Contribution ID: **458** Type: **Oral Presentation**

Validation and calibration of interface conditions for Stokes-Darcy problems

Tuesday, 1 June 2021 15:55 (15 minutes)

Coupled free-flow and porous-medium systems described by the Stokes-Darcy equations are intensively studied in the last decade. Most of the coupling concepts are based on the Beavers-Joseph interface condition, which is developed for one-dimensional flows parallel to the fluid-porous interface. However, this condition is unsuitable for arbitrary flow directions [2], e.g. for industrial filtration problems. Alternative coupling concepts existing in the literature, e.g. [1] contain unknown coefficients, which need to be calibrated before they can be used in computational models. Pore-scale simulations play here an important role, both for the validation of the coupled macroscale models and for the computation and calibration of the effective model parameters.

In this talk, we present a comparison study of several coupling concepts for the Stokes-Darcy problem [3, 4]. Coupled macroscale models are validated numerically by comparison of the macroscale simulation results against the pore-scale resolved models. Effective parameters appearing in the alternative interface conditions [3] are computed numerically based on the geometrical configuration of the underlying problem. The exact location of the sharp fluid-porous interface and the Beavers-Joseph parameter in the classical conditions are optimized for different pore geometries. We show that the coupling conditions proposed in [3] are the most accurate ones and the Beavers-Joseph parameter cannot be fitted for arbitrary flows to the fluid-porous interface.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

[1] P. Angot, B. Goyeau, and J. A. Ochoa-Tapia: Asymptotic modeling of transport phenomena at the interface between a fluid and a porous layer: Jump conditions. Phys.Rev. E,95, 063302, 2017.
[2] E. Eggenweiler and I. Rybak: Unsuitability of the Beavers-Joseph interface condition for filtration problems. J. Fluid Mech., 892, A10, 2020.
[3] E. Eggenweiler and I. Rybak: Effective coupling conditions for arbitrary flows in Stokes-Darcy systems. SIAM Multiscale Model. Simul. (in press), 2021.
[4] I. Rybak, C. Schwarzmeier, E. Eggenweiler, and U. Rüde: Validation and calibration of coupled porous-medium and free-flow problems using pore-scale resolved models. Comput. Geosci., 2020, doi:10.1007/s10596-020-09994-x

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Session Classification: MS9

Track Classification: (MS9) Pore-scale modelling