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Multiscale mixed domain decomposition methods for the simulation of heterogeneous black-oil flows

Monday, 30 May 2022 16:20 (15 minutes)

Multiscale domain decomposition methods have proven to be a reliable way for solving single and two-phase flows in porous media. Among the advantages, the possibility to speed up the parallel simulation of huge domains with nearly ideal performance, is perhaps the most useful for applications in uncertainty quantification. However, in applications such as petroleum reservoir simulation, a more complex black-oil model is often required, which allows the simulation of three different components (water, oil and gas) that form at most three different phases (aqua, liquid and vapor), with possible mass transfer between phases. Among the multiscale domain decomposition methods employed in the solution of such models, are the MMMFEM [1] and MSFV [2].

In this work, we extend the Multiscale Robin Coupled Method (MRCM), a multiscale domain decomposition method recently introduced by the authors [3], for the solution of compressible heterogeneous black-oil model. The MRCM generalizes known mixed methods through the suitable choice of Robin-type boundary condition parameters and the finite element spaces used to span the interface unknowns, introducing flexibility and the possibility of adaptive schemes that greatly increase accuracy when compared to standard techniques. The hyperbolic conservation laws are handled by high order conservative finite volume schemes, while the parabolic pressure equation is discretized by implicit schemes, allowing the application of the domain decomposition method in each time step of the simulation.

We employ a number of test cases to evaluate the application of the MRCM for black-oil simulations, in homogeneous and heterogeneous media. The results show that the MRCM, combined with suitable downscaling techniques, can be successfully employed for the solution of black-oil flows, with good accuracy as compared to the solution of undecomposed cases.

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Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

In person

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