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Some analytical results about countercurrent capillary imbibition.

Monday, 30 May 2022 11:20 (15 minutes)

Capillary imbibition is a major process that controls many transport phenomena in porous media for many applications. In the countercurrent case, the process may be represented as the solution of a strongly non-linear diffusion equation $\partial S(x,t)/\partial t = \nabla.[D(S(x,t))\nabla S(x,t)]$ in which S(x, t) denotes the wetting fluid saturation at position x at time t. The function D(S) depends non linearly on S through an expression involving relative permeabilities and capillary pressure. D(S) vanishes as a power law near the extreme saturations, leading to a singular boundary problem that was investigated by many authors. Considering a finite block, two time regimes can be observed: a short time regime involving the Boltzmann variable x/⊠t, and a long time asymptotic regime that remains to be elucidated. We found an ansatz was proposed that yields a complete analytical determination of the spatial part of the asymptotic long time behavior of S(x, t). The corresponding flux at the boundary of the block exhibits a two regimes that may be represented as a non-linear exchange term involving the average saturation on the block, weighted by a shape factor. This feature is well-suited for setting-up a macroscopic dual porosity description.

Selected references.

Abd, A. S., Elhafyan, E., Siddiqui, A. R., Alnoush, W., & Blunt, M. J.(2019).A review of the phenomenon of counter-current spontaneous imbibition: analysis and data interpretation.Journal of Petroleum Science and Engineering,180 456-470.

Hansen, A., Flekkøy, E. G., & Baldelli, B.(2020).Anomalous diffusion in systems with concentration-dependent diffusivity: exact solutions and particle simulations. Frontiers in Physics,8(519624).

Heaslet, M. A., & Alksne, A.(1961).Diffusion from a fixed surface with a concentration-dependent coefficient.J. Soc. Indust. Appl. Math.,9(4), 584-596.

Kashchiev, D., & Firoozabadi, A.(2003, December).Analytical solutions for 1d345countercurrent imbibition in water-wet media.SPE Journal, 401-408.

Li, L., Wang, M., Shi, A.-F., Liu, Z.-F., & Wang, X.-H.(2020).An approximate analytical solution for one-dimensional imbibition problem in low-permeability porous media.Journal of Porous Media,23(7), 683-694

Tavassoli, Z., Zimmerman, R. W., & Blunt, M. J.(2005).Analytical analysis for oil recovery during counter-current imbibition in strongly water-wet systems.Transport in Porous Media,58, 173-189

Braconnier, Douarche, Momeni, Quintard and Noetinger, About non-linear diffusion in porous and fractured media: Early- and late-time regimes, submitted

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Time Block Preference

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

Participation

In person

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