiantes

A twofold perturbed saddle point–based fully mixed finite element method for the coupled Brinkman–Forchheimer/Darcy problem.

We introduce and analyze a new mixed finite element method for the stationary model arising from the coupling of the Brinkman–Forchheimer and Darcy equations. While the original unknowns are given by the velocities and pressures of the fluid and the porous medium, our approach is based on the introduction of the fluid pseudostress as a further variable, which allows us to eliminate the respective pressure. Needless to say, the latter can be recovered later on by a postprocessed formula that depends only on the former. In turn, aiming to perform a proper treatment of the transmission conditions, the traces on the interface, of both the fluid velocity and the Darcy pressure, are also incorporated as auxiliary unknowns. As a consequence, the resulting fully-mixed variational formulation can be seen as a nonlinear perturbation of, in turn, a twofold perturbed saddle point operator equation. Then, the fixed-point strategy arising from a linearization of the Forchheimer term, along with suitable abstract results exploiting the aforementioned structure, and the classical Banach theorem, are employed to prove the well-posedness of the continuous and discrete schemes. In particular, Raviart-Thomas and piecewise polynomial subspaces of the lowest degree for the domain unknowns, as well as continuous piecewise linear polynomials for the interface ones, constitute a feasible choice. Optimal error estimates and associated rates of convergence are established. Finally, several numerical results illustrating the good performance of the method and confirming the theoretical findings, are reported.

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