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Simulation results for a multirate mass transfer modell for immiscible displacement of two fluids in highly heterogeneous porous media

Jan Tecklenburg (1), Insa Neuweiler (1), Marco Dentz (2), Jesus Carrera (2), and Sebastian Geiger (3)

(1) Institute of Fluid Mechanics in Civil Engineering, Leibniz Universität Hannover, Hannover, Germany, (2) Institute of Environmental Assessment and Water Research (IDÆA), Spanish Council of Scientific Research (CSIC), Barcelona, Spain, (3) Institute of Petroleum Engineering, Heriot-Watt University, Edinburgh, United Kingdom

Flow processes in geotechnical applications do often take place in highly heterogeneous porous media, such as fractured rock. Since, in this type of media, classical modelling approaches are problematic, flow and transport is often modelled using multi-continua approaches. From such approaches, multirate mass transfer models (mrmt) can be derived to describe the flow and transport in the “fast” or mobile zone of the medium. The porous media is then modeled with one mobile zone and multiple immobile zones, where the immobile zones are connected to the mobile zone by single rate mass transfer.

We proceed from a mrmt model for immiscible displacement of two fluids, where the Buckley-Leverett equation is expanded by a sink-source-term which is nonlocal in time. This sink-source-term models exchange with an immobile zone with mass transfer driven by capillary diffusion. This nonlinear diffusive mass transfer can be approximated for particular imbibition or drainage cases by a linear process.

We present a numerical scheme for this model together with simulation results for a single fracture test case. We solve the mrmt model with the finite volume method and explicit time integration. The sink-source-term is transformed to multiple single rate mass transfer processes, as shown by Carrera et. al. (1998), to make it local in time. With numerical simulations we studied immiscible displacement in a single fracture test case. To do this we calculated the flow parameters using information about the geometry and the integral solution for two phase flow by McWorther and Sunnada (1990). Comparision to the results of the full two dimensional two phase flow model by Flemisch et. al. (2011) show good similarities of the saturation breakthrough curves.

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