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Applicability of a multirate mass transfer model for immiscible displacement of two fluids to model two phase flow in fractured porous media

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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. Based on such approaches, we derived a multirate mass transfer (mrmt) model for immiscible displacement of two fluids in highly heterogeneous media including capillary forces by Homogenization theory (see Tecklenburg et. al. (2013)).

For the mrmt model the fractured media is represented by a mobile zone, where "fast" flow takes place, and an immobile zone. The immobile zone would be the rock matrix and the mobile zone would be the connected fracture network, where the fractures are represented by an equivalent porous media. The flow in the mobile zone is modelled by the Buckley-Leverett equation. This equation is expanded by a sink-source-term which is nonlocal in time to model the mass transfer between the mobile and the immobile zone. For immiscible displacement of two fluids the mass transfer can be driven by capillary diffusion. For particular imbibition cases this diffusive mass transfer process can be linearized.

In this contribution we test the applicability of the mrmt model for the two phase flow in two dimensional fracture networks. This is done with numerical simulations of immiscible displacement in fracture networks. We compare the results of the mrmt model and the results of a full two dimensional two phase flow model where the code dumux by Flemisch et. al. (2011) is used. The flow parameters for the mrmt model are calculated by analyzing fracture and matrix geometry and using the integral solution for two phase flow by McWorther and Sunnada (1990).

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