Vertex Approximate Gradient Scheme for Hybrid Dimensional Two-Phase Darcy Flows in Fractured Porous Media

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This paper extends the Vertex Approximate Gradient (VAG) discretization of a two-phase Darcy flow model presented in [2] in order to take into account discrete fracture networks (DFN) including mass exchange between the matrix and the fracture. We consider the asymptotic model for which the fractures are represented as interfaces of codimension one immersed in the matrix domain with continuous pressures at the matrix fracture interface [1]. Compared with Control Volume Finite Element (CVFE) approaches [3], the VAG scheme has the advantage to avoid the mixing of the fracture and matrix rocktypes at the interfaces between the matrix and the fractures, while keeping the low cost of a nodal discretization on unstructured meshes. The convergence of the scheme is proved under the assumption that the relative permeabilities are bounded from below by a strictly positive constant but cover the case of discontinuous capillary pressures. The efficiency of our approach compared with CVFE discretizations is shown on a 3D fracture network with very low matrix permeability as exhibited in the Figure below.

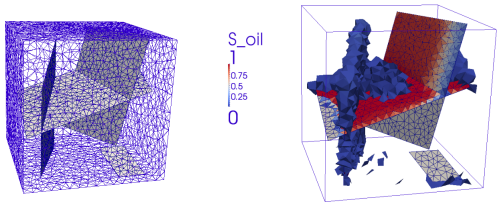

Figure 1: Tetrahedral mesh of the domain with fracture network and the discrete solution obtained by the VAG scheme at final time: oil saturation in the fracture network and in the matrix.

Références

[1] C. Alboin, J. Jaffr, J. Roberts, C. Serres, Modeling fractures as interfaces for flow and transport in porous media. In: Chen, Ewing, editors. Fluid flow and transport in porous media, vol. 295. American Mathematical Society, pp. 13-24, 2002.

[2] R. Eymard, C. Guichard, R. Herbin, R. Masson, Gradient schemes for two-phase flow in heterogeneous porous media and Richards equation, article first published online, ZAMM - Journal of Applied Mathematics and Mechanics, 2013. doi: 10.1002/zamm.201200206

[3] V. Reichenberger, H. Jakobs, P. Bastian, R. Helmig, A mixed-dimensional finite volume method for multiphase flow in fractured porous media, Adv. Water Resources 29 (7), pp. 1020-1036, 2006.

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