Towards more robust and accurate computations of capillary effects in the simulation of multiphase flows in porous media

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The simulation of the water flow in partially saturated porous media is significant in fields such as agriculture, hydrology, environment and waste management. Neglecting the air pressure, the Richards' equation is often used to model the movement of water in an unsaturated porous medium under the action of gravity and capillarity. It is a nonlinear, degenerate elliptic-parabolic partial differential equation whose resolution by means of analytical or numerical techniques is difficult.
Over the years, several researchers have worked on this model in view of improving the robustness of nonlinear solvers such as Newton's method. One popular approach consists in switching the primary variable between the saturation and the pressure. In practice, the problem is solved in saturation in poorly saturated regions and in pressure elsewhere.
Here we consider the method proposed in the paper [1]. This method introduces a fictitious variable parametrizing the nonlinear relation between saturation and pressure and therefore can be seen as a generalization of the classical variable switch. In this work a numerical validation of this technique is performed on different benchmarks.

Références

[1] Brenner, K. and Cancès, C., *Improving Newton's Method Performance by Parametrization: The Case of the Richards Equation*, SIAM Journal on Numerical Analysis, 2017.

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