MAT254 Flow in Porous Media (Spring 2018)

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Lecture Structure

1 Single phase flow in porous media.

- Darcy's law. Hydraulic head. Hydraulic conductivity and permeability.
- Conservation laws and governing equations.
- Energy conservation.
- Model simplifications. Analytical solutions. Reduction of dimensionality.
- Numerical methods.

2 Two-phase flow in porous media.

- Two-phase flow.
- Capillary pressure/Hysteresis.
- Richards' equation.
- Non-standard models.
- Buckley-Leverett solution.
- Numerical methods.

3 Solute transport in porous media.

- One-component transport.
- Multicomponent reactive transport.
- Numerical methods.

4 Flow in deformable porous media.

- The Biot equations.
- Numerical solvers for the Biot model.

I will mainly follow the book [7]. The references below are covering the rest.

References

[1] M. Bause, F. A. Radu and U. Koecher, *Space-time finite element approximation of the Biot poroelasticity system with iterative coupling*, Computer Methods in Applied Mechanics and Engineering 320 (2017), pp. 745-768.

[2] M. Borregales, F.A. Radu, K. Kumar and J.M. Nordbotten, *Robust iterative schemes for non-linear poromechanics*, arXiv:1702.00328, 2017.

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[4] A. Mikelic and M.F. Wheeler, *Convergence of iterative coupling for coupled flow and geomechanics,* Comput. Geosci. 17 (3) (2013), pp. 455-461.

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[7] J.M. Nordbotten and M. A. Celia, *Geological Storage of CO2: Model- ing Approaches for Large-Scale Simulation*, 2011, John Wiley and Sons, Inc.

[8] F. List and F.A. Radu, *A study on iterative methods for Richards' equation*, Computational Geosciences 20 (2016), pp. 341-353.

[9] I. S. Pop, F.A. Radu and P. Knabner, *Mixed finite elements for the Richards' equation: linearization procedure*, J. Comput. and Appl. Math. 168 (2004), pp. 365-373.

[10] F.A. Radu, I.S. Pop and P. Knabner, *On the convergence of the Newton method for the mixed finite element discretization of a class of degenerate parabolic equation*, In Numerical Mathematics and Advanced Applications. A. Bermudez de Castro et al. (editors), Springer, 1194-1200, 2006.

[11] F. A. Radu, J. M. Nordbotten, I. S. Pop and K. Kumar, *A robust linearization scheme for finite volume based discretizations for simulation of two-phase flow in porous media*, J. Comput. and Appl. Math. 289 (2015), pp. 134-141.

[12] F. A. Radu, K. Kumar, J. M. Nordbotten and I. S. Pop, *A convergent mass conservative numerical scheme based on mixed finite elements for two-phase flow in porous media*, arXiv:1512.08387, 2015.

[13] F. A. Radu, *Mixed finite element discretization of Richards' equation: error analysis and application to realistic infiltration problems*, PhD Thesis, University of Erlangen, Germany (2004).

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