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Comparison of Fracture-Tip Models for Fluid Flow in Fractured Porous Media

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ABSTRACT

Single-phase incompressible fluid flow through a fractured porous medium is considered by looking for a pressure field p and a velocity field $\mathbf{v}$ such that

$$\begin{aligned} \mathbf{v} &= -\mathbb{K}\,\mathbf{grad}\,p, \\ \operatorname{div}\mathbf{v} &= q, \end{aligned}$$

for a given permeability field $\mathbb{K}$, source term q and appropriate boundary conditions. The description of the fracture(s) is given by a division of the problem domain Ω into a matrix part Ω_m and a fracture part Ω_f such that the associated permeabilities $\mathbb{K}_\mathrm{m}$ and $\mathbb{K}_\mathrm{f}$ may differ by several orders of magnitude and that the transversal extension of Ω_f is very small in comparison to its lateral extension.

The main interest of this contribution is to discuss the treatment of fracture tips, i.e., fractures ending inside the matrix domain. A discrete-fracture-matrix (DFM) model combined with the extended finite-element method (XFEM) is presented that admits independent grids for the fracture and the matrix domain [2]. A concept for the coupling between fracture and matrix flow at a fracture tip is investigated that admits flow across the tip by exchanging the corresponding fluxes. By means of benchmark examples [1], the results of the approach are compared with solutions from the literature as well as with reference solutions calculated by a mimetic finite difference method on highly resolved equi-dimensional discretizations of fracture and matrix domains.

REFERENCES

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