AN ADAPTIVELY REFINED LEAST-SQUARES FINITE ELEMENT METHOD FOR NON-NEWTONIAN FLUID FLOWS

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Key words: *least-squares, adaptive mesh refinement, non-Newtonian fluid flows.*

The goal of this work concerns an adaptively least-squares method for the solutions of the generalized Newtonian and viscoelastic fluid flows based on the application of the least-squares minimization principle to an equivalent first order system of the Navier-Stokes equations. We provided an a prior error estimate for the linearized velocity-pressure-stress first-order system problem and showed numerical results supporting the estimate. To capture the flow region, we developed an adaptive mesh refinement approach based on the least-squares method. The generated refined grids agree well with the physical attributes of the flows. When we used continuous piecewise linear finite element spaces for all variables, properly adjusting the importance of the mass conservation and with adaptive mesh refinements, we obtained optimal convergence rates for all variables which are better than those of the theoretical prediction. Model problems considered in the study are the flow past a planar channel and 4-to-1 contraction problems. The results show that the adaptively refined meshes are automatic local grid refinement with different flow parameters, and the refinement results are of good quality. Finally, numerical experiments indicate that the method can be extended to more general 4-to-1 contraction problems without major difficulty.

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