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Upscaling of a Cahn–Hilliard Navier–Stokes Model including Precipitation in a Thin Strip

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Multiphase flow and reactive transport are important in many applications, in particular in porous media. We consider the incompressible flow of two immiscible fluids in the presence of a solid phase changing due to precipitation and dissolution. We employ a ternary phase-field model on the pore scale, extending widespread models for two fluid phases by including a solid phase.

We upscale this model in the geometry of a thin strip. In the context of porous media the thin strip can be seen as the representation of a single pore throat. For scale separation we introduce β as the ratio between width and length of the strip. Using asymptotic expansions we investigate $\beta \rightarrow 0$ under moderate assumptions on Peclet number and Capillary number. The resulting multi-scale model consists of upscaled equations for total flux and ion transport, while the phase field equation has to be solved in cell-problems on the pore scale to determine the position of interfaces.

We also investigate the sharp interface limit of the multi-scale model. Here the diffuse interface width ε approaches zero and a sharp interface model is recovered. The resulting model consists only of Darcy-scale equations, as the cell-problems can be solved explicitly. The model is of hyperbolic nature, and we use numerical results to investigate the validity of the upscaling when discontinuities form in the upscaled model.

Time Block Preference

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

References

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