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Control of immiscible displacement in fractures by aperture variability and wettability ZHIBING YANG, State Key Laboratory of Water Resources and Hydropower Engineering, Wuhan University, Wuhan, China, YVES MEHEUST, Universite de Rennes 1, Geosciences Rennes (UMR CNRS 6118), Rennes, France, INSA NEUWEILER, Institute of Fluid Mechanics and Environmental Physics in Civil Engineering, Leibniz University Hannover, Germany — Fractures are ubiquitous in nature, in particular in the subsurface. Understanding and controlling fluid-fluid displacement in fractures is key to many applications. Under a lubrication approximation they can be considered a particular type of 2D porous media. We study primary drainage in rough-walled fractures in this framework. We focus on the combined effect of wettability and fracture surface topography on displacement patterns and interface growth. A minimal computational model has been developed to simulate dynamic fluid invasion under the combined influence of viscous and capillary forces. Viscous pressure drops are obtained by solving the fluid pressure field in both fluids. The aperture field of a fracture is modeled by a spatially correlated random field, self-affine up to a given cutoff length. The model reproduces displacement patterns of stable displacement, capillary fingering and viscous fingering, as well as the transitions between them. Results show that the displacement outside of the viscous fingering regime can be stabilized by reducing the aperture variability and/or increasing the contact angle (from drainage to weak imbibition). This stabilization can be attributed to the influence of in-plane curvature, an effect analogous to that of the cooperative pore filling in porous media.

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