Two-phase Flow in a Quasi-2D Porous Medium: Influence of Boundary Effects in the Measurement of Pressure-Saturation Relationships

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ABSTRACT

We have performed two-phase flow experiments and simulations to analyze the drainage from a quasi-2D random porous medium [1]. The medium is transparent, which allows for the visualization of the invasion pattern during the flow (Figure 1) and is initially fully saturated with a viscous fluid (a dyed glycerol-water mix). As the capillary pressure (pressure difference between the non-wetting and wetting phases) is gradually increased, air begins to penetrate from an open inlet, thus displacing the fluid which leaves the system from the outlet in the opposite side.

A feedback mechanism was devised to control the experiment: the capillary pressure is continuously increased to be just above the threshold value necessary to drive the invasion process. This mechanism is intended to keep the invasion process slow, in the so-called capillary regime, where capillary forces dominate the dynamics. Pressure measurements and pictures of the flow are recorded and the pressure-saturation relationship is computed. The effects of boundary conditions to this quantity are verified both numerically and experimentally by repeatedly performing the analysis using porous media of different sizes. We show that some features of the pressure-saturation curve are strongly affected by boundary effects. The invasion close to the inlet and outlet of the model are particularly influenced by the boundaries and this is reflected in the phases of pressure building up in the pressure-saturation curves, in the beginning and end of the invasion process respectively. Conversely, at the central part of the model (away from the boundaries), the invasion process happens at an essentially constant capillary pressure, which is reflected as a plateau in the pressure-saturation curve.
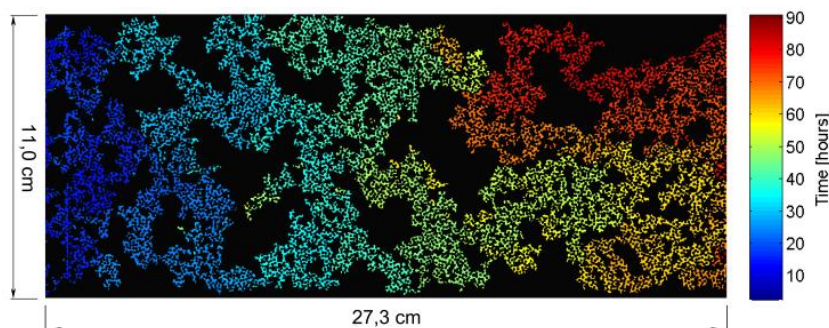
Figure 1: Experimentally measured spatiotemporal evolution of the drainage process.

References

1. M. Moura, E.-A. Fiorentino, K. J. Måløy, G. Schäfer and R. Toussaint, Impact of sample geometry on the measurement of pressure-saturation curves: experiments and simulations, submitted to **Water Resources Research**.