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Direct pore-scale two-phase transport simulation with interface transfer

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Multiphase multispecies transport is an essential field of studies for a wide range of engineering applications including acid gas treatment, waste water management and bubble column reactor. In particular, pore-scale investigations of subsurface processes have recently attracted a lot of attention in many domains such as oil and gas production, CO2 storage and contaminant hydrology. On the one hand, pore-scale experimental techniques allow a direct visualization of the different processes involved in 2D micromodels or in 3D rocks. On the other hand, pore-scale numerical models allow the mixing between phase and chemical species to be resolved on a pore-by-pore level. Numerical investigation of interfacial mass transfer can be done using Direct Numerical Simulation (DNS) of the Navier-Stokes Equation (NSE). DNS of two-phase flow can be performed using the Volume-Of-Fluid (VOF) method. VOF methods have been successfully applied to complex two-phase processes such as drainage and imbibition in complex 2D and 3D porous media. However, extending this work to multiphase multispecies transport in such complex porous media has proven to be a real challenge. One of the reason for this is the difficulty to transport a concentration field in the domain while insuring the continuity of fluxes and chemical potentials at the fluid/fluid interface. The objective of this work is to present a review of recent advancements in this domain, which allow us, for the first time, to simulate multiphase multispecies transport with the VOF method for a wide range of flow regime.

References

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Primary author: MAES, Julien (Heriot-Watt University)

Presenter: MAES, Julien (Heriot-Watt University)

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