Effects of Dynamic Capillary Pressure on Two-phase Flow in Porous Media

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Abstract

Standard theories for two-fluid flow in porous media assume capillary pressure to be in equilibrium. We will present novel pore-scale and Darcy-scale theoretical approaches that account for a dynamic capillary pressure. I present analytical solutions for flow in capillary tubes that account for a velocity-dependent contact angle and that can be used to construct a general phase diagram. We also modify the Darcy-scale Green-Ampt approach for infiltration to account for a capillary pressure that depends on the flow velocity. We show that the new model describes infiltration experiments better than the classical Green-Ampt approach. Finally we generalize Richards' equation to account for a velocity-dependent capillary pressure.