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# Upscaling of Realistic Discrete Fracture Simulations Using Machine Learning

*Wednesday, 1 June 2022 12:00 (15 minutes)*

Fine-scale discrete fracture simulations provide a natural means to model fluid flows in fractured reservoirs. However, an application of discrete fracture modeling on the field scale is challenging due to uncertainties in fractures' properties, difficulties in creating conforming meshes, and the computational complexity of fluid flow simulations. Upscaling of flows in fracture networks has been traditionally used to cope with these challenges. One common approach is to use the dual porosity/dual permeability (DPDP) model (Hill and Thomas, 1985), where all fracture properties are encoded in effective coarse-scale fracture porosity, permeability, and a mass transfer term accounting for the crossflows between the fractures and the matrix.

Recent results (Andrianov and Nick, 2021; Andrianov, 2021) show that it is possible to map the pixelated fine-scale fracture geometry to the DPDP model closures via a convolutional neural network (CNN), and that the DPDP single-phase flow simulations with both reference and learned model closures agree reasonably well with each other. The goal of the present contribution is to extend these results to the case of two phases.

To this end, we simulate the fine-scale single-phase flow in each fractured coarse-scale grid block with a customized Discrete Fracture-Matrix (DFM) module of the open-source numerical simulator DuMuX (Flemisch et al., 2011). These simulation results are used to calculate the reference upscaled fracture permeabilities and to obtain the shape factors, which characterize the fracture-matrix mass transfer.

We demonstrate that the predicted model closures can be obtained by using the pre-trained CNNs from and implement the two-phase DPDP model on top of the dual porosity module of the open-source numerical simulator MRST (Lie, 2019). The DPDP results agree well with the fine-scale two-phase DFM solutions for a realistic fractured outcrop geometry.

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## MDPI Energies Student Poster Award

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## Country

Denmark

## References

Andrianov N. and Nick, H. M. 2021. Machine learning of dual porosity model closures from discrete fracture simulations. Advances in Water Resources, 147:103810. doi.org/10.1016/j.advwatres.2020.103810.

Andrianov, N. [2021] Upscaling of Realistic Discrete Fracture Simulations Using Machine Learning. Society of Petroleum Engineers (SPE). doi.org/10.2118/203962-MS

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## Time Block Preference

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

## Participation

In person

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**Session Classification:** MS15

**Track Classification:** (MS15) Machine Learning and Big Data in Porous Media