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Augmented mixed finite element method for the Oseen problem: a priori and a posteriori error analysis *

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Abstract

We propose a new augmented dual-mixed method for the Oseen problem based on the pseudostress-velocity formulation. The stabilized formulation is obtained by adding to the dual-mixed approach suitable least squares terms that arise from the constitutive and equilibrium equations. We prove that for appropriate values of the stabilization parameters, the new variational formulation and the corresponding Galerkin scheme are well-posed, and a Céa estimate holds for any finite element subspaces. We also provide the rate of convergence when each row of the pseudostress is approximated by Raviart-Thomas or Brezzi-Douglas-Marini elements and the velocity is approximated by continuous piecewise polynomials. Moreover, we derive a simple a posteriori error estimator of residual type that consists of two residual terms and prove that it is reliable and locally efficient. Finally, we include several numerical experiments that support the theoretical results.

Mathematics Subject Classifications (1991): 65N30; 65N12; 65N15

Key words: incompressible flow, Oseen equation, mixed finite element, stabilized finite elements, a posteriori error estimator.

1 Introduction

The Oseen problem can be obtained as a linearization of the stationary incompressible Navier-Stokes equations. The most popular formulation in computational incompressible Newtonian flows is the

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