Peiyao Luo

Uzawa smoother in multigrid for coupled porous medium and Stokes flow system

Delft University of Technology
Mekelweg 4
2628 CD
Delft
The Netherlands
p.luo@tudelft.nl
Carmen Rodrigo
Francisco J. Gaspar
Cornelis W. Oosterlee

The multigrid solution of coupled porous media and Stokes flow problems is considered. The Darcy equation as the saturated porous medium model is coupled to the Stokes equations by means of appropriate interface conditions. We focus on an efficient multigrid solution technique for the coupled problem, which is discretized by finite volumes on staggered grids, giving rise to a saddle point linear system. Special treatment is required regarding the discretization at the interface. An Uzawa smoother is employed in multigrid, which is a decoupled procedure based on symmetric Gauss-Seidel smoothing for velocity components and a simple Richardson iteration for the pressure field. Since a relaxation parameter is part of a Richardson iteration, Local Fourier Analysis (LFA) is applied to determine the optimal parameters. Highly satisfactory multigrid convergence is reported, and, moreover, the algorithm performs well for small values of the hydraulic conductivity and fluid viscosity, that are relevant for applications.

KEY WORDS: Darcy equation, Porous medium, Stokes equation, Free flow, Coupling, interface conditions, Multigrid method, Uzawa smoother, local Fourier analysis