A discrete fracture model using a cell-centered finite volume scheme with multi-point flux approximation

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ABSTRACT

Geological porous media pose many challenges to the numerical models as one often has to deal with discontinuous full tensor permeability fields and complex geometries due to the presence of fractures in the form of e.g. joints, fissures and faults. The properties of the latter can vary substantially, e.g. they can act as preferential flow paths or barriers to flow, depending on the history of their creation. However, in many geotechnical engineering applications fractures play a very important role and their accurate description is a key quality characteristic for numerical models. Many different approaches have been developed in the past, ranging from geometrical representations of the fractures, e.g. discrete fracture models (DFM), to volume-averaged descriptions (multi-continuum models).

In this contribution we want to focus on a discrete fracture model, implemented into the open-source numerical simulator DuMuX [2], that includes the fractures as (n-1)-dimensional geometries in an n-dimensional domain. Fractures and solid matrix have individual meshes assigned to them with the restriction that the facets of the n-dimensional cells align with the (n-1)-dimensional fracture geometries. We use a cell-centered finite-volume scheme with multi-point flux approximation [1] in both sub-domains which leads to a locally conservative scheme and an explicit evaluation of the matrix-fracture fluxes. This paves the way to an accurate modelling of non-linear multi-phase flow and transport phenomena through fractured porous media, as well as the ability to handle fractures acting as barriers to flow.

REFERENCES

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[2] Kilian Weishaupt, Martin Beck, Beatrix Becker, Holger Class, Thomas Fetzer, Bernd Flemisch, Georg Futter, Dennis Gläser, Christoph Grüninger, Johannes Hommel, Alexander Kissinger, Timo Koch, Martin Schneider, Natalie Schröder, Nicolas Schwenck, and Gabriele Seitz. Dumux 2.9.0, March 2016.