Least-squares finite element methods for coupled generalized Newtonian Stokes-Darcy flow

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The coupled problem for an instationary generalized Newtonian Stokes flow in one domain and a generalized Newtonian Darcy flow in a porous medium is studied in this work. Both flows are treated as a first order system in a stress-velocity formulation for the Stokes problem and a volumetric flux-hydraulic potential formulation for the Darcy problem. The coupling along an interface is done by using the well known Beavers-Joseph-Saffman interface condition. A least-squares finite element method is used for the numerical approximation of the solution. It is shown that under some assumptions on the viscosity the least-squares functional corresponding to the nonlinear first order system is an efficient and reliable error estimator which allows for adaptive refinement of the triangulations. The adaptive refinement is examined in a numerical example where boundary singularities are present. Due to the nonlinearity of the problem a Gauss-Newton method is used to iteratively solve the problem leading to a sequence of well-posed variational problems. It is shown that the variational problems arising in the Gauss-Newton method are well-posed.

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