IMMISCIBLE DISPLACEMENT EXPERIMENTS AND NUMERICAL SIMULATIONS IN 2D AND 3D POROUS MEDIA

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ABSTRACT

Aqueous suspensions and Pickering emulsions of iron oxide nanoparticles are synthesized and stabilized by exploiting the polyphenols extracted from plant leaves. These fluids are tested as agents for removing oil from porous media, with applications in enhanced oil recovery (EOR) from reservoir rocks and the remediation of soils polluted with non-aqueous phase liquids (NAPLs) [1]. Rate-controlled immiscible displacement tests are conducted in a 2D transparent glass-etched pore network and a sandstone core plug. The transient responses of fluid saturation and pressure drop across the porous medium are correlated with fluid properties and flow conditions. The 3D pore space of the sandstone is reconstructed using high-resolution CT-scan images, and 3D pore-and-throat networks are used to simulate quasi-static drainage/imbibition processes and produce capillary pressure and relative permeability curves. These curves serve as input data in a dynamic network-type simulator for calculating transient pressure drop and fluid saturation as functions of dimensionless flow parameters. Additionally, employing the phase-field approach [2], direct numerical simulation of immiscible displacement is performed in a 2D capillary network reconstructed from an image of the glass micromodel [3]. Different windows of the micromodel were extracted and arranged in a row, where the outlet of the first window serves as the inlet of the next, allowing for a gradual progression towards simulating the entire micromodel. In the numerical model, the Cahn-Hilliard equation is utilized to predict phase distribution under varying values of viscosity ratio, κ ($=\mu_{injected}/\mu_{displaced}$), Reynolds number, and Capillary number. The numerically predicted transient flow pattern is subsequently analyzed to enhance our understanding of flow dynamics within such porous media.

KEYWORDS: porous network, immiscible displacement, numerical simulation

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